



## Reference Model for Generic Capabilities in Maturity Models

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Jan Merkus, Remko Helms and Rob Kusters

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# REFERENCE MODEL FOR GENERIC CAPABILITIES IN MATURITY MODELS

*Jan Merkus*

*Department of Information Science  
Open Universiteit Nederland  
Valkenburgerweg 177 Heerlen  
+31 (0) 45 - 576 22 22  
Jan.Merkus@ou.nl*

*Remko Helms*

*Department of Information Science  
Open Universiteit Nederland  
Valkenburgerweg 177 Heerlen  
+31 (0) 45 - 576 22 22  
Remko.Helms@ou.nl*

*Rob Kusters*

*Department of Information Science  
Open Universiteit Nederland  
Valkenburgerweg 177 Heerlen  
+31 (0) 45 - 576 22 22  
Rob.Kusters@ou.nl*

## ABSTRACT

**Context** - Many Maturity Models (MMs) have been designed for over 40 years now but selecting the constructs which chart the application areas is at variance. When comparing MMs, application area-specific constructs appear to be diverse. Nevertheless, some constructs are often similar.

**Objective** - This research aims at finding generic constructs in existing MMs as reference for constructing MMs.

**Method** - We conducted literature research for generic MM constructs in organisational readiness MMs. We applied card sorting as a classification method and sorted cards according to Metaplan technique with peers.

**Results** - This research resulted in a limited set of generic capabilities for constructing MMs. Organising these capabilities according to widely accepted reference models in Information Systems (IS) literature results in the Generic Capability Reference (GCR) model.

**Conclusion** - The GCR model serves as a reference model for (re-) designing MMs for the part of the generic capabilities in MMs besides application area-specific capabilities.

## CCS Concepts

**Software and its engineering** → **Software creation and management** → **Software development process management** → **Software development methods** → **Capability Maturity Model**

## Keywords

Maturity model; reference model; organisational readiness; capabilities.

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## 1. INTRODUCTION

In Information Systems (IS) research, many maturity models (MM) have been developed over the years [1]. MMs measure an organisation's status quo by means of a model with separate maturity stages for a set of constructs outlining a specific

application area [2], [3]. Designing a MM requires the selection of the proper constructs [4]. When designing MMs, most researchers start from scratch in identifying constructs for their MM.

However, that is not necessary because, when comparing existing MMs, generic constructs to design MMs seem to exist. That implies a reference model in which these generic constructs could be useful. Maybe such a reference model already exists, but we could not find one in literature, and therefore this is a knowledge gap. To fill this gap and add new knowledge, our research objective is to find generic constructs in existing MMs and compose a reference model of generic constructs. Consequently, our research question is: what are generic constructs in existing MMs?

The theoretical relevance of this research is to compose a new reference model which serves to construct MMs generic constructs. With these generic constructs already given, researchers only have to select the appropriate generic constructs from the reference model suitable for their MM and complete it with application area-specific constructs. The practical relevance is that MM designers save time in finding proper generic constructs and only have to find constructs which specifically outline their application area. Also, the quality of the MMs improves because MM designers do not overlook relevant constructs.

To find generic constructs, we conduct a literature review and classify the constructs found. Below we describe the theoretical background of our research. Then we describe our LR method and research findings. Next, we present the results of our classification with the resulting reference model. Finally, we offer further discussion and implications.

## 2. THEORETICAL BACKGROUND

In IS history, Maturity Models have been developed for almost 50 years. In 1973, Nolan presented his staged model with the first notions of a MM model [5]. Nolan's stage hypothesis about growth towards a final maturity stage in tasks for managing the computer resource in organisations started by differentiating four stages at first and six stages in a later version [6]. Also, in 1979, Crosby presented his quality management maturity grid aiming at the organisational improvement of quality using five different maturity stages [7]. In 1993, Paulk and Curtis designed the widely recognised Capability Maturity Model (CMM) which they developed into CMMi later on. This MM measures how a software organisation matures its development activities and maintenance processes [8].

All three models presented differentiated maturity stages, where a different set of activities identified each stage. Furthermore, maturation was achieved by growth from stage to stage for the entire organisation. Later on, many MM designers followed the

example of the CMM(i) model. Although most of them identify activities per maturity level per application area, this granulation enables different maturity scores per organisational aspect within a single organisation [1], [4], [9].

Around 2010, MM design became more structured with a MM design procedure model [2], [10], [11]. According to this research, MMs determine the status quo of an organisations capability by activities occurring in the organisation. MMs also describe possible organisational improvements by naming activities for all maturity levels. To measure maturity, a set of maturity levels is applied to a relevant set of application area constructs often represented in a tabular format.

MM designers are quite uniform in selecting their four to six maturity levels. But they are very diverse in naming their application area constructs which chart the chosen application area [4], [12]. MMs name these constructs capabilities [13]–[16], capacity, category, dimensions, factors, accountabilities [17]–[20]. For clear language reasons and because capability expresses readiness, we choose to name the constructs capabilities. We base this on the definition of organisational capabilities in recent literature: “a partial representation of the collective ability to carry out specific business processes across a network in a cyclical, efficient, and relatively predictable manner to contribute towards organisational performance” [21]. The resulting table is used as an assessment tool operationalised by assessment criteria in each table cell. See figure 1 Maturity Model format.

**Maturity Model**

Constructs \ maturity levels	1	2	3	4	5
Capability A					
Capability B					
Capability C					

**Figure 1 Maturity Model format**

MM designers also seem to select their capabilities only depending on the chosen application area, which results in apparently very diverse MMs. But there might be commonalities between MMs. We see quite some MMs with the same capabilities indicating that generic capabilities in MMs exist next to specific capabilities. For example, Luftman’s Business-IT alignment MM describes specific application area capabilities, but also generic capabilities, e.g. communication or strategy planning [17]. We also see that articles describing MMs with the same capabilities mention organisational readiness quite often. We agree with researchers who interchange organisational maturity with organisational readiness [22]. So, we suppose that MMs containing generic capabilities can be found in articles mentioning organisational readiness.

However, we have searched the literature and could not yet find a reference model that reveals these generic capabilities in MMs. The absence of such a reference model presumes a knowledge gap in describing generic capabilities in MMs. Although, a reference model of generic capabilities (GCs) is useful to guide MM design based on earlier MM research.

### 3. METHOD

To find GCs in literature, we use the following strategy. First, we search IS literature for existing MMs to identify GCs and to verify

if these even exist by comparing MMs. Next, we apply classification as a strategy for structuring the capabilities found. We select open card sorting as an approach. Open card sorting merges various inputs into a single list of groups. Each group is described according to the generic pattern of the cards in that group. With abstracting the generic pattern from the grouped capabilities, we differentiate generic capabilities from application area specific capabilities. Last, we organise the GCs found into a reference model to show the overall structure between grouped GCs and the relationships with other IS models.

### 3.1 Literature Research

Finding relevant generic capabilities in existing MMs requires literature research (LR). We base our LR method for finding generic capabilities on literature of Kitchenham and Okoli [23], [24]. We conduct our LR in three steps iteratively to balance and refine the results while gaining insights.

1. **Search for articles** in IS literature in the Dutch Open University online library and also Google Scholar including all relevant articles of all times and not just a sample. We identify other relevant articles with back and forward snowballing e.g. SLRs on MMs. We choose organisational readiness limiting criterium because MM literature in IS is too extensive for a full search and articles mentioning organisational readiness include MMs that not only deal with specific but also generic capabilities. After learning from other MM SLRs and conducting example searches, we define the final search query with the keywords (“*maturity model*” OR “*capability model*”) AND (“*organizational readiness*” OR “*organisational readiness*”) where organisational both with UK and American English (s/z) keywords.

2. **Practical screening** of found articles and remove duplicate studies for selecting relevant literature. As exclusion criteria, we only select articles which describe the constructs of the proposed MMs. Also, we choose only research presenting MMs based on proper empirical MM testing to follow up on the criticism of the lack of empirical testing of MMs [25]. This critic advises to reconcile existing MMs and prove its validity and usefulness in experimental studies. Next, we screen title, abstract and keywords of the retrieved studies for focus on our research question. We review potentially relevant studies and discuss its selection. At last, we identify and list the final set of relevant studies.

3. **Quality appraisal** by identifying literature will be based on applicable quality criteria and exclusion criteria from Systematic LR literature for clean and precise results [23], [24], [26]. For quality criteria, we select blind peer review juried journal or conference articles written in English. Furthermore, we select on traceability of used literature, rigour in research method, the credibility of the findings and relevance for research and practice.

4. **Data Extraction** will be achieved by reviewing the entire content of the selected studies. We will extract our research data by listing all the capabilities from all the MMs described in the selected articles.

### 3.2 Capabilities Classification

For classification, we proceed with our research according to the two following steps.

5. **Analysis** of the selected studies and listed capabilities will be achieved by using the classification strategy to harmonise different levels of abstraction in MMs for clear language. To understand and categorise all the capabilities found, we choose the open card sorting approach, which can handle a large number of results from literature [27], [28]. We choose card sorting because it allows all

involved persons together to simple and quickly structure large quantities of results by only handling surface characteristics like capability names. Still, agreement among participants demands tacit knowledge from each of them to find structure. We also will not predefine groupings because there is no knowledge about this topic

**Metaplan technique** is selected as the technique to execute the card sorting [28]. Metaplan is a proven technique to cluster many ideas in a short period effectively and was invented to improve group meetings effectiveness. Preventing deadlock as researchers bias and error, we will select a group of at least three researchers who conduct research and are familiar with the selected research field, thus also achieving a degree of intersubjectivity. They work actively together in clustering ideas into categories rather quickly without too much arguing thus being effective and efficient. The timeframe should not extend three hours for concentration reasons [28]. Our Meta-plan group protocol distinguishes three steps. First, one of the group members prints each capability of each maturity model found on separate paper cards. Second, all group members together cluster the paper cards in category stacks based on a peer discussion. The discussion is led by one of the group members who divides the cards into stacks. Clustering is achieved by adding each card individually either to an existing group or by creating a new group (whereby the first card by definition forms a new group). Third, we code the resulting stacks on basis of the meaning of the cards in the category.

### 3.3 Reference model design

Designing the reference model will be achieved in the final step 6.

6. **Syntheses** of the coded card stacks into a conceptual model is grounded in literature by using the category codes from the referenced literature to build the resulting model. Also, we try to align our resulting model to other reference models and theory in literature.

## 4. RESULTS

Conducting research according to above method resulted in LR outcomes, classification outcomes and resulting reference model as follows.

### 4.1 LR Results

In 2019 we conducted above described LR method iteratively while gaining more insights and found the following results. For step 1, while experimenting, we identified additional selection criteria and excluded “management for change” as being a different research field. For step 2, practical screening and selection on general organisational readiness capabilities relevance led to the choice of only 12 articles of the 905 found. Backward snowballing from MM SLR studies resulted in eight extra articles on Organisational Readiness MMs. For step 3 quality appraisal, the reviewed articles were screened for the selection criteria and for empirically validated MMs. The number of relevant articles found according to step 1 to 3 is shown in table 1 LR article selection steps.

This funneling resulted in the list of selected articles as given in table 2 *Maturity Models Article Selection*. The 21 MMs from these articles cover a diverse variety of application areas within and outside the IS research domain. The list of researched organisations includes not only commercial enterprises but also government organisations indicating the broad perspective of the scope of organisations. Moreover, application areas are outlined by from different types of constructs varying from generic areas to specific CSFs and generic or specific capabilities. Also, the used maturity levels have different origins than CMM, which contains rather specific capabilities. So the set of considered MMs found in our LR

is not too limited to a specific application area but wide enough to conclude on generic capabilities.

As column *Application area* together with column *Application area Construct types* show, many MMs used application area-specific capabilities [1]. A MM outlines an application area by several capabilities abstracted from processes, areas, critical success factors (CSFs) or other relevant capabilities. Although, when comparing capabilities in the selected MMs, we noticed similar capabilities reoccurring among MMs. More specifically, we see a variety of application area-specific capabilities but also quite some similar GCs. We conclude that MM designers use the same GCs more often across models.

**Table 1. LR article selection steps**

	<b>Step 1 Article Search</b>	<b>Step 2 Practical Screening</b>	<b>Step 3 Quality Appraisal</b>
Dutch Open University library	67	2	2
Google Scholar	838	12	11
Backward snowballing SLRs	-	8	8
<b>Total</b>	<b>905</b>	<b>22</b>	<b>21</b>

### 4.2 Classification outcomes

For data extraction, all MMs were extracted from the selected articles. The capabilities were registered, resulting in a list of 127 capabilities. In 2019, we held the Metaplan session together with the three authors of this article while executing the protocol steps, see figure 2 *Card sorting*.



**Figure 2 Card sorting**

The session took about two and a half hours. Clustering the 127 cards with all three peers resulted in 13 stacks of various numbers of paper cards but clear grouping based on meaning. Then, the card stacks are coded based on the meaning of the cards in the stack. The meaning of the capability stack codes is quoted from the capability descriptions in the referenced articles, or from well-known reference models if present, as given in table 3 *Capability descriptions*.

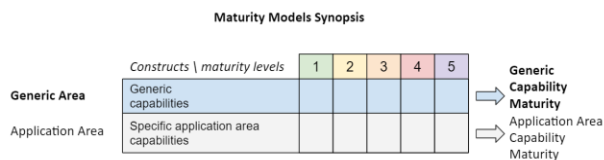
**Table 2. Maturity Models Article Selection**

#	Author	Ref	Application area	Application area Constructs types	Maturity level origin
1	Karandikar, Fotta, Lawson, & Wood, 1993	[29]	Concurrent engineering	Generic areas	CMM
2	Luftman, 2003	[17]	Business IT Alignment	Own areas	CMM
3	Rosemann & Bruin, 2005	[30]	Business Process Management	CSFs	CMM
4	Batenburg, Helms, & Versendaal, 2006	[31]	Product Life-cycle Management	Generic areas	CMM
5	Hammer, 2007	[15]	Process and Enterprise Maturity	Capabilities	Self-defined
6	R. Batenburg & Versendaal, 2008	[32]	Procurement	Procurement areas	Purchasing MM
7	Tapia, Daneva, Van Eck, & Wieringa, 2008	[33]	Business IT Alignment	Generic areas	CMM
8	Rohloff, 2009	[18]	Business Process Management	CSFs	CMM
9	Abu Khadra et al., 2009	[19]	IT Governance	Cobit areas	Cobit
10	de Bruin, 2009	[3]	Business Process Management	CSFs + capabilities	CMM
11	Mouzakitis & Askounis, 2010	[34]	Business 2 Business	Capabilities	Self-defined
12	Hidayanto, Shihab, & Kristianto, 2012	[35]	Business Intelligence	CSFs	eGov procurement
13	Dyk van & Schutte, 2012	[36]	Telemedicine Implementation	eReadiness areas	CMM
14	Cleven et al., 2014	[16]	Business Process Management	Capabilities	CMM
15	Janom, Arshad, Zakaria, Syed Aris, & Salleh, 2014	[37]	B2B E-commerce	CSFs	Self-defined
16	Ossama Matrane & Talea, 2014	[38]	Information Security	CSFs	CMM
17	Mirarab, Fard, Reza, & Kenari, 2014	[39]	Service oriented architecture	Capabilities	Self-defined
18	Hejazi et al., 2016	[40]	Business Intelligence	CSFs	CMM
19	Schumacher, Erol, & Sihm, 2016	[41]	Industry 4.0	Generic areas	CMM
20	Brennan et al., 2018	[21]	Data Value Chains	Capabilities	CMM
21	Lak & Rezaenour, 2018	[42]	Customer knowledge management	CSFs	CMM

MMs may describe more generic capabilities [8], [15], [30], [43]. And these general generic capabilities are validated more than once in several MMs over the years. In other words, when (re-)designing a MM, a MM designer could select generic capabilities relevant for his topic and complete the MM with specific application area capabilities.

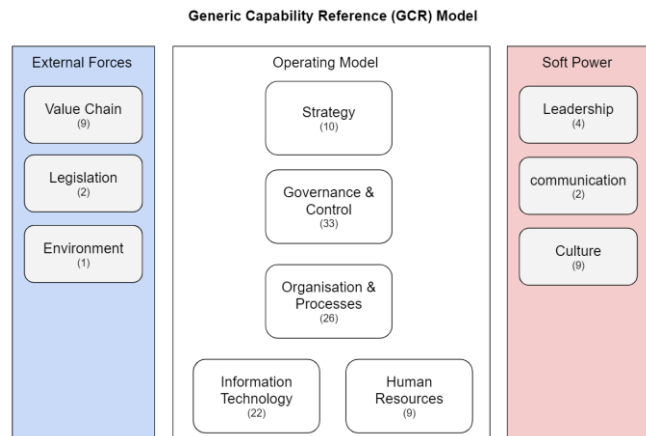
### 4.3 Generic Capability Reference model

Finally, all the coded card stacks are organised into a conceptual model, see Appendix *Generic Capabilities Classification*. Thus synthesising the GCs resulted in our generic capability reference model as given in *figure 4 Generic Capability Reference (GCR) model* with the number of cards given per category.



**Figure 3. Maturity Model Synopsis**

Furthermore, a mature organisation possesses an ability for managing a process [8] p.2., or an application area or even the organisation itself. As opposite of specific application area capability maturity, generic capabilities indicate a more generic capability maturity. Therefore, we could introduce a new concept generic capability maturity which is the ability of an organisation to manage the organisation for the area specific application of the generic capabilities. How generic capability maturity is distinguished from application area capability maturity is shown in figure 3 *Maturity Models Synopsis*.



**Figure 4. Generic Capability Reference (GCR) model**

The coded stacks are grouped into three capabilities clusters according to three organisational models in IS literature; operating model, external forces, soft power.

The first cluster *Operating model* resembles McKinsey's 7S model and Scott Morton's MIT90s framework nearly [44], [45]. But this cluster is arranged differently according to the strategic planning logic strategy – tactics – operations as applied in the strategic alignment model of Henderson & Venkatraman and Maes' generic framework for the business IT relationship [46], [47]. The cluster title *operating model* is chosen because it contains all the hard factors strategy, structure and systems of the 7S-model. This category also resembles the organisational operating model with people, processes and technology as core capabilities [48]–[50].

The second cluster *External Forces* is clustered according to the five forces model of Porter with five forces grouped as value chain. The cluster is completed with legislation as part of Porter's fifth force market entry and also with environment for other factors from the external environment [51]. The cluster name *external forces* is chosen because all these GCs are exercised outside the organisation borders, although within the zone of influence.

In the third cluster, *Soft Power*, we clustered communication with

the factors leadership and culture after Schein and Maris et al. who categorise leadership, culture and communication as soft collaboration in their BPM MM [53], [55]. Culture is grouped as researched by Schein in his three levels of culture model [53]. The cluster name *soft power* is chosen because all these human capabilities are rather intangible after the soft power theory [56], [57]. Also, leadership and culture are internal matters, just like communication.

## 5. DISCUSSION

The numbers of GCs found in the selected models are presented in *Table 4 Distribution of capabilities per author*. It summarizes the number of the capabilities per GC group over the years, which means the number of GCs per coded stack of (cards of) capabilities. It also summarizes the number of stacks per MM which reflects the capability coverage of an MM.

Some GCs are well substantiated because these are often mentioned in organisational readiness MMs: Governance & Control, Organisation & Processes and IT and are found more than 20 times and almost in every article. Strategy, Human Resources, Culture form a middle group with nine or ten capabilities found. The other OCs turns up five times or less. We conclude that Governance & Control, Organisation & Processes and IT are often seen as relevant generic capabilities. Also, the Operating Model Cluster represents

**Table 3. Capability descriptions**

Capability	Description	Source
Strategy	"the adaptive organization—the organization aimed externally, yet depending upon the full utilization of each of its people", or "those actions that a company plans in response to or anticipation of changes in its external environment- its customers, its competitors...How we will create value"	[45], [52]
Governance & Control	"Mechanisms for managing complex projects and change initiatives. Companies can use their evaluations of the enablers and capabilities, in tandem, to plan and assess the progress of process-based transformations"	[15]
Organisation & Processes	"practices, actions, business process, the flexibility, working rules, collaborations and communications, procedures that compliment and accommodate activities within and between organizations", or "Structure divides tasks and then provides coordination. It trades off specialization and integration. It decentralizes and then recentralizes."	[37], [45]
Information Technology	"availability of technology infrastructure, the flexibility and the capability of existing organizational system", or "all the procedures, formal and in-formal, that make the organization go, day by day and year by year: capital budgeting systems, training systems, cost accounting procedures, budgeting systems."	[37], [45]
Human Resources	"people...skills: a company's crucial attributes", or "how to hire and fire, motivate, train and educate, and culture. Going beyond the traditional considerations such as training, salary, performance feedback, and career opportunities. ...factors that include the organization's cultural and social environment."	[17], [45]
Leadership	"Willingness of leaders, management competences and methods, existence of central coordination", or "the basic personality of a top-management team and the way that team comes across to the organization"	[41], [45]
Communication	"Effective exchange of ideas and a clear understanding of what it takes to ensure successful strategies, ensuring ongoing knowledge sharing across organizations"	[17]
Culture	"a pattern of shared basic assumptions that was learned by a group as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems."	[53]
Value chain	"an interdependent system or network of activities, connected by linkages. Linkages occur when the way in which one activity is performed affects the costs or effectiveness of other activities"	[54]
Legislation	"Governmental and institutional policies and procedures, standardization and security"	[36]
Environment	"Environmental context focused on the ways of which the firm conducts its business operations"	[37]





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## Appendix Generic Capabilities Classification

Value Chain	Market forces	Janom	2014	Strategy	Goals & Strategy	Batenburg	2008	Leadership	Leadership	Hammer	2007		
Value Chain	Customer orientation	Karkainen	2014	Strategy	Governance	Rosemann	2005	Leadership	Leadership	LAK	2018		
	Customers	Schumacher	2016		Strategic alignment	Rossmann	2005		Schumacher	2016			
	Individual users	Van Dyk	2012		Strategy	Clevoen	2014		Leadership & Strategy	Mouzakis	2010		
	Interaction/ involvement with community	Van Dyk	2012		Strategy	Hejazi	2016		Culture	Culture	Bruin	2005	
	Social Customer	LAK	2018		Strategy	Schumacher	2016		Culture	Clevoen	2014		
	Partnering structure	Tapia	2008		Strategy	LAK	2018		Culture	Hammer	2007		
	Partnering Maturity	Luftman	2003		Strategy & policy	Batenburg	2006		Culture	Hejazi	2016		
	Supporting industries	Janom	2014		Strategy capabilities	Brennan	2018		Culture	LAK	2018		
	Government	Janom	2014		Strategy/policy	Karkainen	2014		Culture	Rosemann	2005		
	Policy and legislation	Van Dyk	2012		Strategy/policy				Culture	Schumacher	2016		
	Environment	Environmental	Janom		2014					People & Culture	Batenburg	2006	
						Governance & Control	Accountability		Bruin	2005	Karkainen	2004	
	IT	E Technology	Batenburg		2008	Assessment	LAK		2018	Communication	Awareness and communication	Khadra	2009
		Information Technology	Batenburg		2006	Business Management	Matrane		2014		Communications Maturity	Luftman	2003
			Karkainen		2014	Competency/Value Measurements	Luftman		2003				
		LAK	2018	Control	Batenburg	2008							
Information Technology and Systems (IT/IS)		Bruin	2005	Coordination	Tapia	2008							
Infrastructure		Mouzakis	2010	Finance	Mouzakis	2010							
Integration		Mirarab	2014	Goals and measurement	Khadij	2009	Organization & process	Business Process:	Janom		2014		
IS architecture		Tapia	2008	Governance	Hammer	2007	Methodology	Methodology	Bruin		2005		
IT		Clevoen	2014	Governance and Management	Schumacher	2016	Methods & Tools	Methods & Tools	Rosemann		2005		
IT Architecture		Rosemann	2005	Governance Maturity	Mirarab	2014	Operations	Operations	Rohlof		2009		
Resources		LAK	2018	Management	Luftman	2003	Organization	Organization	Schumacher		2016		
Technical Infrastructure		Hejazi	2016	Management& Control	Hejazi	2016	Organization & processes	Organization & processes	Batenburg		2008		
Technology		Batenburg	2006	Performance	Batenburg	2006	Organizational	Organizational	Batenburg		2006		
		Hidayanto	2012	Performance	Karkainen	2014	Organizational	Organizational	Karkainen		2014		
		Janom	2014	Performance	Bruin	2005	Organizational	Organizational	Hidayanto		2012		
		Karandiker	1993	Performance	Brennan	2018	Organizational features	Organizational features	Janom		2014		
		Schumacher	2016	Planning and financial sustainability	Van Dyk	2012	Organizational processes	Organizational processes	Van Dyk		2012		
Technology and maintenance		Van Dyk	2012	Process Optimization	Rohlof	2009	Organizational support	Organizational support	Mirarab		2014		
Technology Scope Maturity		Luftman	2003	Responsibility and accountability	Rohlof	2009	Policies, plans and procedures	Policies, plans and procedures	Khadra		2009		
Tools and automation		Janom	2014	Business Intelligence	LAK	2018	Practices	Practices	Clevoen		2014		
Use of Standards		Mirarab	2014	Data Management	Rohlof	2009	Process & Practices	Process & Practices	Karandiker		1993		
Human resource		Competency	Janom	2014	data value management	Brennan	2018	Process	Process		Batenburg	2008	
		Expertise	Hammer	2007	incident management	Matrane	2014	Process	Process		Hidayanto	2012	
		Human resources	Mouzakis	2010	Information	Batenburg	2008	Process architecture	Process architecture		LAK	2018	
		Individuals	Hejazi	2016	Knowledge Management	LAK	2018	Process Documentation	Process Documentation		Tapia	2008	
	People	Rosemann	2005	Operations Management	Matrane	2014	Process Management Organization	Process Management Organization	Rohlof	2009			
		Schumacher	2016	Problems management	Matrane	2014	Process Management Organization	Process Management Organization	Rohlof	2009			
	Personal traits	Janom	2014	Program Management, Qualification, Commu	Rohlof	2008	Process Portfolio & Target Setting System	Process Portfolio & Target Setting System	Rohlof	2009			
	Skills and expertise	Khadra	2009	Risk Management	Matrane	2014	processes and human factors oriented	processes and human factors oriented	Brennan	2018			
	Skills Maturity	Luftman	2003	Security	LAK	2018	Products	Products	Schumacher	2016			
					Mirarab	2014	Structure	Structure	Clevoen	2014			