

A maturity model for care pathways

Citation for published version (APA):

Schriek, M. B., Turetken, O., & Kaymak, U. (2016). A maturity model for care pathways. In *Proceedings of the European Conference on Information Systems (ECIS 2016), 12-15 June 2016, Istanbul, Turkey* (pp. 1-16). Article Paper 127 Association for Information Systems.

Document status and date:

Published: 13/09/2016

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

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Summer 6-15-2016

A MATURITY MODEL FOR CARE PATHWAYS

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Recommended Citation

Schriek, Mark; Turetken, Oktaý; and Kaymak, Uzay, "A MATURITY MODEL FOR CARE PATHWAYS" (2016). *Research Papers*. Paper 127.

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A MATURITY MODEL FOR CARE PATHWAYS

Research

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Abstract

Over the last recent decades, increasing the quality of healthcare services while reducing costs has been among the top concerns in the healthcare landscape. Several healthcare institutions have initiated improvement programs and invested considerably in process orientation and management. Care pathways are receiving increasing attention from clinicians, healthcare managers, and academics, as a way to standardize healthcare processes to improve the safety, quality, and efficiency of healthcare services. Despite considerable literature on the definition of care pathways, to date there is no agreement on their key process characteristics and the way they traverse from an immature to a mature state. Such a model would guide healthcare institutions to assess pathways' level of maturity and generate a roadmap for improving towards higher levels. In this paper, we propose a maturity model for care pathways that is constructed taking a generic business process maturity model as a basis. The model was refined through a Delphi study with nine domain experts to address healthcare domain specific concerns. To evaluate its validity, we applied it in assessing the maturity of a particular care pathway taking place in 11 healthcare institutions. The results indicate the usefulness of the proposed model in assessing pathway's maturity and its potential to provide guidance for its improvement.

Keywords: Maturity model, business process maturity, care pathway, clinical pathway, healthcare process, Delphi study.

1 Introduction

Healthcare institutions are under increasing pressure to improve their service quality while reducing costs (Hellman et al., 2015). Many stakeholders in the healthcare sector are emphasizing the importance of increased process orientation as a means to address this challenge (Wangler et al., 2003; Gonçalves et al., 2013). Care pathways -also known as clinical pathways or care maps (De Bleser et al., 2006), are considered as a primary means to achieve enhanced service quality and patient satisfaction through standardization in healthcare processes (EPA, 2015). Implementation of care pathways are known to reduce the variability in clinical practice and to improve patient outcomes (Lodewijckx et al., 2011), (Panella, 2003).

Healthcare is a complex, dynamic, and specialized ecosystem, and establishing process thinking and effective process management requires right tools and a supportive organizational culture (Kirchmer et al., 2013). Despite significant effort put in developing, implementing and improving care pathways, healthcare institutions are still facing various challenges in transforming all their processes into care pathways (Vanhaecht et al., 2006). Such initiatives are typically a part of organization wide quality

and process improvement programs where success is influenced by many factors (Brender et al., 2000), (Zander, 2002), (Vanhaecht, 2007). Consequently, management needs guidance on how to implement the process foundations required for achieving enhanced service quality, improved patient outcomes, increased efficiency and patient satisfaction.

Over the last decade, a number of process maturity models have been proposed to guide organizations in improving their process capabilities and organization's process orientation (Röglinger et al., 2012; Van Looy et al., 2013; Tarhan et al., 2016). These models typically consist of a sequence of discrete maturity levels for a class of processes in a particular business domains, and represent an anticipated, desired, or typical evolutionary path for these processes (Becker et al., 2009). Maturity models help companies plan and execute process-based transformations (Hammer, 2007). Some disciplines have defined and successfully used maturity models as a way to appraise and improve the competence of their organizations [e.g. supply chain management (Lockamy III & McCormack, 2004), system/software engineering (CMU/SEI, 2010), business-IT alignment (Luftman, 2000)]. However, there are only very few studies that adapt these maturity models to the healthcare domain or propose healthcare-specific maturity models (Wendler, 2012). The researchers that report on the application of generic business process maturity models in assessing and improving the maturity of healthcare processes report several challenges due to the inadequacy of these models in addressing specific facets of the healthcare domain (Tarhan, Turetken & van den Biggelaar, 2015). An effective use of a generic business process maturity model in a specific domain requires several actions to be successfully performed as a prerequisite. These include the mapping of the domain specific process areas, adopting the domain terminology, and tuning the abstraction level for the descriptions of certain process areas that are critical core competencies in the specific domain (OMG, 2008). Healthcare organizations are mainly characterized as loosely coupled sets of highly specialized silos with special incentive mechanisms (Vera & Kuntz, 2007), which separate them from typical organizations in manufacturing and service industries. Hence, their path for successful process management requires a stronger emphasis on cultural and domain-specific capability areas (Cleven et al., 2014).

The objective of this work is to introduce a maturity model that will allow healthcare institutions to assess the maturity of their care pathways and identify aspects for improvement. We constructed the initial version of the Care Pathway Maturity Model (CPMM) by taking a process maturity model (process and enterprise maturity model – PEMM (Hammer, 2007) as a basis. The initial version was refined through a joint effort of industry experts, using the Delphi technique. To evaluate the validity of the CPMM, we performed a multiple-case study where we applied the CPMM to assess the maturity of a specific care pathway in 11 Dutch healthcare institutions. In addition, we performed a survey with the participants of the multiple-case study to evaluate the usefulness of the model. Our evaluation through the multiple-case study and the survey shows that CPMM can be considered as a useful tool for assessing the maturity of care pathways.

The remainder of this paper is structured as follows. In section 2, we provide a background on the key concepts of care pathways and business process maturity models, and discuss related work on the healthcare process maturity. Section 3 presents the research method that we followed in constructing the CPMM. Section 4 introduces the model. In section 5, we present the multiple-case study for the application of the model in assessing the maturity of care pathways in 11 healthcare institutions and the results of the survey conducted with the domain practitioners. Finally, section 6 presents our conclusions and future research directions.

2 Background and Related Work

The importance of developing and continuously improving healthcare processes to increase quality of care has been a subject of many studies. However, Donabedian's works (1980; 1982; 2003) are considered to have laid the foundation for quality and quality management in healthcare. He defines *quality assurance* as the actions taken to establish, protect, promote, and improve the *quality* of healthcare (Donabedian, 2003). Simply put, *quality healthcare* is 'doing the right thing for the right patient, at the

right time, in the right way to achieve the best possible results' (AHRQ, 2005). To achieve this, Donabedian proposes three basic dimensions: structure, process, and outcome (Donabedian, 1980). *Structure* denotes the context in which care is delivered (e.g., facilities, equipment, personnel, IS, and IT infrastructure). *Process* indicates all actions that make up the healthcare. Finally, *outcome* refers to the effect of structure and process on the health status of patients and populations.

Donabedian's view considers quality as the product of two factors: the science and technology of healthcare, and the *application* of that science and technology in actual practice. This product can be characterized by a set of *quality attributes* including effectiveness, efficiency, optimality, acceptability, legitimacy, equity, and efficacy (Donabedian, 2003). Accordingly, the healthcare delivery should be *effective*; that is, it should achieve the best possible health improvement that can be attained. It should be *efficient* and able to lower the cost of care without diminishing attainable improvements in health. It should oversee an *optimal* point that balances the improvements in the health against the costs of such improvements. The care to be delivered should be *acceptable* by the patients and their families as it should be delivered in accordance with their wishes and expectations. It should be *legitimate* and conform to ethical principles, values, norms, rules and regulations. It should also be *equitable* and endorse principles that are just and fair in the distribution of healthcare and of its benefits among the community-at-large. Finally, the *efficacy* attribute refers to the standard against which any improvement in healthcare achieved in actual practice is to be compared. It is, however, not itself subject to quality assurance when the quality of healthcare is being assessed (Donabedian, 2003).

With respect to the Donabedian model of structure-process-outcome, *care pathways* are means to drive the *application* of healthcare science and technology. They refer to the *process dimension* with an implicit or explicit relation to *structure*, which provides necessary resources and mechanisms for participants to carry out care processes.

Care pathways can be seen as an application of *process thinking* to the improvement of patient healthcare (Vanhaecht et al., 2010). The European Pathway Association defines the term care pathway as "a complex intervention for the mutual decision making and organization of predictable care for a well-defined group of patients during a well-defined period" (EPA, 2015). It describes the suggested sequencing and timing of diagnostic and treatment measures to be performed by actors with different medical professions on a patient with given symptoms or diagnosis (Coffey et al., 1992). It can be thought of as a description of the patient care *process*, which provides a model of the patient's progress from admission through investigation to diagnosis to treatment and finally to discharge or referral. In the BPM context, an analogy between a care pathway and a business process in a manufacturing or service domain (while possibly offensive to some) is consequential (Vanhaecht et al., 2010), (Carroll, 2005). The pathways aim to enhance various attributes of healthcare quality to improve patient outcomes, promote patient safety and satisfaction, and optimize the use of resources (Schippits & Schippits, 2013). However, they address particularly the effectiveness and efficiency attributes of quality through *standardizing care processes*. They facilitate communication, coordination of roles, and sequencing the activities of the multidisciplinary care team, patients and their relatives (De Bleser et al., 2006).

Care pathways are developed and implemented throughout the world (Zander, 2002). However, answering the question of how well a pathway has been designed and implemented is not straightforward. Vanhaecht et al. (2006) presents a comprehensive review of care pathway audit tools that can be used to assess whether a clinical pathway in question meets the key characteristics of pathways. However, even the most complete audit approaches focus merely on the outcome of the pathway and does not provide guidance on the aspects that should be improved (Seys et al., 2013). These tools are typically in the form of checklists that focus on the written artefact and fail to address, for instance, how the care process is organized, managed, and supported (K. Vanhaecht et al., 2006). Care pathways represent more than written instructions, and concern also IT and human resources that have to collaborate (Berg et al., 2005), (Mallock & Braithwaite, 2005).

Business process maturity models are domain independent tools that are used to indicate an organization's existing level of process orientation and how it can mature towards higher levels (Gottschalk, 2009; Pöppelbuss & Röglinger, 2011). Understanding the existing state, i.e. process assessment, is the foundation activity for process improvement. It explores strong, weak, or missing points which are typically transformed into a roadmap for improvement. The business process management (BPM) literature refers to several maturity models that aim to provide guidance in increasing an organization's level of process orientation (Tarhan, Turetken & Reijers, 2015). The ones that are commonly referred to in the literature include the Business Process Orientation (BPO) Maturity Model (McCormack & Johnson, 2001), the BPM Capability Framework (De Bruin & Rosemann, 2005; Rosemann & Brocke, 2015), the Process and Enterprise Maturity Model - PEMM (Hammer, 2007), and the OMG standard Business Process Maturity Model (OMG, 2008). The following works provide a critical review of these models (Röglinger et al., 2012; Van Looy et al., 2013; Tarhan et al., 2016).

The abundance of these models in the BPM and other fields inspired researchers to investigate their use also in the healthcare domain. However, only few aimed at developing models that address the unique requirements of this field. Mettler & Blondiau (2012) propose a maturity model to assist healthcare institutions to improve their cooperation capabilities through the formation of collaborative structures. The work by Tarhan et al. (2015) discusses the challenges of applying a generic business process maturity model in assessing healthcare process maturity by going through a case study. Gillies and Howard (2003) combine a process improvement approach derived from the Capability Maturity Model (CMU/SEI, 2010) with a model of competency derived from a previous work on professional development in healthcare. The study provides a case study on managing change from paper-based to electronic health records. Similarly, Gemmel et al. (2008) adapts an existing maturity model on process orientation - BPO (McCormack & Johnson, 2001), to the specific context of healthcare. The work by Cleven et al. (2014) introduces a staged capability maturity model that is algorithmically derived on the basis of empirical data from 129 acute somatic hospitals in Switzerland. To date their study represents one of the most comprehensive works on this topic. The paper also discusses why generic process maturity models for process management are not applicable in the hospitals' context. The model that they propose has a wider scope at the enterprise level that applies to the overall healthcare process landscape. Hence, despite these attempts in the domain, there exists no model developed or applied for assessing and improving the maturity of care pathways.

3 Research design

In this study, we followed a design science research approach (Hevner et al., 2004; Gregor & Hevner, 2013; Wieringa, 2014), as our primary goal is to develop a new IS artefact, which we refer to as the care pathway maturity model (CPMM), that can be used to assess the maturity level of the care pathways in healthcare institutions. Accordingly, the approach involved defining the problem and the goal of the artefact, the search for and construction of a satisfactory model, and the evaluation of the artefact to examine its validity, utility, reliability or efficacy (Baskerville et al., 2009).

We followed the procedure depicted in Figure 1 in constructing, applying and evaluating the care pathway maturity model proposed in this paper. In the first phase, we developed the initial version of the model and performed a Delphi study with a panel of domain experts to refine and finalize it. The Delphi study ensured the content validity of the model. The second phase involved a multiple-case study where the model was applied to assess the maturity of a specific care pathway of 11 hospitals operating in the Netherlands. The assessments are performed with the involvement of the key hospital employees that participate in the execution of the care pathways. After each assessment in a hospital, we conducted a survey to evaluate how useful and easy-to-use they consider the model is. The following sections describe the details about the tasks that were carried out and the research methods applied in constructing the model.

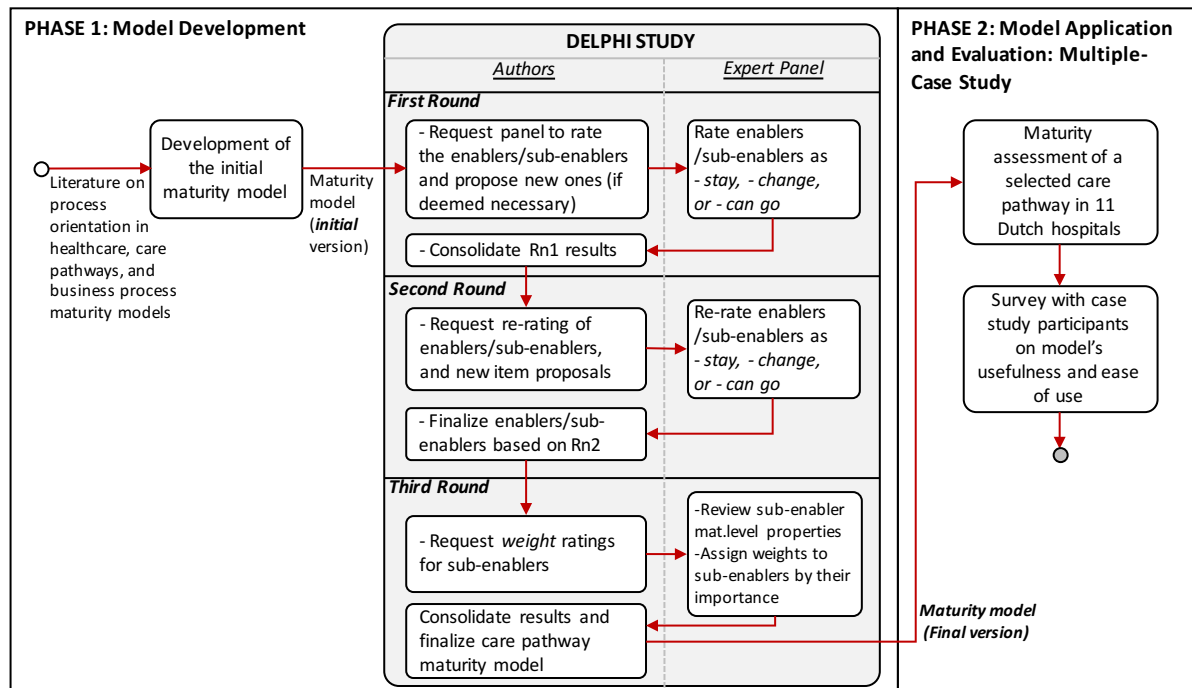


Figure 1. Research procedure.

3.1 Developing the initial version of the maturity model

We developed an *initial* version of the model by taking as a ground the existing works on the process maturity models, and key studies on care pathways and process orientation in the healthcare domain. We aimed at developing a care pathway maturity model that incorporates only essential practices that the organizations should possess and that can be used also by practitioners for self-assessing the maturity of their care pathways. Such models typically show *descriptive* properties (rather than prescriptive) to facilitate assessments but may sacrifice partly the level of support for guiding improvements (Rosemann et al., 2015), (Tarhan, Turetken & Ilisulu, 2015). We selected the PEMM model (Hammer, 2007) as the basis for the care pathway maturity model. This is mainly because it has a *descriptive* purpose of use (Röglinger et al., 2012) and is commonly referred to in the literature as a model that has been successfully applied in practice also for self-assessments (Tarhan, Turetken & Reijers, 2015).

The PEMM incorporates two models; the *process maturity model* that assesses the maturity of processes through *process enablers*, and the *enterprise maturity model* that assesses the entire organization through *enterprise capabilities*. In adopting PEMM, we focused mainly on the *process maturity model* with strong emphasis on the design and performance management of the care-pathway. This is mainly because we aim at addressing care pathways, which are at the process level and relate to a particular healthcare specialty typically structured into a business unit. However, considering their criticality in the healthcare domain at all levels, we have also adopted sub-enablers –such as those that relate to *culture*, from the enterprise maturity model. These, on the other hand, are assessed within the scope of the business unit where the pathway takes place, instead of the entire healthcare organization.

PEMM process maturity model is structured into 5 *process enablers* (design, performer, owner, infrastructure, and metrics) which are further divided into 13 components (sub-enablers). For instance, purpose, context, documentation are components of the *design*. Each component is characterized by four levels of maturity, each of which builds on the preceding level. Hence, based on the presence of characteristics depicted in the level description for that component, a particular level of maturity is chosen during an assessment (among four levels) for that component. The results for the components are aggregated at the enabler level. We adopted PEMM's structure and the process enablers in the base version of our model. Figure 2 shows this structure.

Enablers	Sub-enablers	Maturity Level Characteristics			
		Low	Mid	High	Top
A	A1	A1-Low	A1-Mid	A1-High	A1-Top
	A2	A2-Low	A2-Mid	A2-High	..

	An	An-Low	An-Mid
B	B1

Figure 2. The structure of the maturity model.

As the PEMM is domain independent, we investigated the works in the healthcare domain focusing our attention on the care pathways and their key properties to understand the applicability of the base enablers, and parts that the base model can be improved to better address the domain requirements. We considerably extended the base model to reflect the domain requirements. As a result, the *initial* version of the maturity model incorporated 6 enablers, and 27 sub-enablers.

3.2 Delphi Study

We performed a Delphi study of *three rounds* with *nine* domain experts to refine and finalize the maturity model. The key benefit of this method is that it uses group decision-making techniques while involving experts from the field, which increases the relevancy and validity of the research (Osborne et al., 2003). It is a common method in IS research that is frequently used for exploratory research to deal with complex and interdisciplinary problems (Okoli & Pawlowski, 2004).

Although there is no standard way to conduct Delphi studies, there are general principles that guide the practices to be followed. First, the panel members (participants of the study) should be experts in the relevant field. Moreover, a balance should be established in the panel in terms of, for instance, the number of members characterizing theoretical and practical perspectives in the relevant field (Powel, 2003). Second, Delphi studies consist of multiple rounds, which usually involve suggesting, consolidating, and ranking (Okoli & Pawlowski, 2004). Each round also involves providing background information to panel members on the objectives of the work and feedback based on the results of previous rounds. Finally, the goal of each round and eventually the Delphi study should be determined. While there exists no firm rule on the least number of experts required for a Delphi study, 10 is typically considered appropriate depending on the scope of the problem and the availability of resources (Okoli & Pawlowski, 2004) (Fink et al., 1984).

Our panel consisted of 9 experts from different but relevant fields. Four academicians participated; three with the main research interest on process management and orientation in the healthcare domain, and one medical expert on the design of clinical pathways. Five experts were field practitioners either in healthcare institutions or in firms that provide healthcare advisory services to such institutions.

We planned for three rounds for the study to establish consensus over the enablers and sub-enablers of the maturity model, including the definitions and the maturity level characteristics of each sub-enabler.

Delphi Round 1: The aim of the first round was to elicit feedback not only on the enablers and sub-enablers but also on the overall structure, background, and the objective of the model. In this round, face-to-face meetings (including video calls) were conducted to describe the objectives of the study and the concepts, and to provide immediate guidance on the ratings of the enablers and sub-enablers. Taking the initial version of the maturity model as input, experts were provided with information on the components and the structure of the model. They were asked to rate the sub-enablers by *stay*, *change* (the description or position in the model), or *can go*. In the literature, there is a lack of clarity on the rules or methods used for defining a decision rule for consensus in a Delphi study (Powel, 2003). We decided that if 8 or more (out of 9) experts chose ‘stay’ for a component (enabler or sub-enabler), then the component stays without any changes. If not, then the component is changed or removed depending on the expert comments. After the first round, based on the ratings and comments by the experts, 10 out of 27 sub-enablers were subject to changes and 2 new sub-enablers were added.

Delphi Round 2: The new model that was generated based on the results of the first round was the subject of the second round, in which the experts were asked to go through the same rating scheme for the (sub-)enablers. However, this time the review included also the maturity level characteristics for each sub-enabler. As a result, the majority of the sub-enablers and the maturity level characteristics were revised. The results were consolidated for the new version with 5 enablers and 19 sub-enablers.

Delphi Round 3: The objective of the final round was to finalize the *maturity level characteristics* of each sub-enabler and assign *weights* for sub-enabler's importance towards maturity. The experts rated each sub-enabler's importance on a 5-point Likert scale (very important [5] to not important [1]).

4 Care Pathway Maturity Model (CPMM)

In this section, we present the final model resulting from the Delphi rounds and describe how it can be used for assessing to the maturity level of the care pathways.

4.1 CPMM main components

Table 1 presents the components of the CPMM that resulted from the first phase of our research study. The enablers represent characteristics pertaining to design, pathway owners and performers, infrastructure, performance management, and culture. These were adopted from the process enablers in the PEMM model (Hammer, 2007) but gone through some changes based on the literature review and expert views in the Delphi study. The sub-enablers were also extended to align them to the particular domain. Table 1 also shows the primary sources which the sub-enablers are based on.

The *design* enabler relates to the comprehensiveness and characteristics of the specification on how the pathway is defined and to be executed. It forms an essential component of the model as it provides the basis in standardizing the care process, thereby targeting at the efficiency and effectiveness attributes of healthcare quality. Moreover, it involves facets such as the level by which the specification is aligned with the objective of the care delivery to the specific patient group of the pathway, influencing the acceptability attribute of quality. It includes the degree in which the specification takes into account relevant laws and regulation, addressing legitimacy.

The *owner and performers* enabler relates to the extent to which the pathway ownership structure is effective in improving the pathway performance, to the degree in which pathway participants execute their task as described in the pathway design, and to the level of knowledge on their parts in the pathway. The *infrastructure* enabler concerns the information systems & technology that support the network of pathways, in which the pathway of concern is an integrated part. The *culture* enabler concerns to the context where the pathway executes. This includes concerns such as the stakeholders' attitude towards change and continuous improvement, and the degree by which the pathway participants are empowered to deviate from the pathway specification. From the point of view of the Donabedian's model of structure-process-outcome (Donabedian, 1980), aforementioned three enablers refer largely to the *structure* dimension (only the part of the structure that relates to the care pathway under consideration), on which the care pathway relies to provide resources, means and context to carry out care activities as designed.

The *performance management* enabler denotes the definition, collection, provisioning and use of relevant information to track and monitor the pathway performance. Managing performance for continuous improvement addresses the *outcome* dimension of the Donabedian's model. Monitoring pathway indicators against the targets to assure and - if necessary, improve pathway quality is an essential element of the healthcare quality assurance (Donabedian, 2003).

Enabler	#	Sub-Enabler	Primary source of inspiration	Expert Imp. Weightings	
				mean	st.dev.
Design	1	Pathway objective alignment	[H], [K]	4.50	0.53
	2	Pathway definition	[H], [K]	4.13	0.64
	3	Compliance	[E]	4.13	1.25
	4	Clarity in the decision criteria	[B]	3.88	1.25
	5	Design approach	[E]	4.25	0.46
Owner & Performers	6	Owner (Identity)	[H]	4.38	0.52
	7	Effective behavior	[E]	4.63	0.74
Infrastructure	8	Information systems	[H], [N], [S]	3.63	0.52
	9	Network of paths	[K]	3.38	1.06
Performance management	10	Metrics definition	[H]	4.25	0.71
	11	Metrics uses	[H]	4.75	0.46
	12	Structured collection of data	[D]	4.13	0.35
	13	Availability of performance information	[S], [K]	3.75	1.04
	14	Availability of real-time information	[S], [K]	3.38	0.74
	15	Capacity monitoring	[P]	3.50	0.76
Culture	16	Stakeholder involvement	[N], [K], [H]	4.75	0.46
	17	Awareness	[H]	4.63	0.74
	18	Flexibility	[E]	4.25	0.71
	19	External objectivity	[O]	3.75	0.71

Table 1. Main components of the CPMM. [B]: (Berg et al., 2005), [D]: (De Bleser et al., 2006), [E]: Expert panel judgment, [H]: PEMM (Hammer, 2007), [K]: (KluwerZorg, 2011), [N]: (NABON, 2008), [O]: BPMM (OMG, 2008), [S]: (Schrijvers, 2014)

The last column in Table 1 lists the importance ratings provided by the Delphi experts for each sub-enabler. The experts identified the design, culture and owner & performers enablers significant to the maturity of the pathway. The infrastructure to support the pathway was considered the least important. At the sub-enabler level, the use of the metrics for managing the performance of the care pathway and the high stakeholder involvement are denoted as the most significant sub-enablers. Similarly, the degree of awareness a pathway participant has in performing tasks and contributing to the improvement of the pathway (awareness), and the degree of in which a pathway participant executes his/her task as described in the pathway (effective behavior) are considered critical to the success of the pathway.

The *complete CPMM* with all the components including the maturity level characteristics for each sub-enabler is given in *Appendix A*.

4.2 Using CPMM for pathway maturity assessment

Healthcare institutions can use CPMM to self-assess the maturity level of their pathways. A critical consideration is the presence of key participants during the assessments. As the maturity of the pathway relates to diverse aspects, it is important to take into account the view of multiple stakeholders (such as medical doctors, nurse practitioners, policy makers, quality representatives, etc.) for reliable and accurate representation of the existing conditions (Van Looy, 2015).

During the assessments, the participants are expected to assess the maturity of each sub-enabler in the model. They do so by selecting one of the maturity level characteristic of a sub-enabler (see the model with all elements in Appendix A) labeled as low (1), mid (2), high (3), or top (4). The decision for the selected characteristics should be based on the existing situation in the institution, and should represent the as-is situation of the pathway best. The participants can independently assess sub-enablers (and the individual responses can be aggregated to the sub-enabler level by taking averages) or the participants can act as a single group and can together decide on the characteristics for each sub-enabler. The assessment sessions in the form of focus groups, where the choice of the appropriate ma-

turity level characteristic of each sub-enabler is a result of a group decision, might be effective, as it helps creating awareness about the views of different stakeholders participating in the pathway.

After gathering the levels for all sub-enablers, the results are aggregated first at the enabler level, and second at the overall care pathway level. The aggregation at the enabler level takes into account also the weights attached to each sub-enabler. The result is represented as a *percentage* of the value that the pathway scored for a particular enabler based on selected characteristics, and the maximum value that can be achieved for that enabler. The aggregation at the overall pathway level is an arithmetic mean of the scores gathered for all enablers, as we do not apply weights for the enablers. A value below 25 indicates a low maturity level. A value between 25 and 50 a moderate, between 50 and 75 a high, and between 75 and 100 represents a top level in terms of pathway maturity.

5 Application and Evaluation of CPMM

As a design artifact, the CPMM should be evaluated in the real business environment (Hevner et al., 2004); i.e. in healthcare institutions where care pathways are executed. We designed a multiple-case study (Yin, 2003) with the objective to apply the CPMM in assessing the maturity of care pathways in healthcare institutions and evaluate CPMM's validity. We conducted descriptive surveys (Pinsonneault & Kraemer, 1993) with the case study participants for their opinion on the utility of the model. We investigated how the practitioners participated in the assessments consider the model in terms of its usefulness in identifying the maturity of their pathways and helping for its improvement.

5.1 Multiple-case study for care pathway maturity assessment

As a pre-step to the multiple case study conduct, we selected a care pathway for which the model will be used to assess its maturity in different institutions. For this purpose, we selected the pathway for mammary carcinoma, or in vernacular, breast cancer. This disease is elective care, which makes the process dependent on decisions made by specialists from multiple disciplines, and therefore critical for care pathway implementations (van Hove et al., 2014). Besides, mammary carcinoma is the second most commonly occurring cancer type, and considered to be the cause for the death of over three thousand women in the Netherlands every year (NCR, n.d.).

We approached 25 healthcare institutions in the Netherlands that are registered members of the Dutch Institute for Healthcare Improvement (www.cbo.nl) and are known to have mammary carcinoma care pathway in operation. Of those that were called, 11 hospitals accepted to participate in the case study and in the assessment of their mammary carcinoma pathway using the CPMM. We organized 11 meetings for the assessments in the time period between June-July 2015. Table 2 shows some characteristics of the healthcare institutions that participated in the assessment (including the region where the healthcare institution is located, the institution's turnover, and their total number of employees), and the position/role of the case study participants in relation to the pathway. There was a certain level of diversity in the institutions participated in the case studies in terms of their size and the region they operate. The turnover of the largest is around 10 times more than the smallest.

For the meetings, we asked at least three participants to be present, each with different roles and affiliations regarding the pathway. These were oncologist surgeon, nurse practitioner, and policy maker (e.g. program manager, quality manager). In doing so, we aimed at capturing pathway information from multiple perspectives to be able to accurately assess the maturity of the pathway. However, not in all case studies there were members present during the assessments representing all three roles. In 6 out of 11 cases, the assessments were performed with the participation of one member of the institution. In 3 cases there were two; and in 2 cases there were three participants; which totaled to 18 participants in 11 cases. This constituted a limitation to the accuracy of the maturity level assessment results. However, our focus in these case studies was on the validity of the model in terms of its applicability in real life settings, rather than on the precision of the pathway maturity level.

Inst. ID	Region (in the Netherlands)	Turnover (2013) (million €)	Num. of Employees (2013)	Participants' in the assessments
H01	Drenthe	106.7	868	Care pathways coordinator
H02	North Brabant	113.7	966	Oncology program manager, Care pathway owner, nurse practitioner
H03	Limburg	129.4	1145	Quality policy manager
H04	Gelderland	133.2	1264	Quality manager, nurse practitioner
H05	Limburg	225.3	2056	Oncology program manager, Oncology program management representative, nurse practitioner
H06	North Brabant	262.0	2458	Oncology unit manager, nurse practitioner
H07	Friesland	305.8	2640	Oncology program manager
H08	Gelderland	282.1	2670	Oncology program manager, surgeon oncologist
H09	North Holland	340.4	2751	Nurse practitioner
H10	Utrecht	417.2	3382	Surgeon oncologist
H11	Gelderland	979.5	7706	Nurse practitioner

Table 2. Healthcare institutions participated in the assessment and the case study participants.

The assessment meetings were planned as semi-structured interviews with the participants. In order to increase the effectiveness of these meetings, the assessment material including the CPMM, term and concept definitions, and the interview protocol was sent to participants 2 weeks prior to the meetings.

To help ensure uniformity in the application of the method and to be able to closely observe the assessments, at least one researcher (of this work) was present during all assessments. After a brief introduction to the objective of the assessment and the model to be used, the participants were asked to rate each sub-enabler (by selecting the right maturity level characteristic). The participants functioned as a focus group and only a single decision for each sub-enabler was provided after group discussions. Once all sub-enablers are rated, the results are aggregated at the enabler and at the overall pathway level, and a short report was compiled for each institution summarizing the main findings. The duration allocated for the introduction and assessment sessions in each case was approximately 1.5 hours.

5.2 Assessment results and discussion

Figure 3 presents the results of the assessments for all healthcare institutions. The leftmost graph shows the overall maturity level, while the rest presents the results for each enabler separately. The overall maturity levels for the institutions are within the range of 47 and 74 (out of 100; mean 57.5, st.dev. 7.5). Among 11, only one scored a high maturity value, and the majority is just above a moderate level. We also observed that using weightings for the sub-enablers (as given in Table 1) amplified the difference between the assessment results of the healthcare institutions, which can be considered to provide a better visibility on the enablers that should be given more emphasis for improvement.

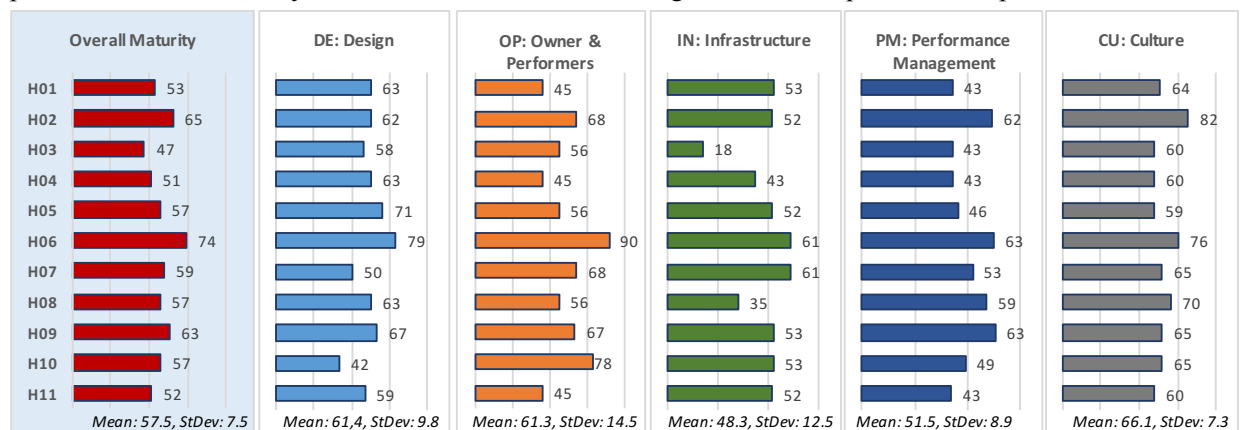


Figure 3. Results of the CPMM based maturity assessment of 11 healthcare institutions.

The results regarding the overall maturity level show that, although there are very few hospitals with relatively high maturity for the breast cancer pathway, there is significant room for many of the institutions to improve the quality of their pathways. The results indicate that the institutions are performing relatively well with regard to the design, owner & performers, and culture, whereas they relatively underperform in terms of IT infrastructure and performance management. The results regarding the difference of the achievement between the enablers are aligned with the general path of maturity increase conceptualized in the process maturity research field. Being able to track and manage the performance of the process (pathway) through defined indicators requires a certain level of maturity in process definitions, role and responsibility assignments, and a certain level of process understanding including recognition of the importance of process management (Rosemann et al., 2015). This situation holds also for IT systems supporting and automating the pathway. These capabilities, such as quantitative process management typically appear at higher maturity stages (OMG, 2008) and build upon the capabilities attained at lower maturity levels.

5.3 Evaluating CPMM's usefulness and ease of use

After each assessment session, the participants were asked to fill out a questionnaire to express their view on the utility of the CPMM. Through this survey, we aimed at eliciting practitioners view on the *usefulness* of the CPMM and its *ease of use* as a tool to assess and possibly improve pathway maturity.

The survey questionnaire was built using a set of statements from the Technology Acceptance Model - TAM (Davis, 1989; Venkatesh & Davis, 2000). TAM and its derivatives e.g. (Venkatesh et al., 2003) are the most commonly referred theories that predict and explain the acceptance and use of design artefacts. It has been used as a theoretical basis for many empirical studies in the information systems field, including the acceptance of IS methods and models (Moody, 2003). TAM has also been used in the healthcare domain to investigate the adoption of healthcare IT systems (Holden & Karsh, 2010).

The original TAM has three primary constructs: *perceived ease of use*, *perceived usefulness*, and *intention to use* (Davis, 1989). *Perceived usefulness* refers to users' perception on the utility of the design artefact in providing gains to its user (Venkatesh et al., 2003). *Perceived ease of use* refers to "the degree to which a person believes that using a particular system (design artefact) will be free from physical or mental effort". Finally, *intention to use* can be defined as the extent to which a person intends to use a particular design artefact. Intention to use is the most proximal antecedent to the artefact use and believed to be determined by perceived usefulness and perceived ease of use.

All constructs of TAM are operationalised using multiple indicators, which have been rigorously evaluated for reliability and validity (Davis, 1989). Following the work in (Venkatesh & Davis, 2000), we used 4 items for perceived usefulness and ease of use, and 2 for intention to use. In line with the approach followed in (Moody, 2003), the wording of the items was modified to accommodate this research. The participant could express their level of agreement with each statement on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to the evaluation of the results, we conducted a reliability analysis on the items used to measure the constructs. The Cronbach's alpha values were above 0.7, which indicates acceptable reliability (Nunally & Bernstein, 1995).

Figure 4 presents the responses for each questionnaire item. The results suggest a positive view on all constructs, i.e. the perceived usefulness, perceived ease of use and intention to use. The responses for the model indicate a general positive attitude towards using the model. Among 18 participants, we only had a single respondent with a negative view on the usefulness and ease of use of the model.

6 Conclusions

The primary objective of a clinical pathway is to improve the quality of care, reduce risks, increase patient satisfaction and increase the efficiency in the use of resources in the healthcare settings (De Bleser et al., 2006). Our study identifies certain enablers that have to be in place in order to achieve this objective. We propose a care pathway maturity model that builds upon these enablers. We identified these enablers based on a generic process maturity model and domain literature, and refined it for

content validity through a Delphi study. We applied the model in 11 Dutch hospitals to assess the maturity level of their breast cancer pathway. To validate the usefulness of the model, we performed a survey with the clinicians and healthcare managers participated in our multiple-case study. The results confirmed the usefulness of the model and likelihood that it will be adopted in practice.

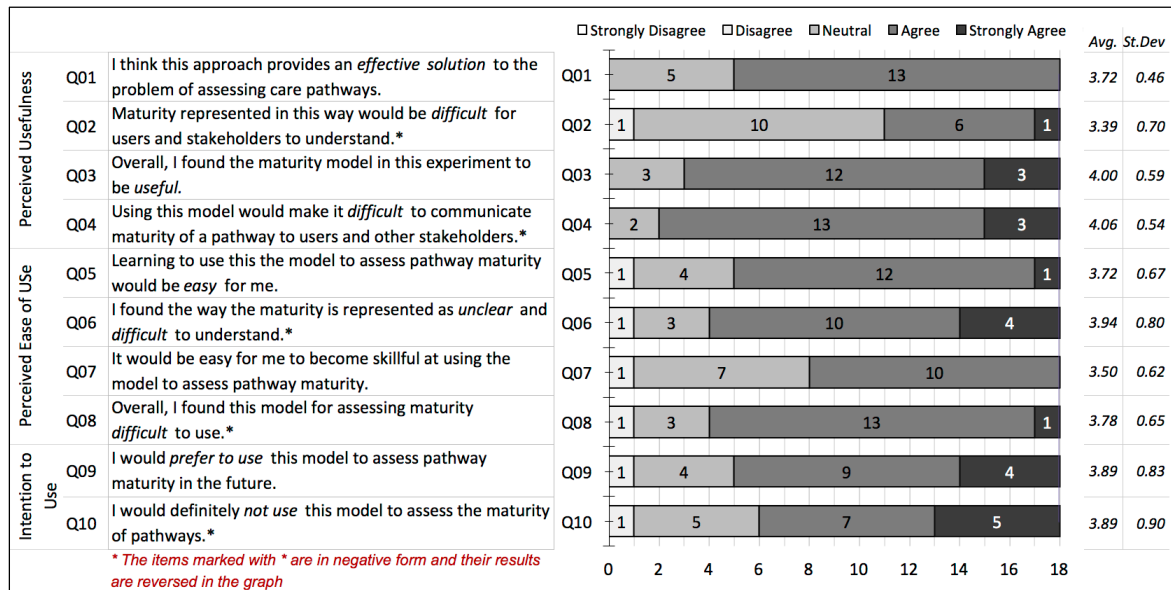


Figure 4. Results of the survey on model's usefulness and ease of use.

Our study contributes to two interconnected streams of research. It shows how a generic BP maturity model can be adopted and operationalized in a specific domain. In that respect, it contributes to the BPM body of knowledge, in particular to the research field of business process maturity and orientation. Successful adoption of such models may inspire researchers in the BPM field to apply them not only in healthcare but also in other domains. The CPMM extends the body of knowledge also in the healthcare domain, in particular in care pathway development and implementation, and care service quality improvement. The CPMM has potential to offer a direct contribution in practice. It can act as a practical tool for hospitals and other healthcare institutions to self-assess their care pathways, possibly for benchmarking purposes, and identify directions and opportunities for improvement.

Our study has limitations mainly in relation to the research methods applied in constructing and evaluating the design artefact, i.e. the CPMM. First limitation concerns the number of Delphi participants. Although the literature does not reach a consensus on the optimal number of subjects in a Delphi study (Okoli & Pawlowski, 2004), nine members can be considered as limited. We aimed at addressing this issue by bringing together both academicians and practitioners with expertise in diverse but complementary fields. To insure soundness of the gathered data we paid particular attention to panel selection and motivation, questionnaire construction, and for consolidating expert opinion.

In computing a precise value of maturity level for the overall pathway and for each enabler, we applied weightings of sub-enablers and applied arithmetic means in aggregating the ratings to the overall level. This approach is simple yet can be ineffective in pinpointing the part where the efforts should focus. Aggregating individual assessments of sub-enablers into overall assessment result is likely to be complex and require a more flexible approach (Kaymak & van Nauta Lemke, 1998).

We applied the model to assess only a single care pathway in a limited number of institutions operating in the *same* country. These pose risks to the validity of the findings we reached through applying it in real life settings. The number of participants in the case study and the survey can also be considered limited. Our future research will involve the application of the model in assessing the maturity level of different pathways in several healthcare institutions in *international* settings, possibly in the form of longitudinal case studies. Such a relationship will not only strengthen the validity of the model but also help verifying the benefits and potential of process orientation in the healthcare domain.

Appendix A: Care Pathway Maturity Model

Enabler	Sub-enabler	Definition	Maturity Level Characteristics				
			Low	Moderate	High	Top	
Design	Pathway objective alignment	The degree by which the objective of the pathway is aligned to the objective of the care delivery to the specific patient group of the pathway.	The pathway has not been designed on an end-to-end basis. Functional managers use the legacy design primarily as a context for functional performance improvement.	The pathway has been redesigned from end to end in order to optimize its performance.	The pathway has been designed to fit with other enterprise processes and with the enterprise's IT systems in order to optimize the enterprise's performance.	The pathway has been designed to fit with customer and supplier processes in order to optimize transmutal performance.	
	Pathway definition	The degree in which the design of the path is defined with a clear structure, terminology and roles.	There is no explicit definition and documentation of the pathway.	The different parts of the pathway, roles and terminology are defined and documented in textual form.	There is a structured and end-to-end documentation of the pathway including roles, and graphical representations.	There is explicit traceability between the pathway description and the rules originating from laws, regulations, and guidelines. New and changed rules are continually reflected in the related structure of the pathway.	An electronic representation of the process design supports its performance and management, and allows analysis of environmental changes and pathway reconfigurations.
	Compliance	The degree in which a pathway is designed taken the laws, regulations, and guidelines into consideration.	There is no explicit consideration of laws, regulations, and guidelines in the design of the pathway.	The laws, regulations, and guidelines are explicitly considered in the design, but no traceability is established between the description and the related rules of the laws, regulations, and guidelines.	There is explicit traceability between the pathway description and the rules originating from laws, regulations, and guidelines.	There is explicit traceability between the pathway description and the rules originating from laws, regulations, and guidelines. New and changed rules are continually reflected in the related structure of the pathway.	There is explicit traceability between the pathway description and the rules originating from laws, regulations, and guidelines. New and changed rules are continually reflected in the related structure of the pathway.
	Clarity in the decision criteria	The level of detail in the decision moments and/or in the (objectively assured) criteria in the design of the pathway.	There is no description of the specific care pathway decisions available.	Just broad lines of the care pathway decisions and criteria are defined in the pathway design.	Decision moments and broad lines of the corresponding criteria are defined in the pathway design.	Decision moments and the corresponding criteria are defined in the pathway design.	Decision moments and the corresponding criteria are defined in the pathway design.
Owner & Performer	Design approach	The degree in which a structured approach (e.g., a reference framework) is used and different stakeholders were involved during the design of the pathway (transmutal care (intern and external)).	No specific structured approach (e.g., a reference framework) is used, and there is no indication of the involvement of different stakeholders in the design of the pathway.	No specific structured approach (e.g., a reference framework) is used, but there is an indication of the involvement of different stakeholders in the design of the pathway.	A specific structured approach (e.g., a reference framework) is used, and there is an indication of the involvement of different stakeholders in the design of the pathway.	A specific structured approach (e.g., a reference framework) is used explicitly, and there is an explicit indication of the involvement of different stakeholders in the design of the pathway.	
	Owner (identity)	The extent to which the pathway ownership structure is effective in improving the pathway performance.	The pathway owner is an individual or a group informally charged with improving the performance of the pathway.	There is an official pathway owner role and it is filled with an individual or a group charged with improving the performance of the pathway.	The pathway comes first for the official pathway owner in terms of time allocation, mind share, and personal goals.	The official pathway owner has high degree of credibility and close relation with the enterprise's senior decision-making body in terms of changing the process.	
	Effective behavior	The degree in which a pathway participant (performer) executes his/her task as described in the pathway design and has knowledge of his/her own part in the pathway process.	Performers know their function/tasks as described in the pathway design, and perform it correctly but aren't aware of the whole pathway they are part of.	Performers know their function/tasks as described in the pathway design, perform it correctly and are aware of the whole pathway they are part of.	Performers know and perform their function/tasks as described in the pathway design and strive to ensure that the pathway process delivers the results needed to achieve the pathway's objective.	Performers know and perform their function/tasks as described in the pathway design and strive to ensure that the pathway process delivers the results needed to achieve the pathway's objective.	
Infrastructure	Information systems	The degree by which the supporting IS is integrated (internally and externally) and are designed with the pathways/end-to-end processes in mind.	Fragmented legacy IT systems support the pathway.	An IT system constructed from functional components supports the pathway.	An integrated IT system, designed with the end-to-end process in mind and adhering to enterprise standards, supports the pathway.	An IT system with a modular architecture that adheres to industry standards for inter-enterprise communication supports the pathway.	
	Network of pathways	The degree in which a pathway is part of a network of system components (e.g. through shared IT support, experienced improvements, shared resources).	The pathway only has some basic cost and quality metrics.	An explicit definition of care pathway exists only for a small set of pathways.	A network of care pathways is designed, through integrated systems.	Synergy is established within a network of care pathways through integrated systems and communication channels.	
Performance Management	Metrics definition	The degree in which metrics (such as patient satisfaction, throughput time) are uniformly defined in the pathway.	The pathway only has some basic cost and quality metrics.	The pathway only has end-to-end process metrics aligned with the pathway objective (e.g. patient satisfaction).	The pathway's metrics are aligned with the pathway objective and enterprise objective (e.g. patient satisfaction, cost).	The pathway's metrics are aligned with the pathway objective, enterprise objective and implemented (e.g. frequent measured patient satisfaction, cost).	
	Metrics use	The degree in which the metrics are effectively used to assess the achieved performance.	The pathway owner uses the pathway's metrics to track its performance, identify root causes of faulty performance, and drive functional improvements.	The pathway owner uses the pathway's metrics to compare its performance to benchmarks, best-in-class performance, and customer needs and to set performance targets.	The pathway owner presents the metrics to pathway performers for awareness and motivation. They use dashboards based on the metrics for day-to-day management of the pathway.	The pathway owner regularly reviews and refreshes the pathway's metrics and targets and uses them in strategic planning.	
	Structured collection of data	Degree of structure in data collection (meaningful data variables also in line with the metrics).	No structured collection of pathway process data exists.	The pathway process data is collected in an unstructured way.	Pathway process data is collected in a structured way for analyzing metrics.	Pathway process data is collected in a structured way and using the defined variables needed for analyzing metrics.	
	Availability of Perf. Info.	The degree in which pathway process performance information is available for all stakeholders.	Pathway process performance information is not available.	Pathway process performance information is available only for the pathway owner.	Pathway process performance information is available for all stakeholders for only certain periods.	Pathway process performance information is always available for relevant stakeholders.	
	Availability of Real-time Info.	The degree in which pathway process and patient data is available in real-time.	Real-time pathway or patient information is not available.	Pathway and patient information are available on request.	Patient information is available in real-time but pathway information is available on request.	Pathway and patient information is available in real-time.	
	Capacity monitoring	The degree by which the capacity of resources involved in the pathway (such as doctors, nurses, beds, tools and other supplies, etc.) is monitored.	Pathway resource capacity is not monitored.	Pathway resource capacity is monitored but not continuously.	Capacity for some of the pathway resources is continuously monitored.	Capacity for the majority of the pathway resources is continuously monitored.	
Culture	Stakeholder involvement	The degree in which the owner and the stakeholders in the pathway chain communicate and indicate improvements of the pathway (intern and external).	There is no explicit focus and process on the improvement of the pathway.	Stakeholders can mention and communicate points of improvement to the owner of the pathway.	The process owner of the pathway regularly improves the pathway based on the points of improvement from the stakeholders.	The process owner of the pathway continuously improves the pathway based on the points of improvement from the stakeholders, and informs all stakeholders.	
	Awareness	The degree of awareness a pathway member has in performing tasks and contributing to the improvement of the pathway as a whole.	Performers have primary focus on their own function/tasks without any explicit emphasis on pathway improvement.	Performers perform their tasks/functions and recognize possible improvements in the pathway.	Performers recognize and propose possible improvements in the pathway.	Performers continuously look for signs that the pathway process should change, and they propose improvements to the pathway process.	
	Flexibility	The degree a specialist in the path is allowed to deviate from the design procedures and is tracked when changes are made.	Specialists are not allowed to deviate from the designed procedure.	Specialists are allowed to deviate from the designed procedure but deviations are not tracked.	Specialists are allowed to deviate from the designed procedure and these deviations are only tracked.	Specialists are allowed to deviate from the designed procedure and these deviations are tracked and analyzed.	
	External objectivity	The degree in which the pathway is externally reviewed and audited (against laws, regulations, guidelines, etc.).	The pathway is not audited internally or externally.	The pathway is audited externally.	The pathway is audited internally and externally.	There is an established governance body and the pathway is audited internally and externally on predefined periods.	

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