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Towards a Maturity Model: Bed Management Capabilities in Hospitals

by

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TOWARDS A MATURITY MODEL: BED MANAGEMENT CAPABILITIES IN HOSPITALS

Research paper

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Abstract

As instrumental healthcare institutions providing high quality patient care, hospitals are currently facing multiple challenges ranging from pressure to reduce costs to a rapidly increasing elderly population. From a process perspective hospitals feature support and management processes, which enable the core process of providing patient care. One of the most crucial process areas – bed management – refers primarily to logistics processes related to the physical beds in hospitals. However, these are closely intertwined with diverse management and support processes (e.g., occupancy management). In order to conceptualize bed management as a process area from a holistic perspective, we develop a capability framework based on a thorough literature review as well as subsequent evaluation of the framework's relevance, completeness, and practical applicability in two German hospitals. The capability framework includes 30 capabilities grouped into six overarching capability areas. It suggests that efficient and effective bed management is predicated on pooling organizational resources from various organizational units and functional areas. Our work serves as a foundation for the development of a respective maturity model. It enables practitioners to systematically manage capabilities related to bed management and supports them in deriving roadmaps, conducting fit/gap analyses, and prioritizing topics, while accounting for the hospital-specific context.

Keywords: Capability Framework, Maturity Model, Hospitals, Bed Management.

1 Introduction

Hospitals play a central role in healthcare systems by ensuring timely and adequate patient treatment and are characterized by their complexity, knowledge-intensity as well as their dynamic and multidisciplinary environment (Kirchmer et al., 2013). They are increasingly put under pressure to improve efficiency while simultaneously enhancing patient care quality (Lee et al., 2017; Vos et al., 2009). A broadly used approach to address increased competition, institutional pressure, and inefficiency (mainly caused by inefficient processes) is the adoption of Business Process Management (BPM) which has positive effects such as quality improvement and costs reduction (Kohlbacher, 2010) due to its inherent process orientation (Zairi, 1997). Further, process thinking, effective process management as well as the introduction of performance measurement have proven vital to increasing patient care quality (Varabyova et al., 2016; Kirchmer et al., 2013; Quaglini, 2010). In general, the BPM literature differentiates core processes (e.g., provision of patient care), management processes (e.g., financial management), and support processes (e.g., materials logistics) (Armistead et al., 1999). Kirchmer (2017) and Rosing et al. (2015) have shown that improving support processes significantly enhances the quality of core processes. One of the most crucial process areas in hospitals – bed management (BM) – primarily encompasses logistics activities related to cleaning or moving beds and supplying patients with clean beds of the right type (Winkelmann et al., 2008). BM is a complex process area that is heavily influenced by a multitude of different factors such as overall workload and staff turnover (He et al., 2018; Fraser and Estabrooks, 2008). Further, it is located at the intersection of different hospital departments (Landa et al., 2018). Hence, BM is an essential target for quality improvement (Asplin et al., 2003) since it can enhance the quality of the core process (i.e., treating patients) as well as internal hospital efficiency and effectiveness.

A common approach to process improvement is the application of a maturity model, the derivation of recommendations for action and their practical implementation (Röglinger et al., 2012). Over the past years, the development of maturity models for the hospital sector has been experiencing increasing interest among researchers (Iadanza et al., 2019; Carvalho et al., 2017; Carvalho et al., 2016; Cleven et al., 2016; Söylemez and Tarhan, 2016; Cleven et al., 2014; Mettler, 2011a). However, several studies show that the utilization of broadly applicable maturity models in healthcare can prove difficult (Söylemez and Tarhan, 2016; Cleven et al., 2014; Vera and Kuntz, 2007). As a vital component and a prerequisite for developing maturity models, capability frameworks (CF) group similar capabilities into broader categories capturing basic features of a given domain (vom Brocke and Rosemann, 2015). They build the foundation for the assessment of process maturity and, thus, are a central component for developing maturity models. Therefore, we contend that identifying capabilities relevant for BM is a worthwhile and necessary effort as a step towards establishing a respective maturity model. Thus, we address the following research question:

What capabilities are relevant for BM in hospitals?

We follow de Bruin et al. (2005) in addressing the research question, who suggest a standard method for the development of a maturity model. The first four phases of this method concern the identification and structuring of capabilities that are relevant for the development of a CF. To evaluate our research, we apply the design science research (DSR) evaluation framework by Sonnenberg and vom Brocke (2012) and evaluate our CF in terms of relevance, completeness, and practical applicability in four expert interviews. The resulting CF for the BM process in hospitals comprises six overarching capability areas and 30 capabilities. Our work contributes to research on BM and process maturity in hospitals. On the one hand, our CF serves as the foundation for the development of corresponding maturity models, which assess the evolution of the underlying capabilities. On the other hand, it supports researchers by offering a holistic definition of BM as a process area including core, support, and management processes. Thus, it enables practitioners to systematically manage capabilities related to BM and shape corresponding transformation/development projects leading to improved patient treatment, and, ultimately, higher-quality healthcare.

The rest of our paper is organized as follows: The next section sets the theoretical foundations for BM as well as BPM capability development. Subsequently, we describe the research method leading to the

derivation of relevant capabilities as well as their evaluation in interviews. A reflective discussion on implications, limitations and future research concludes the paper.

2 Theoretical Background

2.1 Bed Management

The existing body of knowledge provides a variety of conceptualizations addressing different BM-related aspects (Schümann and Gontermann, 2017; Proudlove et al., 2007). In its core, BM is centered on bed logistics activities such as manoeuvring, cleaning, and patient-specific configuration of beds (Winkelmann et al., 2008). Such activities can be thought of as support processes triggered by core hospital processes dealing with the provision of patient care such as inpatient admission, diagnosis, and discharge (Proudlove et al., 2003). Hospitals also feature management processes such as strategy definition that further influence the execution of core and support processes. In order to provide a suitable holistic conceptualization of BM that takes into account such complex dependencies, we use the chain of survival as a starting point for identifying activities in core hospital processes that trigger logistic activities directly related to beds (Ziegler et al., 2012; Vera and Kuntz, 2007). Figure 1 illustrates these activities.

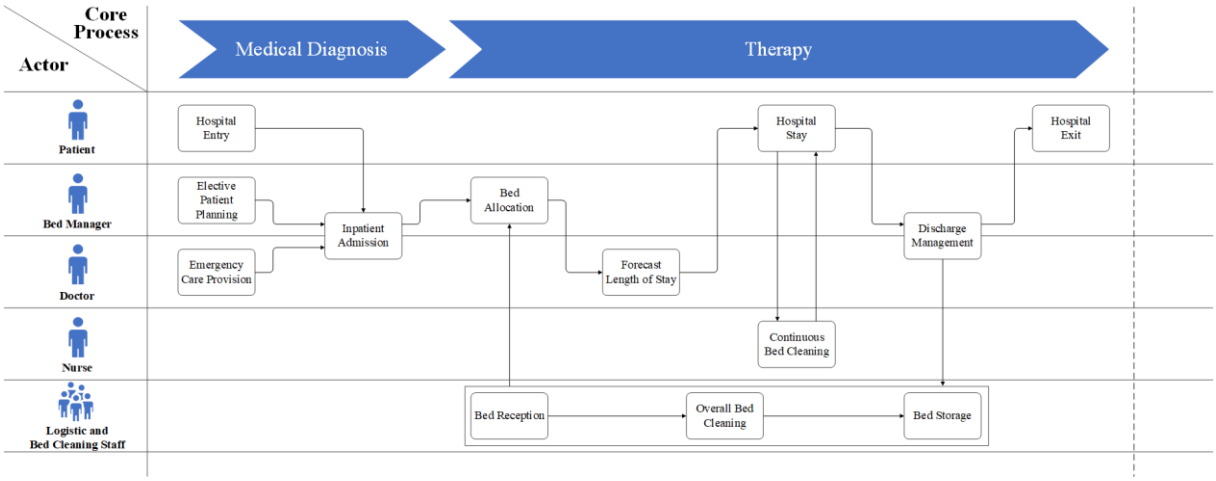

Figure 1. Main activities linking bed logistics to patient treatment

Activities concerning the core process of providing patient care start with the *medical diagnosis* and *therapy* (Holtmann et al., 2007). Thereby, the bed manager is responsible for sustaining a 24/7 BM service (Nierhaus et al., 2014; Barrett et al., 2012), enabling *doctors* and *nurses* to treat *patients* adequately. The relevant literature addresses two main kinds of *inpatient admission*: First, the admission of elective patients with scheduled patient hospital stays, which requires an *elective patient planning*, and second, the admission of emergency patients from the *emergency care provision* (Proudlove et al., 2003; Harper and Shahani, 2002; Thomson, 1997). According to Kumar and Mo (2010), the *bed assignment* itself is a task of the bed manager, which requires matching the availability and the demand of clean beds that suit the patient's specific needs in line with medical requirements concerning gender, diagnosis, and weight. To enable sound bed occupancy planning, a *length of stay forecast* is required (Harper and Shahani, 2002). While the patient is treated during his or her *hospital stay*, the nurse is required to arrange for *continuous bed cleaning* (Winkelmann et al., 2008; Rudolph, 1999). As the recovery of a patient progresses *discharge management* is an important activity, coupled with a corresponding bed status update (Proudlove et al., 2003) . The literature suggests several paths describing how the patient can *exit the hospital* (Mackay and Millard, 1999). All of them involve coordination among different actors (e.g., doctors and bed managers) making it a complex and lengthy procedure (Fleischer, 2015). After the patient's discharge, the *logistics staff* transfers the contaminated bed to a (de)centralized bed cleaning facility (Winkelmann et al., 2008). The *bed reception* is conducted by the *bed cleaning staff*,

after which a (partly) automated *overall bed cleaning* procedure is initialized, covering all relevant bed parts, such as the mattress and additional hardware (Hopman et al., 2015; Rudolph, 1999). Clean beds are finally delivered to *bed storage* points and can be allocated to the next patient (Proudlove et al., 2003). All of the above-depicted core and support processes can be affected by hospital management processes governing resource allocation, the identification and control of process metrics, governing structures as well as process design. In order to capture BM in its entirety, we define it as follows:

Bed management in hospitals comprises all core, support, and management processes, whose collective implementation ensures the integration of bed logistics (e.g., transport, planning, cleaning, or configuration of beds) and occupancy management (e.g., patient allocation, prioritization, or length of stay forecasting) contributing to a seamless admission, treatment, and discharge of patients.

This definition comprises a broad spectrum of activities ranging from the direct logistics of beds subject to core processes centered on the provision of patient care to relevant management processes. Therefore, we also integrate existing conceptualizations in the literature taking a partial view on BM (Lotlikar et al., 2018; Winkelmann et al., 2008; Proudlove et al., 2007; Proudlove et al., 2003; Harper and Shahani, 2002). Thus, we believe the presented conceptualization of BM serves as an adequate basis for identifying and distilling related organizational capabilities.

2.2 BPM Capability Frameworks and Maturity Models

BPM is increasingly being examined from a capability perspective (Niehaves et al., 2014; van Looy et al., 2014; Trkman, 2010). This perspective builds on the dynamic capability theory (Niehaves et al., 2014) and the resource-based view, which posits that firms are bundles of resources, which enable them to achieve competitive advantage (Wade and Hulland, 2004). Resources are split into assets and capabilities. Assets constitute tangible and intangible objects, while capabilities are "repeatable patterns of actions in the use of assets" (Wade and Hulland, 2004, p. 109). The dynamic capability theory further distinguishes operational and dynamic capabilities (Pavlou and El Sawy, 2011). Operational capabilities refer to the basic functioning of organizations whereas dynamic capabilities refer to the ability to build, integrate, and reconfigure operational capabilities (Kim et al., 2011; Winter, 2003). In the context of BPM, operational capabilities are associated with core and support processes while management processes are perceived as dynamic capabilities (Poeppelbuss and Niehaves, 2015; Forstner et al., 2014). Since we conceptualize BM as a process area that includes core, support, and management processes, we view it as a dynamic capability covering multiple operational capabilities.

BPM research regarding capabilities covers three distinct streams. The first is concerned with the identification of BPM capabilities. In this stream, researchers have proposed several CFs that consist of capabilities grouped into capability areas and factors capturing essential features of a given domain (vom Brocke and Rosemann, 2015; de Bruin and Rosemann, 2005). The second research stream focuses on examining how organizations evolve their capabilities (Poeppelbuss and Niehaves, 2015; Niehaves et al., 2014) by providing relevant descriptive and prescriptive approaches. Finally, the third stream combines the other two streams to develop instruments that help organizations advance capabilities. Such instruments include maturity models building on CFs by defining maturity levels that describe the state of development of capabilities along with a pre-defined path (Becker et al., 2009). This work can be assigned to the first stream of capability research and targets the identification of capabilities relevant for BM in hospitals as a prerequisite for developing corresponding descriptive and prescriptive instruments such as maturity models.

3 Research Process

While there is no standard method for the development of a CF, we follow the broadly accepted framework for maturity model development by de Bruin et al. (2005), in which the identification and structuring of capabilities are essential components. Figure 2 shows all activities of the maturity model development phases according to de Bruin et al. (2005). Activities marked with "✓" are relevant for the development of the CF.

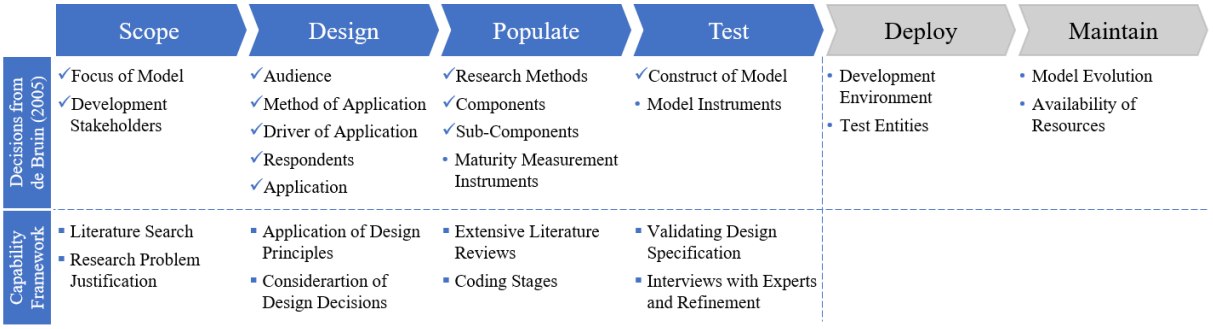

Figure 2. Research process based on de Bruin et al. (2005)

In the first phase of the research process we define the *scope* (1) of the future maturity model. This involves two activities: determining the focus and deciding on relevant stakeholders involved in the development process. The *design* phase (2) requires determining the audience, application, and respondents as well as compliance with design principles, e.g., those proposed by Pöppelbuß and Röglinger (2011). The *population* of the CF (3) is carried out by building a rigorous foundation as suggested by de Bruin et al. (2005). In doing so, we collect existing capability areas and capabilities by conducting an extensive literature review of CFs and maturity models. We process the literature resulting from this review in order to identify business process management, healthcare, and hospital capability areas and capabilities. Subsequently, we describe the identified capability areas and capabilities in detail and evaluate the relevance in the context of BM. Therefore, we conduct a second literature review with a focus on both research papers on BM and practical studies on BM as well as corresponding topics such as occupancy management as discussed in section 2.1. The latter is achieved by means of a focused web search similar to that in Röglinger et al. (2012). A meta-synthesis coding stage in accordance with the hospital-specific literature processing technique proposed by Polit and Beck (2018) ensures that new capability areas and capabilities are added, merged, iteratively refined or adapted to the context of BM. Finally, we *test* (4) our constructed framework for relevance and rigor in line with DSR guidelines (Hevner et al., 2004). Therefore, we apply the DSR evaluation framework by Sonnenberg and vom Brocke (2012) and conduct EVAL1 and EVAL2 to evaluate our results in several expert interviews with key BM stakeholders. We iteratively adapt and refine our CF based on the reviewers' feedback. Besides the fact that our CF is a necessary prerequisite for a corresponding maturity model, an additional component (maturity measurement instruments) is necessary before the final deployment and maintenance of the complete maturity model. Hence, it is not yet possible to perform the *deployment* (5) and *maintenance* (6) phase to evaluate our research from an ex-post perspective (EVAL3 and EVAL4).

4 Bed Management Capability Framework

4.1 Development

We first defined the boundaries of the future maturity model to align the CF as suggested by de Bruin et al. (2005) in the *scoping phase (1)*. This includes two main decisions, namely determining the focus of the model (i.e., deciding on how to distinguish the model from existing ones) and deciding whether the development of the model targets academic, practical, or governmental stakeholders. As of today, there are some maturity models that deal with the change and design of patient flow, the organizational structure of hospitals, and the optimization of hospital support processes (Carvalho et al., 2017; Mettler, 2011a, 2011b). However, these existing models are rather abstract, offer users only a limited amount of specific recommendations, and their applicability or adaptability to other processes or contexts is often insufficient (Söylemez and Tarhan, 2016). Furthermore, maturity models are often lacking substantial theoretical foundation (Cleven et al., 2014; Lahrmann et al., 2011; Mettler, 2010) and cannot be easily applied by practitioners, as they do not provide actual and detailed practical guidelines (Röglinger et al., 2012). Therefore, we conducted an extensive theoretical research in the development of maturity models

across various domains to address these problems and aim at proposing a CF that balances the strict criteria for theory building with high practical relevance and applicability.

Having decided on the boundaries, we specified the *design (2)* of our CF. Design decisions include basic information and the definition of central maturity constructs. For this purpose, we followed the design principles proposed by Pöppelbuß and Röglinger (2011). These design principles should be addressed within a maturity model design process and are structured in three groups: basic (1.1-1.4), descriptive (2.1-2.2), and prescriptive (3.1-3.3). However, there is no formal requirement to meet all design principles (Röglinger et al., 2012). For the design of our CF, we provide a set of basic information (1.1) as shown in Table 1. Since we are developing a CF in the first place without a corresponding descriptive maturity model, the other design principles regarding maturity and maturation (1.2) as well as the descriptive design principles of the maturity model (2.1-2.2) are not applied. Nonetheless, these principles should be considered when developing the descriptive maturity model. The definition of central constructs related to the application domain (1.3) is covered in the theoretical background and the target group-oriented documentation (1.4) is ensured by the work at hand.

Design Principles (Pöppelbuß, Röglinger 2011)	Basic Design Decisions Within this Work
a) Application domain and prerequisites for applicability	The application domain is hospitals which have to deal with scarce resources when it comes to BM The field of activity concentrates primarily on the needs of those responsible for BM or the corresponding organizational unit in the hospital, including clinical and administrative hospital managers. For its applicability, a thorough insight into BM is required
b) Purpose of use	Descriptive
c) Target group	Academics as well as practitioners who are concerned with the development and implementation of innovative support processes in hospitals using digital technologies, in particular those who deal with BM
d) Class of entities under investigation	BM capabilities in hospitals
e) Differentiation from related maturity models	Focus on BM Offer specific guidance applicable by practitioners
f) Design process and extent of empirical validation	Two-step literature review on maturity models and capability frameworks in business process management, healthcare, hospital, and bed management Validation through expert interviews

Table 1. Design decisions in developing the BM capability framework

Following the suggestion of de Bruin et al. (2005), we structured the components of the CF in a hierarchy. Therefore, our CF describes capability areas on the top level and each area is further specified by capabilities. In accordance with the hierarchical structure, further detailed information on the capabilities can be provided through the specification of items for each capability as part of a possible maturity measurement instrument in future work. In order to elaborate the capability areas and capabilities, we applied the inductive approach (i.e., capabilities are characterized first and the corresponding maturity is assigned subsequently) within our work as de Bruin and Rosemann (2005) recommend for more mature domains.

Following the scope and the design, we identified "what needs to be measured in the maturity assessment" (de Bruin et al., 2005, p. 5). In the *population phase (3)* we focused on the conceptualization of 'what' is going to be measured, i.e., the capabilities and capability areas, as they build the foundation for the future assessment instrument. The capability areas and capabilities were iteratively developed in a two-step process to benefit from the guidance of existing models on the one hand and to consider special aspects of BM on the other hand. This development process is illustrated in Figure 3.

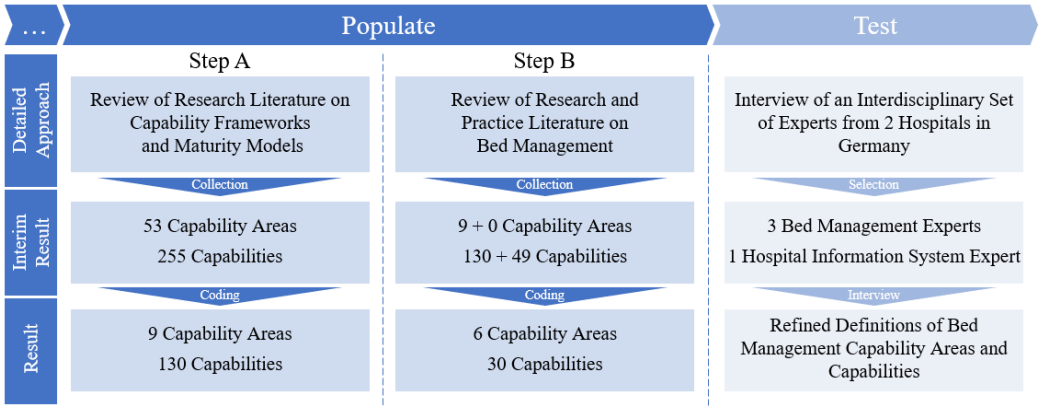

Figure 3. Population phase in the development of the CF

In step A, we aimed to identify already existing capability areas and capabilities in the literature. For the identification of relevant literature, we started with Röglinger et al. (2012) and vom Brocke and Rosemann (2015) in order to gain a broad insight into existing BPM maturity model publications. Also, we followed the literature search guidelines proposed by vom Brocke et al. (2009) to carry out a literature review for relevant maturity models and CFs in different domains (e.g., business process management, healthcare, and hospitals). The literature review aimed at identifying research articles in the database BASE and in digital libraries (SpringerLink and ScienceDirect) in order to identify papers from diverse backgrounds. Applying the search string "('maturity model' OR 'capability framework') AND ('business process management' OR 'healthcare' OR 'hospital')" we identified 2540 publications. Analyzing the title and abstract we narrowed down the search results to a total of 170 publications for further processing. In addition, we manually added seven publications found during an unstructured literature search. Extracting relevant aspects for BPM, healthcare and hospital domain out of the 177 publication resulted in a list of 255 capabilities and 53 capability areas. We assigned the identified capabilities to the capability areas in a coding stage. The goal of the coding was to semantically partition the 53 capability areas and 255 capabilities in order to rearrange them into new semantically similar capability areas and capabilities. Existing definitions of the capability areas provided guidance in assigning capabilities to a corresponding area (Maxwell, 2008). The areas were iteratively refined (i.e., based on the knowledge of identified capability areas, new ones are generated or existing ones are eliminated) until a consensus in the author team was achieved. To consolidate the 255 capabilities, we merged identical capabilities and pooled capabilities covering similar aspects based on extensive discussion in the author team. After the coding stage of step A, nine capability areas were derived, including *people*, *culture*, *strategy*, *environment*, *information technology*, *information*, *governance*, *practices*, and *infrastructure* (Carvalho et al., 2017; Cleven et al., 2014; Mettler, 2011a; Lahrmann et al., 2011; Mettler and Rohner, 2009; Rohloff, 2009; de Bruin and Rosemann, 2005) and the capability list was reduced to 130 capabilities.

However, the identified capabilities were not specific to the context of BM yet and did not comprehensively cover the specific requirements of BM. Additionally, these capabilities did not exhibit the same level of granularity. For instance *IT infrastructure* (Mettler 2011b), *people* (Carvalho et al., 2017), and *work practices* (Mettler, 2011b) were contrasted by specific capabilities such as *ease of maintenance* (Alter, 2010), *electronic medical record* (Carvalho et al., 2017), and *process participants* (Alter, 2013). In order to adapt our capability areas and capabilities to and evaluate their relevance for the BM context, we used our result from step A to conduct a second literature review in step B.

Using the previously obtained capability areas as a starting point, we extended our literature review to BM-specific academic and practical literature to better understand methods, skills as well as other factors and assets necessary for successful BM. To derive BM specific capabilities from the literature, we conducted another literature review applying established healthcare literature processing methodologies (Polit and Beck, 2018; Booth and Grant, 2009; Cronin et al., 2008). We did not limit our search to the IS or the hospital domain and complied with the following criteria: (1) The authors have to be experts

in their field; (2) the topic of the publication has to have a relation to BM, and (3) the publication has to be quality-assured (e.g., appear in a peer-reviewed outlet). The literature review resulted in 49 new capabilities in the nine identified areas. In order to process our results and combine them with the results of step A, we performed an interpretative categorizing analysis, using the connecting strategy, which is a commonly applied method to identify homogenous groups of objects and is considered beneficial in case of multiple terms with similar meaning (Maxwell, 2008; Atkinson, 1992). The aim was to create a commonly exhaustive and mutually exclusive list of capabilities within our definition of BM, which are comparable in terms of their level of granularity. To achieve this, overlapping capabilities that have large coincidence were merged either to a new capability or into existing ones. All thematic overlaps were eliminated during this step; however, all thematic aspects of the capability areas were kept.

In the course of the transition from the second coding stage, the original nine capability areas were transformed to six areas as reflected in Figure 4. The six final capability areas are *people*, *culture*, *strategic alignment*, *governance*, *operations*, and *infrastructure*. The capability area *environment* is seen as a subset of the capability area *strategy*. The external environment can pose opportunities as well as threats for hospitals and, therefore, needs to be considered as part of the hospital's strategy (Burlton, 2010). Both areas were therefore merged into the area *strategic alignment*. The capability area *practices* was renamed to *operations* to cover not only business processes but also BPM and the way that individuals and units work together on a daily basis (Slack et al., 2013). The two capability areas *information* and *IT* are extensively investigated. The literature reveals that the degree of digitalization, as well as its speed digitization in hospitals in Germany is still insufficient (Graumann et al., 2017; Wibbeling et al., 2016). The primary focus of hospitals is on diagnostic and therapeutic processes in line with hospitals' primary purpose of treating patients. Despite an increase in digitalization and IT (Wibbeling et al., 2016), the direct human-to-human interaction in hospitals is essential. As for the capability area *information* we define information as the communication of facts (Krcmar, 2015). Therefore, it plays an essential role in many different capabilities and has an overarching interface function across other areas, mainly *strategic alignment*, *operations*, and *infrastructure*. With regard to the capability area *IT*, we define IT as an infrastructural component, and, thus, as the medium that enables information exchange (Krcmar, 2015). Therefore, other capabilities are explicitly examined in the light of their degree of integration of information and IT in our CF.

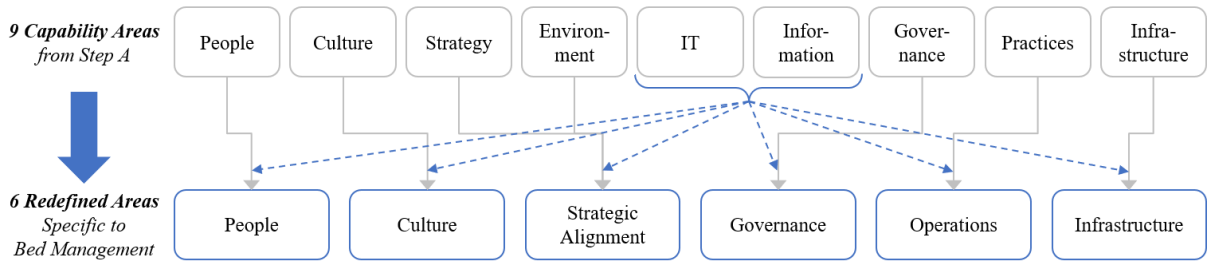

Figure 4. The transition of Capability Areas during the Second Coding Stage

We built our framework by applying a two-step approach. Both steps were necessary in order to map business process management, healthcare and hospital aspects with BM's specific features. The capabilities and capability areas from the first step still featured gaps and missing specificity since the academic literature does not cover the detailed requirements of BM. On the other hand, the second step needed an initial theoretical grounding. Therefore, it could not be used as a stand-alone source for the capabilities of the maturity model. Nevertheless, the detailed analysis of content allowed for a more holistic and refined understanding of BM capabilities. Combining both approaches in a complementary way led to a higher degree of completeness and, consequently, to a more comprehensive CF.

4.2 Evaluation

Having populated our framework, we *test (4)* it for relevance and rigor in line with DSR guidelines (Hevner et al., 2004) to evaluate it in terms of relevance, completeness, and practical applicability. Thus,

we apply the DSR evaluation framework by Sonnenberg and vom Brocke (2012) that includes four evaluation activities (EVAL1 to EVAL4). The goal of EVAL1 is to justify the research problem from an artificial ex-ante perspective within the DSR paradigm, which we examine in the introduction part of this work. EVAL2 also takes an ex-ante perspective since the artifact has not been instantiated yet. It aims at validating the design specification (Sonnenberg and vom Brocke, 2012). We conducted expert interviews to evaluate the model from a naturalistic perspective (i.e., to assess its suitability for practice), which is presented in the following. Taking an ex-post perspective, EVAL3 involves the ex-post-validation of an artifact by instantiating it, whereas EVAL4 strives for validating the artifact's instantiation. Both EVAL3 and EVAL4 are subject to future research, as it is not possible to evaluate our research from an ex-post perspective yet.

In line with the presented research method, we evaluated the resulting CF by conducting interviews with key stakeholders in two German hospitals. The interview partners are either involved in the hospital's BM or have strong expertise with technology-based logistics systems in hospitals. Overall, we conducted four semi-structured interviews with a Lead of Patient Management (hospital 1), a Head of the Emergency Department (hospital 2), a Head of Information Management (hospital 2), and an employee involved in the operative bed logistics (hospital 2). These stakeholders have been selected to account for the interdisciplinary and complex nature of BM as well as the multitude of organizational units involved. The goal was to validate the *relevance*, *completeness*, and *practical applicability* of the CF.

In the beginning of the interviews, we introduced our definition of BM to achieve a common understanding and explained both the goal of the study and the applied research method. Then, we asked each interview partner to elaborate on their view of BM as currently executed in the respective hospital. We then presented the CF as well as the definitions of the individual capability areas and capabilities, and asked for feedback on their descriptions, their accuracy and completeness. The first two experts (the Head of the Emergency Department and the Head of Information Management) were interviewed simultaneously in an interview that lasted two hours. The third expert (bed logistics employee) was interviewed for about 30 minutes. The last one-hour interview was conducted with the Lead of Patient Management focusing on the CF as well as the definition of BM. During the interviews, the experts pointed to certain capability areas/capabilities as highly *relevant* for BM in the respective hospital. We infer from those statements that BM capabilities feature varying degrees of importance in different hospitals based on context factors as well as the current state of the other capabilities.

Based on the experts' feedback we refined the wording as well as the focus of several capabilities. In the following, we illustrate some annotations of the experts with regard to the CF prior to the interviews:

- One expert stated that BM could be looked upon from a strictly logistics perspective that includes all activities related to physically moving, cleaning and supplying beds in hospitals. It could, however, also refer to planning activities such as patient forecasting, an update of expected patient length of stay, and collaboration among heads of functional units in hospitals. As we opt for a broad perspective on BM, we illustrated this distinction more clearly in the customized definition of BM as well as in the definitions of the capabilities.
- One expert pointed out that there are various ways to differentiate incoming patients in hospitals regarding bed capacity management (i.e., elective and emergency patients versus patients with short- and long-term expected length of stay). Since we cannot make any formal claims as to which categorization delivers greater utility, we did exclude phrases implying the superiority of specific types of organizing incoming patients in the definitions. In the same manner we excluded references to central and decentral BM regarding distributing process authority along the hospital hierarchy.
- We defined patient satisfaction as the primary goal of the capability *patient competency*. However, one expert pointed out that the literature-induced definition that although the patient is the customer, the primary goal is to understand the needs and desires and to align them with the BM goals. We rephrased the respective definition to account for that feedback.

- Since one expert emphasized the importance of soft factors in BM such as accurate and timely communication, escalation processes, and assertiveness, we decided to incorporate those into existing definitions related in the capability area *culture*.

Subsequently, we asked all experts about their feedback regarding the relevance, completeness, and practical applicability of our work in the sense of EVAL2. While the experts confirmed the completeness and validity of the CF's design, they mention the need to further validate it in a natural environment in detail in order to confirm its utility. Regarding the *practical applicability* of our framework, the experts confirmed the complexity of BM with its various aspects that in turn impedes its assessment by a single person in the hospital. Therefore, they appreciated the functional tree architecture, which allows to deliberately select single aspects of the BM (e.g., the capability area *people* for a Head of Human Resources). However, they expressed their wish for a higher level of detail per capability that would ease its operationalization. While we agree that more specific descriptions of the capabilities would be helpful in a practical context, the research question aims to identify a comprehensive set of relevant BM capabilities that could be used as a foundation for a maturity measurement instrument in the future.

4.3 Results and Discussion

The following CF (Figure 5) is the final result of our research. It includes 30 capabilities structured along five capability areas – *people*, *culture*, *strategic alignment*, *governance*, *operations*, and *infrastructure*.

People	Operational Competency	Collaboration Competency	Technology Competency	Patient Competency	Innovation Competency
Culture	Process Orientation	Communication	Employee Orientation	Patient Orientation	Willingness to Change
Strategic Alignment	Strategic Bed Management Alignment	Bed Management Positioning	Information Alignment	Bed Management Stakeholder Alignment	Strategic Innovation Agility
Governance	Responsibility	Transparency of Structures and Processes	Process Compliance	Regulation Compliance	Performance Measurement
Operations	Operational Planning	Inpatient Admission Management	Integration of Hospital Core Process	Patient Discharge Management	Material and Logistics Management
Infra-structure	Hospital Facility Management	Bed Equipment Management	Patient Equipment Management	Employee Equipment Management	IT Infrastructure Management

Figure 5. Capability Areas and Capabilities of our Bed Management Capability Framework

The capability area *people* comprises all individuals and groups, who continually apply and enhance their skills and knowledge to improve BM (vom Brocke and Rosemann, 2015). *Culture* refers to the collective values and beliefs that shape BM-related attitudes and behavior (vom Brocke and Rosemann, 2015). *Strategic alignment* represents the overarching alignment of priorities and processes, enabling efficient and effective BM in the overall hospital context (vom Brocke and Rosemann, 2015). The capability area *governance* refers to establishing accountability regarding roles and responsibilities taking into account relevant goals as wells as existing regulation (vom Brocke and Rosemann, 2015). *Operations* comprises all the activities necessary for the day-to-day fulfilment of an effective and efficient BM and i*nfrastructure* is defined as all systems and facilities serving BM (e.g., informational infrastructure, technical infrastructure, and property).

Table 3 contains a brief description of each capability based on the literature, which is also a result of the research process.

People		**Governance**	
Operational Competency	Ability to develop and apply employees' knowledge and expertise in all activities related to bed management.	**Responsibility**	Definition of roles and responsibilities in bed management tailored to the bed management design, goals, and requirements.
Collaboration Competency	Ability to work in team settings whenever reasonable and to apply relevant communication and management skills.	**Transparency of Structures and Processes**	Definition of communication and information channels across all stakeholders that fit bed management design, goals, and requirements.
Technology Competency	Ability to understand the implications of using technologies in accordance with bed management goals and requirements.	**Process Compliance**	Definition of standards for and monitoring activities in bed management ensuring compliance with hospital requirements.
Patient Competency	Ability to perceive, communicate, and react to patient needs and desires in accordance with bed management goals and requirements.	**Regulation Compliance**	Definition of standards for and monitoring of activities in bed management ensuring compliance with prescribed (inter)national regulation.
Innovation Competency	Ability to identify, communicate and make use of innovation opportunities in accordance with bed management goals and requirements.	**Performance Measurement**	Definition of bed management performance measurement metrics ensuring effective and efficient decision-making.
Culture		**Operations**	
Process Orientation	Commitment to embrace bed management as a cross-functional and cross-departmental process area.	**Operational Planning**	Data- and evidence-driven planning of short- and long-term bed capacity based on length of stay forecasting for different patient groups.
Communication	Commitment to embrace open communication among organizational units in bed management.	**Inpatient Admission Management**	Allocation of incoming patients based on relevant bed management criteria and policies (e.g., elective and emergency patient).
Employee Orientation	Commitment to grant employees the sovereignty to make self-dependent decisions whenever reasonable as well as to continuously develop employees' skills related to bed management.	**Integration of Hospital Core Processes**	Integration of bed management with relevant core hospital processes during inpatients' hospital stay.
Patient Orientation	Commitment to act on patients' objective and subjective needs and desires according to standards and guidelines.	**Patient Discharge Management**	Synchronization of patient discharge with subsequent support and core processes (e.g., bed cleaning).
Willingness to Change	Commitment to continuously scrutinize existing practices in bed management as well as to embrace various improvement and innovation approaches.	**Material and Logistics Management**	Integration and synchronization of hospital material and logistics processes with bed management (e.g., bed reallocation, linen management).
Strategic Alignment		**Infrastructure**	
Strategic Bed Management Alignment	Alignment of bed management goals and requirements with the overall hospital strategy.	**Hospital Facility Management**	Administration of physical hospital assets such as patient rooms and bed storage spaces in line with bed management goals and requirements.
Bed Management Positioning	Design and execution of bed management as part of internal and external health value chains spanning hospital departments and healthcare service providers.	**Bed Equipment Management**	Administration of beds and bed equipment as a central asset in bed management including retaining an overview of existing and required bed configurations.
Information Alignment	Alignment of information flow within bed management with the overall hospital strategy as well as relevant regulation.	**Patient Equipment Management**	Administration of hard- and software that is used by patients in line with relevant goals and requirements of bed management.
Bed Management Stakeholder Alignment	Balancing the interest and requirements of stakeholders in bed management in line with the overall hospital strategy.	**Employee Equipment Management**	Administration of all hard- and software that is used by employees in line with relevant goals and requirements of bed management.
Strategic Innovation Agility	Systematic exploitation and exploration of innovation opportunities in bed management as well as their alignment with the overall hospital strategy and relevant regulation.	**IT Infrastructure Management**	Administration of hospital IT infrastructure including hard- and software, networks, and servers in line with the goals and requirements of bed management.

Table 2 Description of the BM Capabilities

We now discuss our findings in the context of three studies concerning capability development/maturity model development in hospitals – Carvalho et al. (2017), Mettler (2011b), and Cleven et al. (2014). The identified capabilities reflect the multidisciplinary nature of BM in line with the provided definition of BM in the theoretical background. Nearly all capability areas are adapted from the study of de Bruin and Rosemann (2007) and aim at a holistic representation of BM from a process perspective. They are compatible with the process management capabilities in the study of Cleven et al. (2014), in which the authors develop a staged capability maturity model for hospitals. They identify five respective capability dimensions – *culture*, *strategy*, *structure*, *practices*, and *IT* – and subsequently define maturity stages for those. Based on the provided definitions, the capability areas in Cleven et al. (2014) closely resemble the capability areas present in our framework. The capability area *culture* has a direct equivalent in our framework. *Strategy* is partly covered in *strategic alignment* and partly in the capability area *culture* since it also refers to cross-departmental and cross-clinic cooperation. *Structure* is akin to *governance* and *practices* is related to *operations* in our framework. Finally, *IT* is represented in our framework in the capability area *infrastructure*. Compared to the study of Cleven et al. (2014) we provide a more detailed CF consisting of 30 individual capabilities in each area. The second study – that of Carvalho et al. (2017) – focuses on the identification of information systems (IS) capabilities and respective maturity stages. The authors of the study provide a maturity model for hospital IS structured along six maturity-influence factors and six stages. In contrast, our study sets a broader context, as we aim at identifying a holistic capability set for BM. While the model of Carvalho et al. (2017) is specifically tailored to IS, we can identify several maturity-influence factors in the study that are also covered in our model. *Strategy*, *people*, *systems* and *IT infrastructure* closely resemble the capability areas *strategic alignment*, *people*, and *infrastructure*, respectively. Naturally, Carvalho et al. (2017) examine these in detail when describing the maturity stages aiding their evaluation in hospitals. The final study – that of Mettler (2011b) – presents a maturity model for supplier relationship management systems in hospitals. The model includes five maturity levels for four dimensions – *work environment*, *work practices*, *IT infrastructure*, and *people capabilities*. Just as in the previous studies these dimensions closely resemble the capability areas in our model with a significant overlap between *work practices* and *operations*, *IT infrastructure* and *infrastructure*, *people capabilities* and *people*.

Based on the comparison with similar studies in the context of hospitals, we can conclude that studies on capability development/maturity assessment in hospitals structure respective maturity stages or capabilities along very similar overarching elements that can vary according to scope and depth of the respective topic. Therefore, we believe that our findings are consistent with the body of knowledge on hospital management. The CF contributes to a more comprehensive understanding of BM in hospitals that complements current studies in the healthcare domain and provides a broader context, in which they can be examined. It investigates BM from a process-centered capability perspective and builds largely on the established BPM core elements identified in the study of de Bruin and Rosemann (2007). While our study does not provide details on operationalizing the capabilities as related maturity-model studies do, it can serve as a blueprint for organizing BM-related projects aiming at improving related BM-capabilities in hospitals. The descriptions of the capabilities could aid senior hospital managers in deriving roadmaps, conducting fit/gap analyses, and prioritizing topics, while accounting for the hospital-specific context. Our findings can also aid in defining new organizational structures accountable for specific capability areas/capabilities in BM.

5 Conclusion

In this paper, we developed a CF for BM, which is well-grounded in literature and is a first step towards the development of a maturity model for BM. We applied the maturity development process proposed by de Bruin et al. (2005) and followed all phases that are relevant to the development of the CF. This also includes the definition of the scope and design of a possible maturity model. For the population of the maturity model, and, consequently, the development of the CF, we employed a two-step approach and identified 30 capabilities structured along six capability areas. These capabilities are based on literature regarding maturity models and CFs in business process management, healthcare, and hospitals as

well as on good practices in BM. To evaluate our framework in terms of *relevance*, *completeness*, and *practical applicability*, we followed the evaluation framework proposed by Sonnenberg and vom Brocke (2012) and completed EVAL1 and EVAL2 by conducting interviews with four BM stakeholders in two German hospitals.

The main theoretical contribution of our work is the development of a targeted CF for BM in hospitals that can serve as the foundation for developing corresponding maturity models, which assess the evolution of relevant capabilities. Thereby, we offer a holistic definition of BM as a process area including core, support, and management processes. Regarding its practical implications, the proposed framework spans existing hospital functions and organizational units to address BM in its entire complexity. Thus, it can serve as a blueprint for establishing a central BM department in hospitals. Additionally, the framework can serve as a reference point for different hospital units involved in BM and can be used to conduct fit/gap analyses of existing hospital capabilities concerning BM.

Despite its comprehensive nature reflected in a broad literature study and practical evaluation, our research features some limitations. We evaluated our CF with four BM stakeholders in two different German hospitals. Although we considered the aspect of transferability by choosing experts from different hospitals, we acknowledge that the evaluation is currently limited to German hospitals. Furthermore, we focused on the development of the CF as the first step towards a possible maturity model. Hence, a maturity measurement instrument for assessing different maturity levels has not been developed yet, even though this is required for a maturity model. As EVAL3 and EVAL4 focus on an ex-post perspective that requires the implementation of the maturity model including the measurement instrument, our research is only evaluated from an ex-ante point of view that justifies our findings but does not provide evidence for its practical utility in hospitals yet.

Regarding future research, the next step towards a maturity model is the development of a maturity measurement instrument. It requires a more detailed analysis of the different capabilities to derive items specifying maturity stages as well as describing these stages in terms of the different characteristics of the capabilities. Prior to this step it is necessary to determine the number of and describe the respective maturity levels. Moreover, an aggregation approach to determining the maturity level of capability areas and the general maturity of BM requires the development of the maturity stages for single capabilities. A possible approach can be found in the work of Cleven et al. (2014) in which the Rash algorithm is applied. In order to provide actors in BM with clear guidance as to the actual improvement measures for BM, a future maturity model should also be prescriptive in nature. Based on the actual maturity of different capabilities derived from the maturity measurement instrument, a desirable target state for a given hospital can be identified. Hence, a comparison between the current and desired maturity enables the derivation of recommendations for action. This is an aspect of our research that the interview partners deemed important from a practical perspective since it can support actors in building a transformation path to an improved BM. Finally, further studies across different hospitals in both a national and an international context would enable a broader evaluation regarding completeness.

In summary, our CF is an essential step towards a maturity model for BM in hospitals enabling practitioners to analytically scrutinize different aspects of BM in their hospitals. A maturity model building on our CF would enable researchers and practitioners to benchmark BM in hospitals facilitating its operationalization as well as the derivation of relevant commonalities and differences across different aspects (e.g., regional, cultural, educational, technological).

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