UNIVERSITEIT GENT

FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

TWEEKERKENSTRAAT 2
B-9000 GENT
Tel. : 32 - (0)9 – 264.34.61
Fax. : 32 - (0)9 – 264.35.92

WORKING PAPER

A theoretical framework and classification of capability areas for business process maturity

Amy Van Looy[1]

Manu De Backer[2]

Geert Poels[3]

September 2011

2011/743

[1] Corresponding author. Affiliated researcher at Dept. Management Information Science and Operations Management, Faculty of Economics and Business Administration, Ghent University, Ghent, Belgium.
[2] Affiliated researcher at Dept. Management Information Science and Operations Management, Faculty of Economics and Business Administration, Ghent University, Ghent, Belgium.
[3] Dept. Management Information Science and Operations Management, Faculty of Economics and Business Administration, Ghent University, Ghent, Belgium.

D/2011/7012/48

A theoretical framework and classification of capability areas for business process maturity

Abstract

Organisations are increasingly striving to excel by improving their way of working, or in other words, to obtain mature business processes. However, no consensus exists on the capability areas (or skills) needed to excel. Therefore, this study presents a theoretical framework to overcome this gap. It particularly draws on theories regarding the traditional business process lifecycle, which are supplemented by recognised organisation management theories. The comprehensiveness of the framework is successfully validated by a sample of 69 business process maturity models (BPMMs). Nonetheless, as a consensus neither exists among the collected BPMMs, a classification of different maturity types is proposed.

Keywords

Business process; maturity; theoretical framework; capabilities; process improvement; excellence

1 Introduction

Business processes are at the heart of each organisation. They describe how organisations operate, and therefore impact how organisations perform. Their business importance is already shared among many executives [1,2]. Moreover, organisations are increasingly focussing on their business processes to excel. This means that they strive for the highest level of performance. This is mainly due to (1) higher customer expectations in the globalised market, and (2) growing IT possibilities to support business processes [3,4].

But how well does an organisation improve its business processes? This brings us to ‘maturity’, which is a measure to indicate how excellent business processes can perform. Maturity aims at systematically assessing and improving the capabilities, i.e. skills or competences, of business processes and their organisation to deliver higher performance [3,5]. de Bruin and Rosemann [6] distinguish two types of maturity: (1) maturity of specific business processes, and (2) maturity of business process management in general, i.e. of all business processes in the organisation.

Since process improvements are not easy to realise, business process maturity models (BPMMs) have been designed from which organisations gradually benefit in their journey towards excellence. BPMMs present a sequence of maturity levels and a step-by-step roadmap with goals and best practices to reach each consecutive maturity level [5]. Currently, a BPMM proliferation exists [7], which prompts us to evaluate the different BPMM designs. For instance, models like OMG [8] have labelled their levels by focussing on business process optimisation, e.g. ‘initial’, ‘managed’, ‘standardised, ‘predictable’, and ‘innovating’. Other BPMMs, like the one of the Rummler-Brache Group [9], express maturity levels as advancements in business process management, e.g. ‘BPM initiation’, ‘BPM evolution’, and ‘BPM mastery’. Thirdly, there are BPMMs which rather prefer emphasising business process integration, e.g. McCormack and Johnson’s levels of ‘ad hoc’, ‘defined’, ‘linked’, and ‘integrated’ [10]. Although their primary focus differs, BPMMs take into account similar capability areas. The latter are collections of related capabilities that need to be assessed and improved in order to reach business (process) excellence.

BPMMs are frequently criticised for oversimplifying complex issues [11]. One of the reasons is that theories or comprehensive studies on business process maturity are still lacking. This particularly counts for the theoretical foundation of the capability areas, and the relationship with performance. However, many scholars have (mostly empirically) examined the capability areas as critical success factors to realise business (process) excellence. And many of them have translated these factors into a BPMM, e.g. Hammer [12], Harrington [13], McCormack and Johnson [10], and de Bruin and Rosemann [6]. Our study consolidates their findings in a theoretical framework.

Particularly, the latter BPMM was designed by means of a sound methodology using Delphi studies with international BPM experts, validated by case studies. It comprises six main capability areas (i.e. critical success factors): (1) strategic alignment, (2) governance, (3) methods, (4) information technology, (5) people, and (6) culture. Each area has 5 sub areas. Nowadays, these capability areas are presented as '*a framework that consolidates and structures the essential factors that constitute BPM as a whole*' [14, p.107]. For instance, they structure the outline of a recent BPM Handbook [4]. These capability areas rely on studies on critical success factors for BPM and empirical research to build a maturity model, albeit without relying on underlying theories. We will address this gap, and also compare de Bruin and Rosemann's framework with our theoretical framework and with other existing BPMMs.

Furthermore, Mathiesen *et al.* [15] refer to efforts of professional communities to standardise the capabilities (or skills) required per practitioner's role in a body of knowledge. For instance, they differentiate the activities of a business analyst from a business process owner. Nevertheless, to the best of our knowledge, no consensus currently exists on the formal capability areas for mature business processes in the literature [4,16], and among practitioners [17,18].

Consequently, this article elaborates on the following research questions.

- *RQ1. Which capability areas can be assessed and improved by a BPMM in order to reach business (process) excellence?*
  → Identification and foundation of the theoretical framework
- *RQ2. Which capability areas are actually assessed and improved by existing BPMMs?*
  → Empirical validation of the theoretical framework, based on prior BPMM efforts
- *RQ3. If RQ2 shows that different capability areas are actually assessed and improved, do existing BPMMs measure different types of maturity?*
  → Classification of BPMMs to refine the earlier findings of de Bruin and Rosemann [6]

The purpose is to theoretically identify and empirically validate the capability areas which allow classifying and evaluating the coverage of existing BPMMs. Hence, we make sense of and provide a structure for the wide diversity of BPMMs out there.

The remainder of the paper is structured as follows. Section 2 explains the methodology. As this research takes a top-down approach, the main capability areas (section 3) are separated from the sub areas (section 4). Each section is structured according to a theoretical and empirical part. Afterwards, the classification is elaborated on (section 5) and discussed (section 6). Finally, section 7 recalls the most important findings with avenues for future research.

2 Methodology

2.1 Literature study (RQ1)

The theoretical framework was rigorously built by an iterative and top-down approach. First, three relevant concepts in the business process literature were defined: (1) business process (BP), (2) business process management (BPM), and (3) business process orientation (BPO). We used clear and accepted definitions to derive the capability areas that are related to these concepts. The BP, BPM, and BPO concepts were already used in the context of BPMMs [3,6,10]. Moreover, they are umbrella terms in contemporary business process literature. For instance, the radical business process reengineering or the incremental total quality management are two possible improvement approaches within BPM. Hence, we built on the business process fundamentals, instead of being biased by the lacking consensus on capability areas and the manifold BPMMs.

Afterwards, this high-level perspective was refined in sub areas. Besides relying on the broader literature on business processes, we used validated theories to underpin the findings. Since BPMMs aim to improve business processes throughout their lifecycle, we relied on established theories regarding the traditional business process lifecycle. We must note that this lifecycle differs from a one-off project lifecycle, e.g. Prince2 [19] or the Rational Unified Process [20], in which project stages are defined to realise a particular process change [21]. We also looked for recognised organisation management theories in the field of (1) performance and change management, (2) human resource management, and (3) strategic management. This link is appropriate, since most organisational changes also involve business processes [22]. Moreover, BPMMs aim to gradually increase business (process) performance [23].

2.2 Sampling (RQ2 and RQ3)

The resulting capability areas and sub areas were empirically validated by mapping them to a sample of existing BPMMs. To fully acknowledge prior BPMM efforts, we compare the theoretically found areas that a BPMM ‘can address’ with the empirically found areas that BPMMs ‘actually address’. Particularly, our purpose is to theoretically ground the capability areas in BPMMs.

Data was collected during the second quarter of 2010. We initially searched for articles in academic databases (i.e. SCI-Expanded, SSCI, A&HCI, CPCI-S, CPCI-SSH, BPM Journal) and non-academic search engines (i.e. Google, Google Scholar) by using the combined keywords of ‘*process*’ and ‘*maturity*’. Then, we traced the references in the identified articles to get access to other relevant sources. Given the proliferation of BPMMs [7], the research scope was set to generic business processes. Also supply chains and collaboration processes were included to examine cross-organisational value chains.

In total, 69 BPMMs were collected, listed in appendix A: (1) 37 BPMMs for generic business processes (13 academic and 24 non-academic), (2) 24 BPMMs for supply chains (9 academic and 15 non-academic), and (3) 8 BPMMs for process collaboration (6 academic and 2 non-academic). By including non-academic BPMMs, our sample is larger than most comparative studies on BPMMs [14]. Furthermore, by including different process types (i.e. generic, supply chains, collaboration), our sample suggests versatility which facilitates transferability of our findings to other process types, e.g. software processes.

2.3 Content analysis and descriptive statistics (RQ2)

The documents of the collected BPMMs were repeatedly analysed over time, beginning in the third quarter of 2010 until the second quarter of 2011. The first author was the main coder. In case of any

confusion, the other authors were exhaustively consulted to obtain a reliable coding and investigator triangulation. This type of content analysis is called positivist (not interpretivist) text analysis by Lacity and Janson [24], because researchers are assumed to be outsiders, who interpret texts from semantics without personal biases or experiences.

2.4 Classification by multivariate statistics (RQ3)

If descriptive statistics shows that BPMMs do not necessarily address all theoretical capability areas, it demonstrates a cluster tendency, which makes formal classification worthwhile [25]. Classification is frequently conducted by combining cluster analysis (i.e. unsupervised or exploratory classification) with discriminant analysis (i.e. supervised or confirmatory classification) [26,27]. First, cluster analysis produces a BPMM classification based on the distance or similarity between the theoretical capability areas. Next, discriminant analysis uses the same capability areas, i.e. independent variables, to predict cluster membership as obtained from the cluster analysis, i.e. dependent variable. Discriminant functions are calculated to predict which BPMMs belong to the previously found clusters. The resulting percentage of correct predictions is used as a validity measure for the BPMM classification.

Additionally, validity is assured by: (1) choosing a meaningful and statistically correct cluster solution after considering all algorithmic clustering methods available in SPSS (version 18), and (2) guaranteeing stable results on both the complete and split dataset.

Finally, all assumptions regarding the underlying data distribution are satisfied to properly conduct both cluster analysis and discriminant analysis [28].

3 Main capability areas in the theoretical framework (RQ1, RQ2)

3.1 Theoretical identification of main capability areas

Most definitions for a business process refer to a transformation of inputs to outputs [29,30]. For instance, *'a process is a series of interconnected activities that takes input, adds value to it, and produces output. It's how organizations work their day-to-day routines. Your organization's processes define how it operates'* [3, p.xxii]. This transformational view originates from manufacturing, and is less clear in service delivery. Hence, other definitions exist which emphasize a coordination of activities [31]. Despite these different emphases, business process definitions implicitly focus on *business process modelling* and *deployment*. The latter means running processes in real life. It requires modelling or predefining business processes in textual or graphical descriptions [32]. As a result, both aspects are selected as main capability areas.

Secondly, BPM involves continuously managing and improving business processes, guided by process owners. Depending on their background, authors underline more the IT benefits [33] or the management aspects [34]. Gillot [31], Gulledge Jr. and Sommer [35] summarize four foci in BPM definitions: (1) *modelling*, (2) *deployment*, (3) *optimisation*, or improving business processes based on real metrics, and (4) the *management* of business processes, each with a process owner and a cross-functional team. For instance, Weske [32] defines BPM as '*concepts, methods, and techniques to support the* (1) *design*, (4) *administration*, (2) *configuration, enactment, and* (3) *analysis of business processes*' [32, p.5]. Similarly to BP, these four foci are selected as main capability areas. BPM differs by also addressing optimisation and managerial efforts for one, more or all business processes.

Some authors go beyond these four BPM areas by also referring to organisation management. Particularly, by adopting (5) a process-oriented culture with rewards linked to the performance of business processes instead of departments, and (6) a horizontal structure or organisation chart [10]. For instance, McCormack and Johnson [10] define BPO as an organisation that *'emphasises process, a process oriented way of thinking, customers, and outcomes as opposed to hierarchies*' [10, p.185]. Although the distinction between BPM and BPO is not always explicitly made, e.g. in [6], it allow separately examining the different nuances.

Consequently, six main capability areas are derived from the BP, BPM and BPO definitions. Each area must be assessed and improved in order to reach business process maturity [5].

3.2 Empirical validation of main capability areas

It turned out that actual BPMMs do not necessarily cover all main capability areas. This particularly counts for 'modelling', 'culture' and, 'structure', which are respectively covered by 56, 57 and 30 BPMMs (out of 69 models). The other areas are mostly present, i.e. 66 BPMMs for 'deployment', 68 for 'optimisation', and 67 for 'management'. Nevertheless, most models cover four (15.9%), five (37.7%) or all (37.7%) main areas. Descriptive statistics also showed that some BPMMs are limited to BPM capability areas, whereas most models cover at least one BPO-specific capability area, i.e. 'culture' or 'structure'. This proposes a dichotomy between BPM maturity and BPO maturity.

Furthermore, we noticed that the assessment items in BPMMs (i.e. questions to assess or measure capability areas) literally refer to one, more or all business processes within the involved organisation(s) or value chain. The models for a single business process are less numerous (N=9). More often, BPMMs are used in a business domain with multiple (sub-)processes (N=36). For instance, supply chains have business processes for buying, producing, selling and planning products and services. This finding confirms the idea of a large cross-departmental or cross-organisational business process, or horizontal value chain, with sub-processes in each department. Also frequent are BPMMs involving all business processes (N=26), which rather take a management perspective instead of focusing on particular business processes.

Hence, the empirical findings refine earlier findings [6] by suggesting the existence of six maturity types: BPM maturity for one, more or all business processes, and BPO maturity for one, more or all business processes. Few BPMMs offer multiple maturity types of which practitioners can choose according to the organisational needs, for instance for both a single business process and all business processes in [12] and [36]. The findings also indicate that BP maturity does not exist, since no model only addresses the 'modelling' and 'deployment' areas. However, our dataset is restricted to BPMMs for generic business processes, supply chains and process collaboration, as explained in the methodology section. Consequently, BP maturity may exist for BPMMs regarding specific business process types, such as manufacturing workflows, but this possibility is not further investigated.

4 Capability sub areas in the theoretical framework (RQ1, RQ2)

4.1 Theoretical identification of capability sub areas

The six main capability areas are now specified in 17 sub areas by relying on the business process and organisation management literature. We build on recognised theories that give evidence to the found sub areas, particularly (1) business process lifecycle theories, and (2) organisation management theories regarding organisational change management, strategic management, and human resources

management. The first three main capability areas are primarily addressed by the business process lifecycle theories, whereas the other three are supported by organisation management theories.

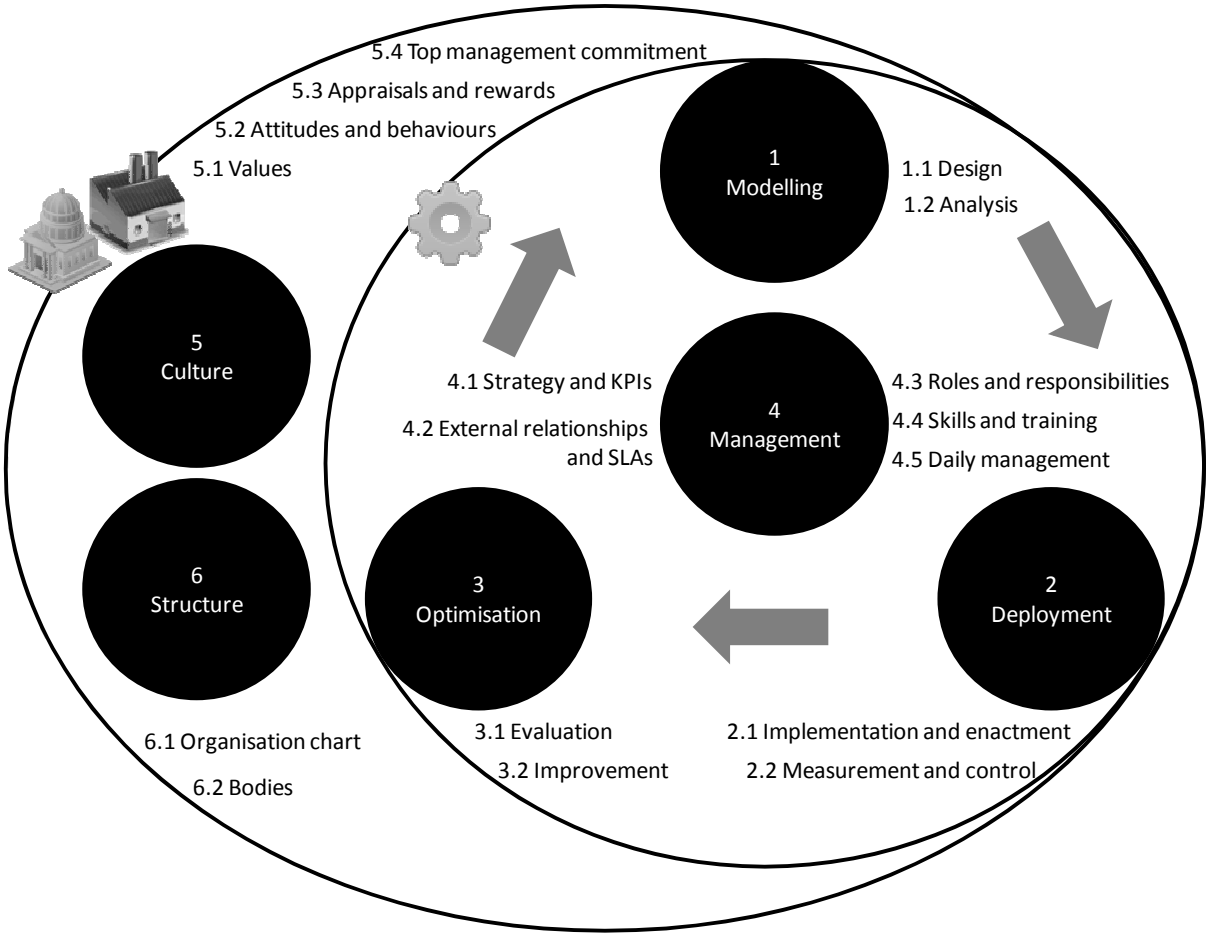


Figure 1. An overview of the capability sub areas per main capability area

Figure 1 also visualises that the first four main capability areas represent the characteristics of a specific business process. On the other hand, the final two main capability areas represent the characteristics of organisations. Hence, these characteristics impact their whole portfolio of Business processes. Subsequently, each sub area is detailed by relying on the corresponding theories.

4.1.1 Theories on the traditional business process lifecycle

The first business process lifecycles were presented by the classical quality thinkers: Shewhart [37] and Deming [38]. During the 1920s-1930s, Shewhart interpreted production processes as a cycle of specification (i.e. modelling), production (i.e. deployment) and inspection (i.e. optimisation) [37]. During the 1950s, Deming generalised Shewhart's cycle to business processes in his PDCA circle [38]: (1) 'plan' (i.e. design and analysis), (2) 'do' (i.e. enactment and measurement), (3) 'check' (i.e. evaluation), and (4) 'act' (i.e. improvement). Nowadays, many variants exist which do not do not fundamentally differ [13,32,33,39,40,41]. Translated to our research, they all agree on the three most basic capability areas: 'modelling', 'deployment' and 'optimisation'.

4.1.1.1 Main capability area 1: modelling

First, the 'modelling' capability area relates to methods and IT regarding the first phase(s) of the business process lifecycle.

- **Business process design** deals with the identification and representation of a business process model. Designers start from an initial set of the business process purpose, performance targets (or KPIs, Key Performance Indicators), required behaviours and deliverables [32,39,41].Based on this set, business processes are modelled in a textual and/or graphical representation. Netjes, Reijers and van der Aalst [40] explain that business process modelling specifies: (1) the process structure, i.e. the relationship between inputs, activities, outputs, business rules and data, (2) the resource structure, i.e. who (e.g. role) or what (e.g. departments, IT) executes the activities, (3) the allocation logic, i.e. how activities are assigned to resources, and (4) the interfaces between business processes and between business processes and external partners.
- **Business process analysis** refers to the validation, simulation, and verification of a (re)designed business process model. Business stakeholders must validate that these models conform the business reality. Simulations must test the models in real-world settings. A third method verifies whether graphical models are compliant with the used notation language [32,40].

4.1.1.2 Main capability area 2: deployment

Secondly, the 'deployment' capability area includes methods and IT regarding the intermediate phase(s) of the business process lifecycle

- **Business process implementation and enactment** implies both the preparation and actual running of business processes. During implementation, the high-level business process models are translated into deployable models by adding operational details. The operational systems are selected, configured, tested and released. These systems include human process participants, who follow the defined procedures, and/or process-aware information systems, such as a BPM suite or a workflow system [32,39,41]. Business process enactment starts when business processes are actually executed by following the implemented procedures and software systems. Each time the business process runs in real life, a process instance is created [39]. Although implementation and enactment cover distinct lifecycle phases, they are intertwined regarding the aspects that need to be matured: all enactment changes are prepared by related implementation changes.
- **Business process measurement and control** means gathering log files and real-time monitoring [32]. During business process enactment, the performance of business process instances must be measured by recording activities in log files [41]. It allows real-time monitoring (during enactment) and process optimisation (after enactment). The log files of active process instances are used to: (1) maintain conformance with the business process models by correcting deviations, and (2) to provide information on the current status of active instances, e.g. to customers [32,40]. The use of log files after enactment belongs to the next capability area.

4.1.1.3 Main capability area 3: optimisation

Thirdly, the 'optimisation' capability area contains methods and IT regarding the final phase(s) of the business process lifecycle.

- **Business process evaluation** uses enactment information to quantify the performance of finished business process instances, specified during business process modelling, and the operational environment, specified during business process deployment. Two frequently used evaluation techniques are business activity monitoring and process mining [32,41].

- **Business process improvement** implies both making business processes conform to their models, and optimising the models through redesign. Depending on the evaluation, business process optimisation varies from larger, radical projects, such as business process reengineering (BPR) [42], to smaller, incremental changes [13]. Many optimisation techniques originate from the classical quality thinkers and Total Quality Management, such as Shewhart's Statistical Process Control [37]. Individual techniques are frequently combined in a larger improvement methodology, such as the theory of constraints, Lean and Six Sigma [43].

Business process optimisation gives input for a new lifecycle to redesign business processes, based on the diagnosed improvements and collected data for simulations [39,40].

4.1.2 Theories on organisation management

To our knowledge, most business process lifecycle theories are restricted to the phases above. A limited number mention some management aspects [41,44]. Nevertheless, they do not cope with all critical success factors to mature business processes. vom Brocke and Sinnl [45] explain that, starting from BPR in the 1990s, the business process literature '*initially focused on technical IT-related aspects of business processes and their design via technology. (...) Researchers have only in recent years more broadly considered BPM to be an integrated approach that moves beyond purely an IT focus'* [45, p.358-359].

Hence, the three final main capability areas are concretised by relying on the broader business process literature. Additionally, they are underpinned by organisation management theories regarding: (1) performance and change management [46,47], (2) human resource management [48], and (3) strategic management [49].

The table below introduces eleven additional sub areas. They were found by following a twofold approach: (1) in the literature regarding four business process evolutions, i.e. business process reeningeering [42,50], business process improvement [13], X-engineering [51], and business process management [33], and (2) in review articles on business processes that differ from maturity theories [29,34,52]. These additional elements are also frequently mentioned in the general business process literature [16,23,31,35,53,54,55,56,57,58]. An illustrative mapping is given to two recognised models regarding organisational performance and change [46,47].

Table 1. An illustrative mapping to organisation management theories

Capability areas for organisational performance and change:		Capability areas for business process maturity (i.e. expected performance):	
7-S model [47]	Burke-Litwin model [46]	Main areas	Sub areas
Systems	Systems (policies and procedures) (1)	Modelling	• Business process design • Business process analysis
		Deployment	• Business process implementation • Business process enactment • Business process measurement and control
		Optimisation	• Business process evaluation • Business process improvement
Strategy	Mission and strategy	Management	• Strategy and KPIs
	External environment		• External relationships and SLAs
Skills	Task and individual skills		• Roles and responsibilities • Skills, expertise, training
	Management practices		• Daily management
Super-ordinate goals	Organizational culture	Culture	• Values
Staff (soft aspects)	Motivation		• Attitudes and behaviours
	Work unit climate		
	Individual needs and values		
Staff (hard aspects)	Systems (2)		• Appraisals and rewards
Style	Leadership		• Top management commitment
Structure	Structure	Structure	• Organisation chart • Bodies

The organisational performance and change theory of Waterman, Peters, and Philips [47] claim that the organisation's ability to change depends on the organisation strategy, structure, systems (or Business processes), style, skills, staff, and 'superordinate goals' (or culture). Burke and Litwin [46] have formalised this claim in a causal model in which the external environment affects the organisational mission and strategy, leadership and culture. In turn, they affect the organisational structure, systems, management practices, individual tasks and skills, work unit climate, and individual values. A combination of these factors will result in motivation, and performance.

The relationship between business processes and business (process) excellence is further explained by theories on strategic management. Business processes are means to achieve strategic, tactical and operational objectives [23]. For instance, Kaplan and Norton [49] present the strategy as a translation of the vision, which in turn is a translation of the core values and mission. Their balanced scorecard (BSC) systematically derives KPIs regarding four perspectives: (1) the financial situation, (2) the customers, (3) the internal business processes, and (4) learning and growth. Variants of the BSC exist, which add other stakeholders [59,60]. For instance, the business motivation model of OMG [60] distinguishes: (1) the ends (i.e. vision, and KPIs), (2) the means (i.e. mission, strategic and tactic activities, business rules and policies), (3) the influencers (i.e. internal, such as values, or external, such as stakeholders or regulation), and (4) their assessment (e.g. a SWOT analysis). With regard to the main capability areas, the translation of the organisational strategy into the strategy of a specific

business process is classified within the 'management' capability area. It concerns an effort per business process, instead of the whole organisation and its portfolio of business processes.

Finally, Atkinson, Waterhouse, and Wells [59] define the KPIs derived from the strategy as primary objectives. Also secondary objectives exist to guide employee behaviours, which are investigated by human resource management theories. Particularly, employee alignment involves: (1) action alignment, i.e. obtaining the skills and knowledge to perform, and (1) interest alignment, i.e. obtaining the motivation to perform [61]. Thorough research is conducted by Boswell on this 'line of sight', or the '*employee understanding of the organization's objectives and how to contribute to those objectives*' [62, p.851]. Her research gave evidence to four secondary objectives [48]: (1) top management communication, (2) employee involvement in decision-making, (3) extrinsic motivation, e.g. rewards and promotions, and (4) intrinsic motivation, e.g. personal values and attitudes. With regard to the main capability areas, action alignment impacts the performance of a single business process, and thus belongs to the 'management' capability area. Interest alignment depends on an organisation's way of doing business, and is thus classified within the 'culture' capability area.

The organisation management theories discussed above clarify the importance of the identified sub areas for the final three main capability areas i.e. 'management', 'culture', and 'structure'.

4.1.2.1 Main capability area 4: management

The 'management' capability area surrounds the traditional business process lifecycle by providing five sub areas necessary to govern the previous sub areas.

- **Strategy and KPIs**. Since Business processes must contribute to customer satisfaction and business performance, they need to serve the organisational mission, vision and strategy. This is called 'strategic alignment', i.e. aligning Business processes with strategic objectives and customers' needs [34], or systematically connecting Business processes with the business strategy and thinking in terms of customer goals [54]. Many scholars agree that the organisational strategy must be translated into a business process strategy, and the organisational performance targets (KPIs) must be translated into business process performance targets (KPIs) [13,16,23,29,31,33,34,35,50,52,58].
- **External relationships and SLAs**. For strategy realisation, business processes must take into account their external environment. Moreover, external parties must be actively involved in activities regarding business process modelling, deployment, optimisation or management. Examples are external communication or committing to Service Level Agreements (SLAs) with partnering suppliers and customers [13,33,51].
- **Roles and responsibilities**. A permanent business process owner must be appointed by top management. He is responsible and accountable for the performance and continuous improvements of a specific business process, as well as for the budget, resources and the interfaces with other business processes. He can be assisted by a process team to model, deploy and optimise business processes. He also leads a cross-functional team of business process participants [13,16,23,29,31,34,35,42,50,52,58]
- **Skills and training**. In order to fulfil these roles, individuals must be trained to obtain the required skills and knowledge. Besides knowledge on the process models, employees can be trained in problem solving, process improvement, and decision making [13,16,58]. However, Trkman [58] explains that a trade-off must be made between the use of specialist and generalist employees.
- **Daily management**. The process owner applies project management activities, e.g. decision making, planning, budgeting, communication, business-IT alignment, change management,

risk management, compliance management, quality assurance, and configuration management [50,55].

4.1.2.2 Main capability area 5: culture

As from the fifth capability area, i.e. 'culture', we cope with organisational characteristics, instead of a specific business process. This capability area has four sub areas.

- **Values**. A process-oriented culture implies '*a certain set of values considered supportive of BPM objectives*' [45, p.369]. An organisation must cherish values that facilitate the realisation of the previous capability areas Examples are a customer focus, empowerment, innovation, multidisciplinary collaboration, and trust [34,50,51,52,53].
- **Attitudes and behaviours**. These values must be concretised in attitudes and behaviours that go beyond a specific business process. For instance, employees who are aware of the business processes within their organisation, who are motivated to do their job, who do not resist to change, who share technological and organisational facilities, as well as lessons learned among Business processes through a repository or social network [34,50].
- **Appraisals and rewards**. Employees must be appraised and rewarded according to the performance of Business processes, instead of departments, e.g. by combining team incentives with individual benchmarks. Hence, process-related skills must be added to the job descriptions and career paths of all employees [13,16,34,42,52,53].
- **Top management commitment**. Top managers must support or sponsor business processes [13,23,29,31,34,52]. It implies: (1) a leadership style, i.e. considering Business processes as a way of managing the business, and (2) a leadership role with responsibilities, i.e. a top manager (e.g. Chief Process Officer, CPO) who is centrally responsible for and actively engages in all Business processes within the organisation, e.g. by assigning the process owner, or setting the business process strategy and KPIs [56].

4.1.2.3 Main capability area 6: structure

Finally, the 'structure' capability area is also an organisational characteristic. It implies a permanent, structural reconfiguration with two sub areas.

- **Process-oriented organisation chart**. Various authors suggest a shift from a vertical, departmental organisation towards a horizontal organisation [29,34,35,42,50,52,53,58].By structurally emphasising end-to-end business processes or value chains, this shift expresses process-oriented values, such as a customer focus, and multidisciplinary collaboration. Silvestro and Westley [57] explain the (dis)advantages of a vertical and horizontal organisation. A matrix structure allows combining both advantages.
- **Process-oriented management / governance bodies**. Additional bodies must be created, such as (1) a process management council or office (per business process), (2) a program management council or office, or a steering committee (among business processes), and (3) a centre of excellence or support office (i.e. a competence centre to assist these councils) [52, 54,56,58]. A program manager must be assigned to coordinate the process owners. He leads a centralised centre of excellence, comprising process experts or internal consultants in methods and IT for process management and project management [55,56]. In other words: the centre of excellence is for the BPM head, what the improvement team is for the process owner. The realisation of centralised services belongs to the higher maturity levels of previous sub areas. This sub area merely addresses the existence of the bodies, with associated roles and responsibilities among business processes.

4.2 Empirical validation of capability sub areas

Appendix B demonstrates that all collected BPMMs were successfully mapped to the 17 capability sub areas. This means that the BPMMs showed no capability areas that could not be ranked in one of the theoretically identified sub areas. Nonetheless, only one model addresses all sub areas, i.e. [36]. The mapping is summarised in Figure 2.

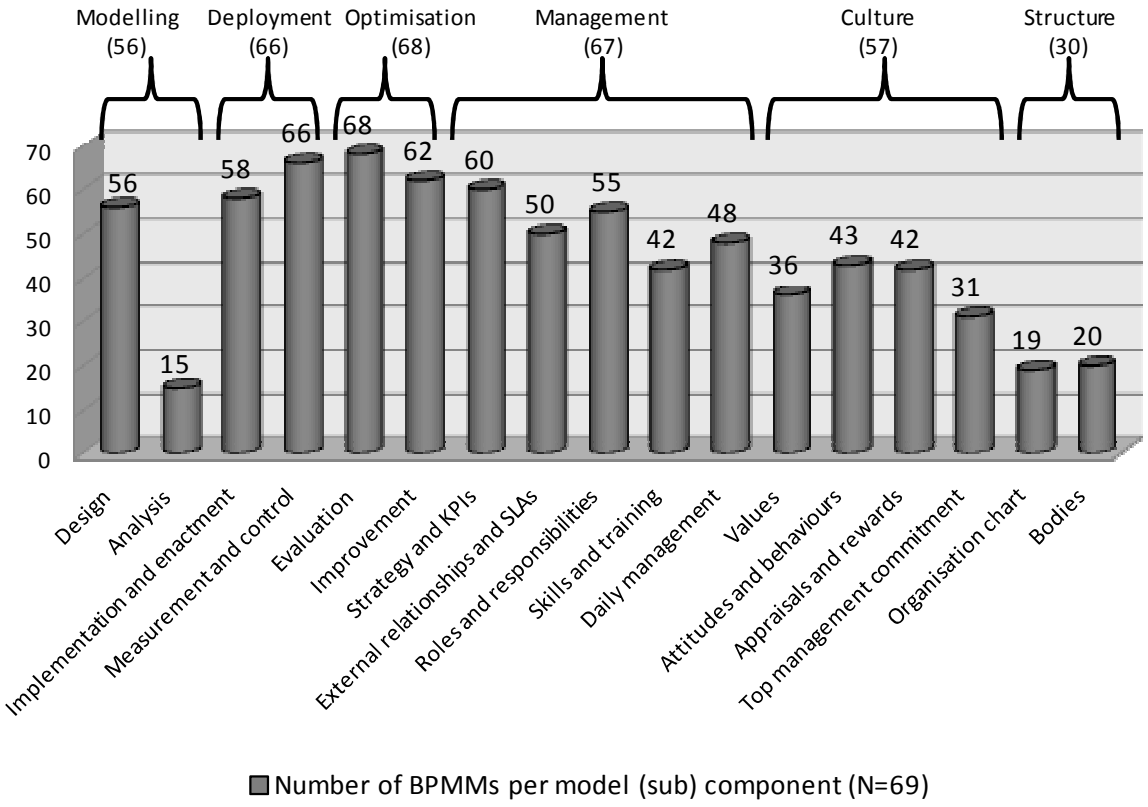


Figure 2. The capability sub areas in actual BPMMs

Most models actually cover both sub areas within 'deployment', both sub areas within 'optimisation', and the sub area of strategy-setting with KPIs within 'management'. Other sub areas are less frequently addressed. Particularly the sub areas of business process analysis, the organisation chart and the corresponding bodies are only covered by 20 models or less. This implies that BPO maturity is mostly determined by the 'culture' capability area, particularly represented by the more tangible sub areas of 'attitudes and behaviours' and 'appraisals and rewards', without structural reconfigurations. The latter are more drastic than introducing a process-oriented culture, and seem to be less obvious or necessary for most BPMMs. Finally, the more technical BPMMs are supposed to focus more on the BP lifecycle aspects, i.e. by also requiring detailed process analyses.

The mapping of theoretical capability areas to existing BPMMs has approved the comprehensiveness of our theoretical framework. Nonetheless, it turned out that some BPMMs are restricted to BPM capability areas, whereas others include BPO capability areas. Also the sub areas are not always addressed. Consequently, different types of maturity seem to be measured by the existing BPMMs, which make statistical classification worthwhile.

5 Classification (RQ3)

5.1 Exploratory classification by cluster analysis

We applied trial-and-error to choose the algorithmic method and the number of clusters that best fit our data, by using SPSS (version 18). The independent variables were the 17 capability areas. Since they are binary (i.e. present or not), no standardisation was required.

- First, all methods available in SPSS (version 18) were tried on the full dataset (N=69), resulting in four methods with clusters containing at least three BPMMs. Other methods with clusters containing one or two BPMMs are considered as less reliable, and thus omitted.
- Next, to obtain stable results, these four methods were used on a split dataset, comprising only BPMMs for generic business processes (N=37). It makes abstraction of the specific process types included, i.e. supply chain or collaboration processes, to be applicable to any process type. All four methods, resulting from the previous step, showed similarity on the split dataset for two clusters. Since two clusters merely confirm the previous distinction between BPM maturity and BPO maturity, we opted for a refinement into more clusters to provide more information. This option resulted in two methods, each with three clusters, that stayed fairly similar on the split dataset: Ward's method and k-means.

The previous steps reduced our choice to two algorithmic methods (i.e. Ward and k-means) with three clusters. Both clustering solutions were further examined to evaluate which one best fits our data.

- A Cohen's Kappa value was computed as a measure of agreement on group memberships. A good agreement was found between both methods on the full dataset ($kappa=0.4<0.455<0.75$; $P<0.001$). Still 30 (out of 69) BPMMs were assigned to a different cluster, which indicates that both methods propose different solutions. When comparing the full and split dataset, more agreement exists. The Ward's method showed a good to almost excellent agreement ($kappa=0.4<0.703<0.75$; $P<0.001$), with seven (out of 37) BPMMs being differently classified on the split dataset. Regarding k-means, an excellent agreement was found ($kappa=0.815>0.75$; $P<0.001$), with merely four (out of 37) BPMMs being differently classified on the split dataset.
- Since both solutions statistically fit our data, the final clustering was guided by the meaningfulness of the proposed solutions. We have chosen for the Ward's method as it almost equally divides the 69 BPMMs in three clearly separated clusters (i.e. 20, 23, and 26 BPMMs): a partial BPM cluster, a quasi-full BPO cluster, and an intermediate cluster combining BPM with some BPO capability areas.

The representation of the capability areas in the final cluster solution is detailed in appendix C. It also visualises the great similarity between the clustering of the full sample and the split sample, indicating reliability or secondary validity. In general, the capability areas regarding business process analysis and the structural reconfiguration of the chart and bodies are merely addressed in the BPO cluster (C). Although the BPM cluster (A) assesses and improves BPM, the models included cover more optimisation capability areas than management capability areas, except for the strategic link. Particularly, the need for appropriate skills and training is frequently underestimated. The intermediate BPO cluster (B) combines BPM with cultural capability areas. Especially process-oriented attitudes and corresponding appraisals are highly represented. These tangible actions appear to be the first steps to introduce BPO in an organisation. Finally, the BPO cluster (C) covers quasi-all theoretical capability areas. However, adapting the whole organisation chart is more drastic and seems

to be less obvious than establishing a competence centre. Nevertheless, this cluster gives evidence to the comprehensiveness of our literature study.

Table 2 shows which BPMMs belong to which cluster. Each cluster contains models for generic BPs, supply chains and collaboration BPs. However, supply chains are mostly addressed in the clusters for BPM and intermediate BPO (A and B), and collaboration BPs in the intermediate BPO cluster (B). Hence, the quasi-full BPO option of cluster C primarily addresses generic BPs.

Table 2. The group membership according to cluster analysis.

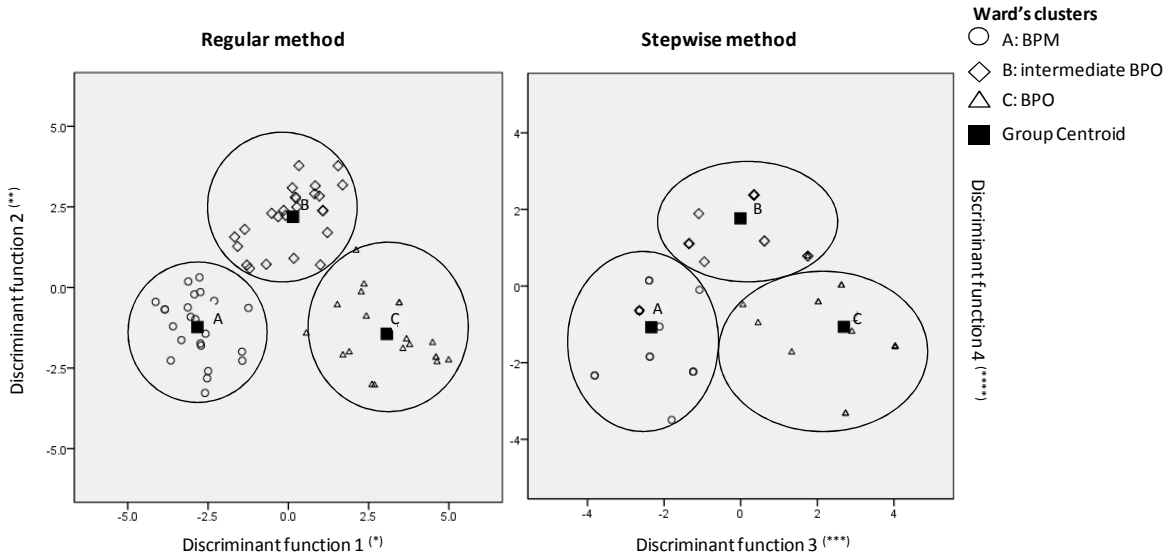
Cluster A (23) BPM	Cluster B (26) Intermediate BPO	Cluster C (20) BPO
BP: AOU, ARM, BIS, BPM, DET, ISO, MAU, MCC1, O&I, SKR, SMI, SPA **SC:** ABE, AND, ARY, CGR, IBM, JER, MAN, MCL, RIV, SCC **Collaboration:** SIM	**BP:** BPT, CAM1, DEL, ESI1, FIS, HAR2, ROH, RUM, SAP **SC:** BOH, CAM3, CHI, CSC, MCC2, MIC, NET, PMG, SCH2, STE, TOK **Collaboration:** ESI2, FRA, MAG, RAM, VIC, WOG	**BP:** CAM2, CHA, FAA, GAR1, GAR2, HAM, HAR1, IDS, LEE, OMG, ORA, REM, ROS, SCH1, SEI, WIL **SC:** CGF, EKN, LMI **Collaboration:** TAP

We must note that group membership to a particular cluster does not imply that all models included are restricted to the typical characteristics of that cluster. For instance, the BPM cluster (A) also contains BPMMs addressing some BPO capability areas, albeit in a minor way.

5.2 Confirmatory classification by discriminant analysis

To validate the three clusters, a discriminant analysis was conducted to predict which BPMM belongs to which cluster. If this predicted group membership corresponds to the group membership obtained from cluster analysis, our proposed BPMM classification is confirmed. Hence, the independent variables (i.e. discriminators or predictors) were the 17 capability areas, measured as binary values. The dependent variable is the categorical membership variable, resulting from the cluster analysis.

The two discriminant methods available in SPSS (version 18) were performed, i.e. regular and stepwise. First, the regular method included all independent variables. Secondly, in the stepwise method, subsequent steps included only the most discriminating independents until an additional step did not significantly increase the proportion of total variability explained. Per method, the discriminant analysis calculated two linear equations, i.e. two discriminant functions (= the total number of clusters minus one), to predict group membership. In both methods, the discriminant functions were highly significant ($P<0.001$). The discriminant functions in the regular method respectively explain 96.3% and 75.3% of the total variability between the clusters (R^2), whereas those in the stepwise method respectively explain 93.4% and 66.4%. All discriminant functions and the associated scatter plot with BPMMs are available in Figure 3. In future research, these functions can also be used to classify new BPMMs that do not appear in our dataset.



(*) D_1 = -0.475*design + 2.381*analysis - 0.209*implementation + 0.474*measurement + 2.173*evaluation + 1.224*improvement – 0.633*strategy + 0.049*external + 0.254*roles + 0.874*skills – 0.141*daily + 0.713*values + 1.796*attitudes + 1.045*appraisals + 0.237*top – 0.107*chart + 1.143*bodies – 6.308

(**) D_2 = -1.391*design – 2.867*analysis + 1.593*implementation – 1.821*measurement + 6.328*evaluation + 0.238*improvement + 0.853*strategy – 0.301*external – 0.524*roles + 1.216*skills + 0.594*daily + 0.062*values + 1.525*attitudes + 1.556*appraisals – 0.768*top + 0.453*chart – 1.689*bodies – 6.774

(***) D_3 = 2.282*analysis – 0.273*implementation + 1.441*improvement + 1.695*attitudes + 1.296*appraisals + 1.405*bodies – 3.814

(****) D_4 = -2.363*analysis + 1.205*implementation + 0.491*improvement + 1.275*attitudes + 1.745*appraisals – 1.597*bodies – 2.334

Figure 3. The canonical discriminant functions to classify BPMMs (with unstandardised coefficients).

Figure 3 shows the centroids of each cluster, based on the cluster means of the independents. The points represent BPMMs per cluster of the cluster analysis. Since the stepwise method is more accurate, one point represents multiple BPMMs. BPMMs with discriminant scores near to a centroid are predicted as belonging to that group. An approximation of the predicted memberships are visualised by circles per method. Since almost all BPMMs in each circle belong to the same cluster, it reveals that the classification results are fairly similar with those of the cluster analysis.

A more formal statistic to validate the BPMM classification is shown in Table 3, as the degree of conformance between cluster analysis and discriminant analysis. Particularly, the original cluster membership (in the rows) is compared with the predicted group membership by the discriminant analysis (in the columns).

Table 3. The classification results of discriminant analysis compared to cluster analysis.

Ward's clusters			Predicted group membership for the regular method			Predicted group membership for the stepwise method			Total
			A (BPM)	B (interm. BPO)	C (BPO)	A (BPM)	B (interm. BPO)	C (BPO)	
Original	Count	A(BPM)	23	0	0	22	**1**	0	23
		B (interm.BPO)	0	26	0	**1**	25	0	26
		C (BPO)	0	**1**	19	0	**3**	17	20
	Result		**98.55%** (i.e. 68/69) of original grouped cases correctly classified. (kappa=**0.978**>0.75; P<0.001)			**92.75%** (i.e. 64/69) of original grouped cases correctly classified. (kappa=**0.890**>0.75; P<0.001)			
Cross-validated[a]	Count	A(BPM)	21	**2**	0	21	**2**	0	23
		B (interm.BPO)	**4**	22	0	**1**	23	**2**	26
		C (BPO)	**1**	**3**	16	**1**	**3**	16	20
	Result		**85.51%** (i.e. 59/69) of cross-validated grouped cases correctly classified. (kappa=**0.780**>0.75; P<0.001)			**86.96%** (i.e. 60/69) of cross-validated grouped cases correctly classified. (kappa=**0.802**>0.75; P<0.001)			

a. In cross validation, each case (i.e. BPMM) is classified by the discriminant functions derived from all cases other than that case.

Depending on which discrimination method was used, 85.51% or more of the BPMMs were predicted in the same clusters as in cluster analysis. This percentage is significantly higher than the percentage by chance (i.e. 33.33% for three clusters of equal size). The percentages of the stepwise method are more accurate, since they focus on the best discriminators. When translating to the formal Cohen's Kappa, it means an excellent agreement between cluster analysis and discriminant analysis (kappa>0.75; P<0.001). The BPMM classification is thus strongly confirmed.

6 Discussion

Based on the theoretical capability areas to reach business (process) excellence, our sample is classified into three maturity types: BPM maturity, intermediate BPO maturity, and BPO maturity. This formal classification refines the initial dichotomy of BPM maturity and BPO maturity.

Cluster C in Figure 3 represents BPO maturity, and is the most comprehensive regarding the theoretical capability areas. Cluster B, with intermediate BPO maturity, is a good alternative for organisations wishing to improve business processes in a holistic way, but without formal structural reforms. For instance, initiatives by middle managers without input of top managers, or for less intense collaborations between departments or organisations. BPM maturity in cluster A does not cope with organisational aspects, and is the least comprehensive. For instance, it is more suited for teams wishing to improve their business processes without input of higher management.

The three BPMM examples regarding maturity levels in the introduction section each belong to a different cluster. OMG [8] belongs to the BPO cluster (C) by assessing and improving all theoretical capability areas, except for BPO-oriented values. In the intermediate BPO cluster (B), the Rummler-Brache Group [9] measures most BPM capability areas (except for BP analysis, external relationships, and skills), supplemented by BPO-oriented values, attitudes, and rewards. Finally, McCormack and Johnson [10] illustrate the BPM cluster (A), by addressing BP design, measurement, evaluation, strategy, roles, and BPO-oriented attitudes. It thus includes one BPO capability area, but lacks half of the fundamental BPM capability areas. Furthermore, the other BPMMs mentioned in the introduction are classified in the BPO cluster (C) [6,12,13], although [13] is more on the border line with the intermediate BPO cluster.

Furthermore, we recall from section 3.2 that assessment items may literally refer to one, more or all business processes in the organisation. By taking into account this additional dimension, the BPMM classification can be further refined into nine maturity types being measured by the currently proposed BPMMs: BPM maturity for one, more or all business processes, intermediate BPO maturity for one, more or all business processes, and BPO maturity for one, more or all business processes in the assessed organisation(s) or supply chain. Consequently, the BPMM classification further refines earlier findings regarding the maturity for specific or all business processes [6].

Interestingly, this classification allows evaluating the 'maturity' of BPMMs, or the completeness of BPMMs with respect to the theoretical capability areas. Figure 4 is based on logical induction, with BPM being contained in BPO, which includes organisational aspects across business processes.

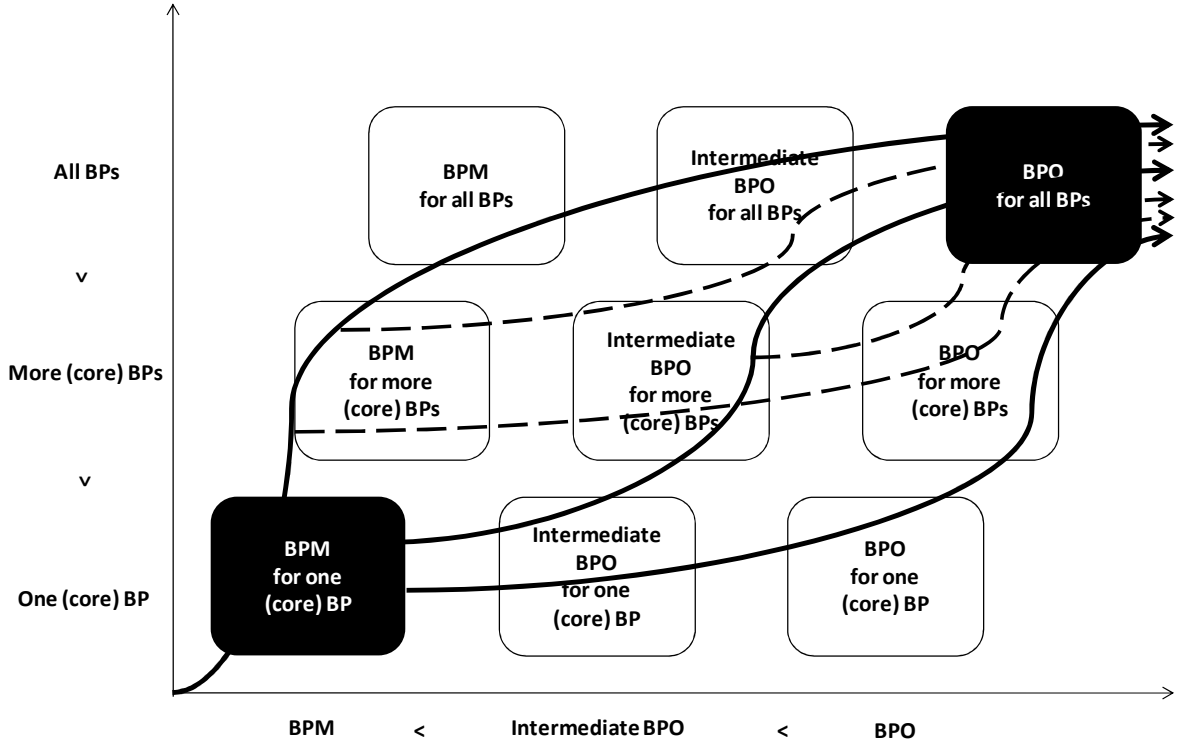


Figure 4. The completeness of BPMMs

Of all maturity types identified, BPM for one business process is the least complete, whereas BPO for all business processes is the most complete. The relationships in between are less hierarchical, by indicating that completeness increases (1) from BPM over intermediate BPO to BPO, and (2) from one over more to all business processes. For instance, we do not assert that BPO for one or more business processes is necessarily better than BPM for all business processes. We only claim that BPO models are more complete than intermediate BPO models, which in turn are more complete than BPM models, and this for an equal or lower number of business processes.

7 Conclusion

This research responds to the lack of consensus on the capability areas necessary for business process maturity. Therefore, we have presented a theoretical framework which underpins 6 main capability areas and 17 sub areas.

The main capability areas are based on accepted definitions of three umbrella terms in the business process literature, i.e. ‘business process’ (BP), ‘business process management’ (BPM), and ‘business process orientation’ (BPO): (1) modelling, (2) deployment, (3) optimisation, (4) management, (5) culture, and (6) structure. It turned out that some collected BPMMs are limited to BPM maturity (by addressing areas 1 to 4), whereas others cover BPO maturity (by addressing areas 1 to 6).

The sub areas within the first three main capability areas are primarily founded by the business process lifecycle theories, whereas the others are more supported by established organisation management theories. On the other hand, the first four main capability areas represent the characteristics of specific business processes, whereas the final two main capability areas characterize the whole portfolio of business processes within the involved organizations. All sub areas are represented by the collected BPMMs, but especially those within ‘deployment’ and ‘optimization’. Not surprisingly, these are the two areas which are most directly related to business process performance, or excellence. The other areas are less frequently addressed, which suggest different maturity types being measured by the collected BPMMs.

Particularly, cluster and discriminant analysis have elicited three maturity types:

- business process management (BPM) maturity, primarily focussing on business process modelling (1), deployment (2), optimisation (3) and management (4);
- business process orientation (BPO) maturity, combining BPM maturity with a process-oriented culture (5) and structure (6);
- intermediate BPO maturity, limiting BPO maturity to some process-oriented aspects, usually cultural (5).

BPO maturity is the most comprehensive, but requires top management commitment. Alternatively, intermediate BPO maturity is also realisable by middle management. BPM maturity is more suited for team initiatives. Evidence has shown that a business process (BP) maturity type, merely centred on modelling and deployment, does not exist for generic business processes.

Furthermore, we added the number of business processes addressed to each BPMM type, i.e. does it concern the maturity of one, more, or all business processes in the involved organisation(s)? The extended BPMM classification allows evaluating the completeness of BPMMs by arranging those nine resulting maturity types. It implies that existing BPMMs do not measure the same maturity, and blindly comparing results leads to incorrect conclusions. Thereby, opportunities exist to refine many models towards more complete BPMMs.

Consequently, the research gave evidence of a theoretical framework with six main capability areas and 17 capability sub areas. Together with the classified maturity types, it contributes to the grounding of BPMM literature. For instance, our theoretical framework can be translated towards a maturity theory, in which an increase in capability areas contributes to higher maturity and higher business (process) performance. Future research can demonstrate which combinations of capability areas (i.e. maturity types) contribute more to performance than others. Furthermore, this framework can be used to evaluate the scope of existing BPMMs or to direct the design of new BPMMs, e.g. regarding cross-organisational business processes.

References

[1] Gartner, Gartner EXP worldwide survey of more than 1,500 CIOs shows IT spending to be flat in 2009, 2009, retrieved September 8, 2011, from: http://www.gartner.com/

[2] McKinsey, How IT is managing new demands: McKinsey global survey results, 2010, retrieved September 9, 2011, from: https://www.mckinseyquarterly.com/

[3] H. J. Harrington, Process Management Excellence, Paton Press, California, 2006.

[4] J. vom Brocke, M. Rosemann, Foreword, in: J. vom Brocke, M. Rosemann (Eds.), Handbook on Business Process Management 2, Springer, Berlin Heidelberg, 2010, pp. vii-ix.

[5] Not included for review reasons

[6] T. de Bruin, M. Rosemann, Using the delphi technique to identify BPM capability areas, ACIS Proceedings (2007) 642-653.

[7] S.A. Sheard, Evolution of the frameworks quagmire, IEEE Comput. 34 (2001) 96-98.

[8] OMG, Business Process Maturity Model. Version 1.0, 2008, retrieved December 2, 2009, from: http://www.omg.org/

[9] Rummler-Brache Group, Business process management in U.S. firms today, 2004, retrieved June 23, 2010, from: http://rummler-brache.com/

[10] K. McCormack, W.C. Johnson, Business Process Orientation: Gaining the e-Business Competitive Advantage, St. Lucie Press, Florida, 2001.

[11] A.M. Maier, J. Moultrie, J.P. Clarkson, Developing maturity grids for assessing organisational capabilities: practitioner guidance, MCD Proceedings (2008) 1-29.

[12] M. Hammer, The process audit, Harvard Bus. Rev. 4 (2007) 111-123.

[13] H.J. Harrington, Business Process Improvement, McGraw-Hill, New York, 1991.

[14] M. Rosemann, J. vom Brocke, The six core elements of business process management, in: J. vom Brocke, M. Rosemann (Eds.), Handbook on Business Process Management 1, Springer, Berlin Heidelberg, 2010, pp. 107-122.

[15] P. Mathiesen *et al.*, A comparative analysis of business analysis (BA) and business process management (BPM) capabilities, ECIS Proceedings (2011) 1-12.

[16] P.A. Smart, H. Maddern, R.S. Maull, Understanding business process management: implications for theory and practice, Brit. J. Manage. 20 (2009) 491-507.

[17] G. Doebeli *et al.*, Using BPM governance to align systems and practice, BPM J. 17 (2011) 184-202.

[18] S. Reiter *et al.*, The phenomenon of business process management: practitioners' emphasis, ECIS Proceedings, (2010) 1-12.

[19] OGC, Prince2, 2010, retrieved May 11, 2010, from: http://www.ogc.gov.uk/

[20] J. McGovern *et al.*, A Practical Guide to Enterprise Architecture, Pearson Education, New Jersey, 2004.

[21] R. Skrinjar, V. Bosilj-Vuksic, M.I. Stemberger, The impact of business process orientation on financial and non-financial performance, BPM J. 14 (2008) 738-754.

[22] U. Baumöl, Cultural change in process management, in: J. vom Brocke, M. Rosemann (Eds.), Handbook on Business Process Management 2, Springer, Berlin Heidelberg, 2010, pp. 487-514.

[23] J. Jeston, J. Nelis, Business Process Management: Practical Guidelines to Successful Implementations, Butterworth-Heinemann, Elsevier, Oxford, 2006.

[24] M.C. Lacity, M.A. Janson, Understanding qualitative data: a framework of text analysis methods, J. Manage. Inform. Syst. 11 (1994) 137-155.

[25] A.K. Jain, M.N. Murty, P.J. Flynn,. Data clustering: a review, ACM Comp. Surv. 31 (1999) 264-323.

[26] G. Punj, D.W. Stewart, Cluster analyisis in marketing research: review and suggestions for application, J. Marketing Res. 20 (1983) 134-148.

[27] C.H. Romesburg, Cluster Analysis for Researchers, Lulu Press, North Carolina, 1984.

[28] W.R. Klecka, Discriminant Analysis, Sage Publications, California, 1980.

[29] K. Palmberg, Exploring process management: are there any widespread models and definitions?, Total Qual. Manage. 21 (2009) 203-215.

[30] M. Zairi, Business process management: a bounderyless approach to modern competitiveness, BPM J. 3 (1997) 64-80.

[31] J.-N. Gillot, The Complete Guide to Business Process Management, Booksurge Publishing, South Carolina, 2008.

[32] M. Weske, Business Process Management. Concepts, Languages and Architectures, Springer, Berlin, 2007.

[33] H. Smith, P. Fingar, Business Process Management: the Third Wave, Meghan-Kiffer Press, Tampa, 2002.

[34] R.G. Lee, B.G. Dale, Business process management: a review and evaluation, BPM J. 4 (1998) 214-225.

[35] T.R. Gulledge Jr., R.A. Sommer, Business process management: public sector implications, BPM J. 8 (2002) 364-376.

[36] B. Champlin, Dimensions of business process change, 2008, retrieved June 20, 2010, from: https://www.bpminstitute.org/uploads/media/Champlin-6-25-08.pdf

[37] W.A. Shewhart, Statistical Method from the Viewpoint of Quality Control, second ed., Dover Publications, New York, 1986.

[38] W.E. Deming, The New Economics: for Industry, Government, Education. Center for Advanced Educational Services, Cambridge, 1994.

[39] U. Kannengiesser, Subsuming the BPM life cycle in an ontological framework of designing, CAiSE Workshop Proceedings (2008) 31-45.

[40] M. Netjes, H.A. Reijers, W.M. van der Aalst, Supporting the BPM life-cycle with FileNet, CAiSE Workshop Proceedings (2006) 497-508.

[41] M. zur Muehlen, D.T.-Y. Ho, Risk management in the BPM lifecycle, BPM Workshops Proceedings (2005) 454-466.

[42] M. Hammer, J. Champy, Reengineering the Corporation, second ed., HarperCollins Publishers, New York, 2003.

[43] D. Nave, How to compare six sigma, lean and the theory of constraints, Qual. Prog. (2002) 73-78.

[44] B. Curtis, J. Alden, The business process maturity model: what, why and how, BPTrends February (2007).

[45] J. vom Brocke, T. Sinnl, Culture in business process management: a literature review, BPM J. 17 (2011) 357-377.

[46] W.W. Burke, G.H. Litwin, A causal model of organizational performance and change, J. Manage. 18 (1992) 523-545.

[47] J.R. Waterman, T.J. Peters, J.R. Phillips, Structure is not organization, Bus. Horiz. (1980) 14-26.

[48] W.R. Boswell, J.B. Bingham, A.J. Colvin, Aligning employees through “line of sight”, Bus. Horiz. 49 (2006) 499-509.

[49] R.S. Kaplan, D.P. Norton, The Strategy-Focused Organization, Harvard Business School Press, Boston, 2001.

[50] T.H. Davenport, Process Innovation. Reengineering Work through Information Technology, Harvard Business School, Boston, 1993.

[51] J. Champy, X-Engineering the Corporation. Reinventing Your Business in the Digital Age, Warner Business Books, New York, 2002.

[52] M. Kohlbacher, The effects of process orientation: a literature review, BPM J., 16 (2010) 135-152.

[53] C. Armistead, S. Machin, Implications of business process management for operations management, Int. J. Oper. Prod. Man. 17 (1997) 886-898.

[54] T. Neubauer, An empirical study about the status of business process management, BPM J. 15 (2009) 166-183.

[55] M. Rosemann, The service portfolio of a BPM center of excellence, in: J. vom Brocke, M. Rosemann (Eds.), Handbook on Business Process Management 2, Springer, Berlin Heidelberg, 2010, pp. 267-284.

[56] A.-W. Scheer, E. Brabänder, The process of business process management, in: J. vom Brocke, M. Rosemann (Eds.), Handbook on Business Process Management 2, Springer, Berlin Heidelberg, 2010, pp. 239-265.

[57] R. Silvestro, C. Westley, Challenging the paradigm of the process enterprise: a case-study analysis of BPR implementation, Omega-Int. J. Manage. S. 30 (2002) 215-225.

[58] P. Trkman, The critical success factors of business process management, Int. J. Inform. Manage. 30 (2010) 125-134.

[59] A.A. Atkinson, J.H. Waterhouse, R.B. Wells, A stakeholder approach to strategic performance measurement, Sloan Manage. Rev. 38 (1997) 25-37.

[60] OMG, Business Motivation Model. Version 1.1, 2010, retrieved May 3, 2011, from: http://www.omg.org/

[61] A.J. Colvin, W.R. Boswell, The problem of action and interest alignment: beyond job requirements and incentive compensation, Hum. Resour. Manage. Rev., 17 (2007) 38-51.

[62] W.R. Boswell, J.W. Boudreau, How leading companies create, measure and achieve strategic results through "line of sight", Manage. Decis. 39 (2001) 851-859.

Appendix A. The collected BPMMs (N=69)

ID	Author(s)	BPMM name
(1) Business process (BP)		
(1.1) Academic		
AOU	Aouad, Cooper, Hinks, Kagioglou & Sexton	Co-maturation model for synchronising BP and IT
ARM	Armistead, Machin & Pritchard	BPM's degree of progress (as part of a larger survey)
DET	DeToro & McCabe	Process condition rating model
HAM	Hammer	Process and Enterprise Maturity Model (PEMM)
HAR1	Harrington	Process maturity grid
LEE	Lee, Lee & Kang	Value-based process maturity model (vPMM)
MAU	Maull, Tranfield & Maull	BPR maturity model
MCC1	McCormack & Johnson	BPO maturity model
ROH	Rohloff	Process management maturity assessment (PMMA)
ROS	Rosemann, de Bruin & Power	BPM maturity model
SEI	SEI, Software Engineering Institute (Carnegie Mellon University)	• Capability maturity model integration (CMMI) • Standard CMMI appraisal method for process improvement (SCAMPI)
SKR	Skrinjar, Bosilj-Vuksic, Stemberger & Hernaus	BPO maturity model
WIL	Willaert, Van den Bergh, Willems & Deschoolmeester	Holistic BPO maturity framework
(1.2) Non-academic		
BIS	Bisnez Management, Business & IT Trends Institute, students of Erasmus University, BPM Magazine, Information Magazine	BPM maturity model (in Dutch: 'BPM volwassenheidsmodel')
BPM	BPMInstitute	State of BPM (as part of a larger BPM survey)
BPT	BP Transformations Group & BPGroup (previously BPM Group)	8 Omega ORCA (Organisational readiness & capability assessment)
CAM1	CAM-I, Consortium for Advanced Management-International	Process-based management loop: • discipline model (organisation's current philosophy, business model, methods and tools) • process-based management assessment model (components) • process continuum model (levels)
CAM2	CAM-I, Consortium for Advanced Management-International	Process-based management assessment and implementation road map
CHA	Champlin (ABPMP)	Process management maturity model
DEL	Deloitte & Utrecht University	Business maturity model & scan

ID	Author(s)	BPMM name
ESI1	ESI, European Software Institute	EFQM/SPICE integrated model
FAA	FAA, Federal Aviation Administration	• FAA integrated capability maturity model (FAA-iCMM) • FAA-iCMM appraisal method (FAM)
FIS	Fisher (BearingPoint)	Business process maturity model
GAR1	Gardner	Process improvement road map
GAR2	Gartner	BPM maturity & adoption model
HAR2	Harmon (BPTrends)	Informal BP maturity evaluation model
IDS	IDS Scheer, Software AG	• BPM maturity check • BPM road map assessment
ISO	ISO/IEC Commission	ISO/IEC 15504
O&I	O&i	BPM scan
OMG	OMG, Object Management Group	Business process maturity model (BPMM)
ORA	Oracle & BEA Systems	BPM lifecycle assessment survey
REM	Remoreras	Process culture maturity model
RUM	Rummler-Brache Group	Process Performance Index
SAP	SAP	Process maturity analysis & plan
SCH1	Scheer	BPM check-up
SMI	Smith & Fingar	Process management maturity model (PMMM)
SPA	Spanyi	BP competence grid
(2) Supply chain (SC)		
(2.1) Academic		
ARY	Aryee, Naim & Lalwani	SC integration maturity model
BOH	Böhme & Childerhouse	SC integration evaluation tool and maturity model
CAM3	Campbell & Sankaran	SC integration enhancement framework (SCIEF)
MCC2	McCormack et al.	SC management maturity model
MCL	McLaren	Web-enabled SC integration measurement model
MIC	Michigan State University	21st Century Logistics Framework
NET	Netland, Alfnes & Fauske	SC maturity assessment test (SCMAT)
RIV	Riverola	SC management – Technology maturity model
TOK	Tokyo Institute of Technology	Logistics scorecard (LSC)
(2.2) Non-academic		
ABE	AberdeenGroup	Global SC maturity framework
AND	Andersen Consulting (Accenture)	SC continuum
CGF	CGF, Consumer Goods Forum (former GCI, Global Commerce Initiative)	Global scorecard for efficient consumer response capability
CGR	CGR Management Consulting	SC management maturity model
CHI	Chicago Consulting	SC maturity model
CSC	CSC, SC Management Review Magazine & Michigan State University	• SC maturity model (until 2006) • Ten SC competencies (as from 2007)
EKN	eKNOWtion	SC maturity monitor (SCM²)
IBM	IBM	SC maturity model
JER	Jeroen van den Bergh Consulting & VU University Amsterdam	SC maturity scan
LMI	LMI Research Institute	GAIA SC sustainability maturity model
MAN	Manugistics & JDA Software	SC Compass
PMG	PMG & PRTM	SC maturity model
SCC	SCC, Supply Chain Council & APQC	SCORmark Survey
SCH2	Schoenfeldt	SC mgt maturity model
STE	Stevens	SC integration model
(3) Collaboration		
(3.1) Academic		
FRA	Fraser, Farrukh & Gregory	Collaboration maturity grid
MAG	Magdaleno, Cappelli, Baiao, Santoro & Araujo	Collaboration maturity model (ColabMM)
RAM	Ramasubbu & Krishnan	Process maturity framework
SIM	Simatupang & Sridharan	SC Collaboration index
TAP	Tapia, Daneva, vanEck & Wieringa	IT-enabled collaborative networked organisations maturity model (ICoNOs MM)
WOG	Wognum & Faber	Fast reactive extended enterprise – capability assessment framework (FREE-CAF)
(3.2) Non-academic		
ESI2	ESI, European Software Institute	Enterprise Collaboration Maturity Model
VIC	Voluntary Interindustry Commerce Standards	Collaborative planning, forecasting & replenishment (CPFR) rollout readiness self-assessment

Appendix B. The mapping of BPMMs to capability sub areas

BPMM	Design	Analysis	Implemen-tation	Measure-ment	Evaluation	Improve-ment	Strategy	External	Roles	Skills	Daily	Values	Attitudes	Appraisals	Top	Chart	Bodies
AOU	1	1	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0
ARM	1	0	0	1	1	1	1	0	1	1	0	0	0	1	1	1	0
DET	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
HAM	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
HAR1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	0	0
LEE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
MAU	1	0	1	1	1	1	1	0	1	0	0	1	0	0	0	1	0
MCC1	1	0	0	1	1	0	1	0	1	0	0	0	1	0	0	0	0
ROH	1	0	1	1	1	1	1	0	1	1	1	0	1	1	0	0	1
ROS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
SEI	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	0
SKR	1	0	1	1	1	0	1	0	1	0	0	0	1	0	0	0	0
WIL	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1
BIS	1	0	1	1	1	1	1	0	1	0	1	0	0	0	0	0	1
BPM	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1
BPT	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0
CAM1	1	0	1	1	1	1	1	0	1	1	0	0	1	1	0	0	0
CAM2	1	0	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1
CHA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DEL	1	0	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0
ESI1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
FAA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
FIS	1	0	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0
GAR1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1
GAR2	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
HAR2	1	0	1	1	1	1	1	0	1	1	0	0	0	1	0	0	0
IDS	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	1	1
ISO	1	0	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0
O&I	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0
OMG	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
ORA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1
REM	1	0	1	1	1	1	0	0	1	1	0	1	1	0	1	0	1
RUM	1	0	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0
SAP	1	0	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0

SCH1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1
SMI	1	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0
SPA	1	0	0	1	1	1	1	0	0	0	0	1	0	0	1	0	0
ARY	0	0	1	0	0	0	0	1	0	1	1	1	1	0	0	1	0
BOH	0	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0
CAM3	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
MCC2	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1
MCL	0	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0
MIC	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0
NET	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
RIV	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
TOK	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0
ABE	0	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0
AND	1	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0
CGF	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CGR	1	0	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1
CHI	0	0	0	1	1	1	1	1	0	0	1	0	1	1	0	0	0
CSC	0	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0
EKN	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
IBM	1	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0
JER	1	0	1	1	1	1	1	1	1	0	1	0	0	1	1	0	0
LMI	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1
MAN	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
PMG	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0
SCC	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SCH2	0	0	0	1	1	1	1	1	1	0	1	0	1	1	1	0	0
STE	1	0	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0
FRA	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
MAG	1	0	1	1	1	0	0	0	1	1	1	0	1	1	0	0	0
RAM	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
SIM	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0
TAP	1	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1	0
WOG	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
ESI2	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0
VIC	0	0	1	1	1	1	1	1	1	0	1	1	0	1	0	0	0

Appendix C. The degree of capability area representation per cluster

Full sample: hierarchical Ward's method (N=69)

Clusters		Design	Analysis	Imple-men-tation	Measure-ment	Eva-luation	Improve-ment	Strate-gy	External	Roles	Skills	Daily	Values	Attitu-des	Appra-isals	Top	Chart	Bodies
A (BPM) N=23	Mean	.74	.04	.74	.87	.96	.74	.74	.52	.52	.22	.57	.26	.13	.09	.17	.17	.13
	Std. Dev.	.449	.209	.449	.344	.209	.449	.449	.511	.511	.422	.507	.449	.344	.288	.388	.388	.344
B (interm. BPO) N=26	Mean	.73	.00	.92	1.00	1.00	.96	.96	.81	.88	.69	.81	.62	.81	.92	.46	.27	.08
	Std. Dev.	.452	.000	.272	.000	.000	.196	.196	.402	.326	.471	.402	.496	.402	.272	.508	.452	.272
C (BPO) N=20	Mean	1.00	.70	.85	1.00	1.00	1.00	.90	.85	1.00	.95	.70	.70	.95	.80	.75	.40	.75
	Std. Dev.	.000	.470	.366	.000	.000	.000	.308	.366	.000	.224	.470	.470	.224	.410	.444	.503	.444
Total N=69	Mean	.81	.22	.84	.96	.99	.90	.87	.72	.80	.61	.70	.52	.62	.61	.45	.28	.29
	Std. Dev.	.394	.415	.369	.205	.120	.304	.339	.450	.405	.492	.464	.503	.488	.492	.501	.450	.457

Split sample: hierarchical Ward's method (N=37)

Clusters		Design	Analysis	Imple-men-tation	Measure-ment	Eva-luation	Improve-ment	Strate-gy	External	Roles	Skills	Daily	Values	Attitu-des	Appra-isals	Top	Chart	Bodies
A (BPM) N=8	Mean	.88	.13	.63	.75	1.00	.50	.75	.25	.50	.00	.13	.50	.25	.00	.13	.13	.00
	Std. Dev.	.354	.354	.518	.463	.000	.535	.463	.463	.535	.000	.354	.535	.463	.000	.354	.354	.000
B (interm. BPO) N=9	Mean	1.00	.00	1.00	1.00	1.00	1.00	1.00	.33	1.00	.78	.56	.11	.44	.67	.00	.00	.33
	Std. Dev.	.000	.000	.000	.000	.000	.000	.000	.500	.000	.441	.527	.333	.527	.500	.000	.000	.500
C (BPO) N=20	Mean	.95	.60	.85	1.00	1.00	1.00	.90	.80	1.00	1.00	.55	.70	.85	.80	.80	.40	.65
	Std. Dev.	.224	.503	.366	.000	.000	.000	.308	.410	.000	.000	.510	.470	.366	.410	.410	.503	.489
Total N=37	Mean	.95	.35	.84	.95	1.00	.89	.89	.57	.89	.73	.46	.51	.62	.59	.46	.24	.43
	Std. Dev.	.229	.484	.374	.229	.000	.315	.315	.502	.315	.450	.505	.507	.492	.498	.505	.435	.502

Dark grey = high representation (1>=0.665); light grey = medium representation (0.335<0.665).