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Navigating within the Digitalization Journey: Results and Implications of the First Maturity Assessment of German Public Health Agencies

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Research Paper

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Abstract. The Covid 19 pandemic revealed the need for Public Health Agencies to mature digitally. To help those agencies with their digitalization endeavor, a public health agency maturity model (PHAMM) has been developed, evaluated, and employed by 366 institutions to determine their digital maturity and to prioritize actions within digitalization projects. This paper discusses the digital maturity of German public health institutions and derives first insights into components spanning the PHAMM dimensions. Public health agencies can use these components to leverage their digital maturity in future digitalization projects. Implications are discussed for how digitalization projects with an enhanced impact can be defined and for future maturity modeling research.

Keywords: Maturity Model, Public Health Agency, Component Analysis, Digital Maturity, PHAMM.

1 Introduction

The German public health service (PHS) and its approximately 375 public health agencies (PHAs) are essential in protecting the population's health (Arnold et al. 2021). In addition to the visible areas of responsibility, such as infection tracking, PHAs are responsible for diverse tasks, including monitoring hygiene in public facilities, checking drinking water quality, and offering citizens a wide range of counseling services (Rechel et al. 2018). Despite playing an essential role in the German PHS, PHAs have been underfunded for decades leading, for example, to a lack of resources, e.g., in terms

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of employees or IT equipment, as well as non-existent interoperable systems (Behnke et al. 2020; Schreyögg 2020). These shortcomings became apparent during the Covid 19 pandemic. In the awareness that PHAs need to be better prepared to respond to potential future crises, we developed a maturity model (MM) to support their digitalization efforts, referred to as the Public Health Agency Maturity Model (PHAMM). The PHAs first used it in 2022 to determine their digital maturity. Institutions planned digitalization projects to achieve higher maturity levels based on this as-is digital maturity. The government financially supports these digitalization projects through a €4 billion pact, of which €800 million are intended to fund the digitalization of PHAs (Federal Ministry of Health 2020). The €800 million funding for the digitization of the public health system is part of the German Reconstruction and Resilience Plan (Deutscher Aufbau- und Resilienzplan; DARP), which is in turn part of the EU's NextGenEU. The PHAMM serves as a reference indicator for milestones defined by the DARP. To receive funding, the PHAs must define projects enabling digital maturing for at least two maturity levels in two dimensions (Bundesgesundheitsministerium 2022). This work uncovers the digital maturity level of PHAs prior to governmental funding, thereby providing a baseline for PHA digital maturity. This baseline serves as a reference for future evaluations, assisting in determining the efficacy of granted funds. Thus, this work engages in answering the following research question (RQ):

RQ1: What is the baseline level of digital maturity within public health agencies?

After establishing the baseline level of digital maturity within PHAs, we delve deeper into understanding the intricate connections between various digitalization practices across different digitalization areas (dimensions) defined in the PHAMM. We tackle this interconnectedness in a second RQ using a principal component analysis (PCA):

RQ2: How can the interconnectedness of practices within different dimensions be leveraged to define digitalization projects with multi-dimensional impacts?

The aim of this paper is twofold. First, we report on the digital maturity of 366 public health institutions, especially PHAs, who participated in surveying the digital maturity. Second, we discuss six overarching components spanning the eight dimensions that PHAs can use to leverage their digital maturity in follow-up digitalization projects.

2 Background

2.1 Governmental Public Health Service

The PHS is a component of the public administration sector in Germany, consisting of public health institutions at the federal level (e.g., Robert Koch Institute), state level (e.g., state health ministries), and local level (e.g., PHAs). In particular, the 375 PHAs faced acute challenges during the pandemic suffering from high staff shortages and insufficient digital infrastructure. To cope with these challenges, they resorted to self-

made isolated solutions and outdated communication tools such as fax machines for receiving laboratory reports. This led to delays and inaccuracies in outbreak detection (Schreyögg 2020), unnecessary documentation efforts, and loss of information, for example, in contact person management (Gerlach et al. 2021). In response to these deficiencies, the Public Health Service Pact was adopted in 2020, aiming to not only "somehow survive" (Spahn 2020) but also to sustainably strengthen the PHS and acknowledge its relevance politically (Arnold et al. 2021). Following this vision, the pact seeks to promote establishing standards regarding digital applications (Federal Ministry of Health 2020). A key element for implementing these digitalization measures is the development of a MM, which enables PHAs to assess their level of digitalization, sets minimum requirements, provides development paths, and allows for the allocation of funding from the Pact (Federal Ministry of Health 2020).

2.2 Maturity Model for Assessing the Digitalization of Public Health Agencies

MMs are long-proven tools for supporting digitalization efforts (Subba et al. 2003; Mehta et al. 2007; Becker et al. 2009). They enable the assessment and understanding of an organization's capabilities and the identification of potential for enhancement. MMs guide digitalization by supporting prioritizing, tracking progress, and allocating resources (Becker et al. 2009; De Bruin et al. 2005; Doctor et al. 2023). Although MMs were initially developed for private organizations, MMs are recommended for federally organized institutions like PHAs, as they help negotiate a shared objective and steps toward it (Doctor et al. 2023). MMs exist in many areas, including IT management (Becker et al. 2009), knowledge management (Freeze et al. 2005), business process management (Rosemann et al. 2005; Hammer 2007), or e-government (Layne et al. 2001; Andersen et al. 2006; Yildiz 2007; Klievink et al. 2009). While MMs have their advantages, they are also often subject to some critics. For example, the MM development field tends to lack an empirical and theoretical foundation due to its reliance on deductive methods and literature-derived concepts, which may not always align with practical needs (Pereira et al. 2020). Additionally, MMs can oversimplify reality (Solli-Sæther et al. 2010), limiting their usefulness and hindering organizational development. They also exhibit limited applicability in diverse organizational structures and have not been widely used for budget allocation.

Given the limitations and the demand for a guided digital PHA transformation, developing a new MM was crucial. We based the development process on a widely adopted model for MM development (Becker et al. 2009) and included build-and-evaluate cycles and a collaborative approach involving PHA practitioners and government stakeholders from all federal states. The development process incorporated four interview rounds, three workshops, and a survey leading to the creation of the PHAMM. The PHAMM is designed to address the limitations of previous MMs: It is applicable across a broad range of federally structured public institutions, aims to decrease the structural discrepancies among PHAs, and offers a means for budget allocation to the PHAs. More information about the development can be found in Doctor et al. (2023). The PHAMM comprises 355 digitalization criteria (practices), classified into 27 subdimensions subsumed into eight dimensions (bold in Table 1). For each dimension and

subdimension, five maturity levels are distinguished (levels 0 to 4), and each includes various practices. The practices in the PHAMM can be directly implemented in digitalization projects, serving as criteria for measuring the level of digitalization (Doctor et al. 2023). One practice in the dimension *of IT security* is, for example, "Reporting channels for security-relevant events are regularly checked, tested, and updated." The PHAs rate practices on a three-level scale as "applies," "is being implemented," or "does not apply". The PHA must evaluate all 355 practices. A maturity level for a dimension is achieved when at least 80% of its practices are applied. In the example of the subdimension *dealing with IT security risks and attacks*, a PHA at maturity level 0, for example, meets a few of the desirable practices for preventing, detecting, and responding to IT security risks and attacks. At higher levels, suitable measures for preventing, detecting, and responding to IT security risks and attacks exist and are continuously evaluated as part of a success-control measurement. As part of the funding appeal of the Federal Ministry of Health, a general goal is to reach maturity level 3 in all eight dimensions by 2025, thus reaching the mission statement of "Gesundheitsamt 2025" (Bundesgesundheitsministerium 2022).

Table 1. Dimensions of the PHAMM (Doctor et al. 2023)

Dimension	Description, including **subdimension**
Digitalization strategy	This dimension comprises (1) **the definition, communication, and implementation** of the digitalization strategy, (2) **the definition of responsibilities**, and the planning of (3) the **digitalization budget** for the PHAs' tasks.
Employees	This dimension includes (1) **sensitization** and (2) **participation** of the employees in digitalization activities and the aspects of (3) **training**.
Process digitalization	This dimension includes the extent to which processes are (1) **documented**, (2) **IT-supported,** and the extent to which there are (3) **overlapping processes** to be addressed via cross-process coordination. Finally, we lay out practices for the (4) **evaluation of processes**.
IT security	This dimension includes the scope of (1) **IT security management**. It also addresses concrete measures for (2) **dealing with IT security risks and attacks** and (3) **identity and access management**.
IT provision	This dimension includes the equipment of the (1) **IT workplace** (hardware and operating systems), the (2) **organization of the IT procurement,** the (3) **IT infrastructure**, and the (4) **application of IT service processes.**
Citizen focus	This dimension includes considering the (1) **interaction** with citizens and orientation and design of the available information and (2) **preferences**.
Cooperation	This dimension includes (1) **cooperation within the PHAs**, (2) **cooperation between PHAs and provincial offices**, and (3) **cooperation with external stakeholders**.
Software, data, and interoperability	This dimension includes the (1) **use of specialist applications,** their (2) **technical interoperability**, (3) **data analysis, and reporting**, (4) **requirements and documentation** of specialist applications, and (5) the **protection of data**.

3 Methods

3.1 Data Collection[1]

In early 2022, the Federal Ministry of Health issued its inaugural call for project funding (Federal Ministry of Health 2022). Applicant institutions had to evaluate their digital maturity via the PHAMM and provide justifications for funding based on the practices. The PHAMM is implemented as an online survey available to determine digital maturity from May to July 2022. Beyond the classification into the PHAMM, the online survey included demographic data such as type of institution, number of employees, and professional background of the management. It also included questions about the quality of each PHAMM dimension and user-friendliness using 18 of the 19 items from the scale by Lewis (2002). To ensure high data quality, we provided participating institutions with additional material, such as a glossary. At the beginning of the assessment period, several online workshops took place. The public health institutions then answered the survey using an individual link. So, participating institutions could fill in the survey in several sessions an also forward the link to stakeholders. We advised including relevant stakeholders within the assessment procedure to secure identifying their most appropriate state of digital maturity. The coordination of the assessment procedure was entrusted to the management of the institutions. User-friendliness of the PHAMM was assessed on a scale from 1 to 7 (1 representing higher user-friendliness). Overall, the PHAs and related institutions rated the usability as good (mean of 2.51). The tool was rated as easy to learn and helpful. The open-ended questions revealed that the dimensions, digitalization strategy, IT security, and IT provision required input from the institution in which the PHA is embedded. The results suggest that despite the high volume of questions, and the focus on PHAs, completion was generally feasible.

3.2 Sample

A total of 366 institutions participated in the first survey wave, including 330 PHAs. Table 2 summarizes all participating institutions, which we included in our sample, and which play an essential role within the public health service. On average participating institutions have M = 106.6 employees (min:18, max:1500). The catchment area of 86 institutions was mixed, 70 institutions had an urban and 156 had a rural catchment area, 54 did not respond.

Table 2. Number of participating institutions in the 2022 maturity measurement

	Health Department	Other local authority	Institution/body under the auspices of a federal state	State	Other
Type of institution*	330	4	3	8	17

[1] The results listed here are based on the data collected in the first collection period (May to July 2022). By now, there is more data available as in the second collection period (December 2022 to February 2023) additional institutions provided answers, also for the first time-period.

* The data were evaluated manually. Four institutions did not provide any information.

Table 3 summarizes the professional background of the management, showing that a medical background is the most common. Only 128 participating institutions stated that they employ an IT specialist within their organization, 149 noted that no IT specialist was employed, 15 were unsure or replied "others", and 54 did not respond.

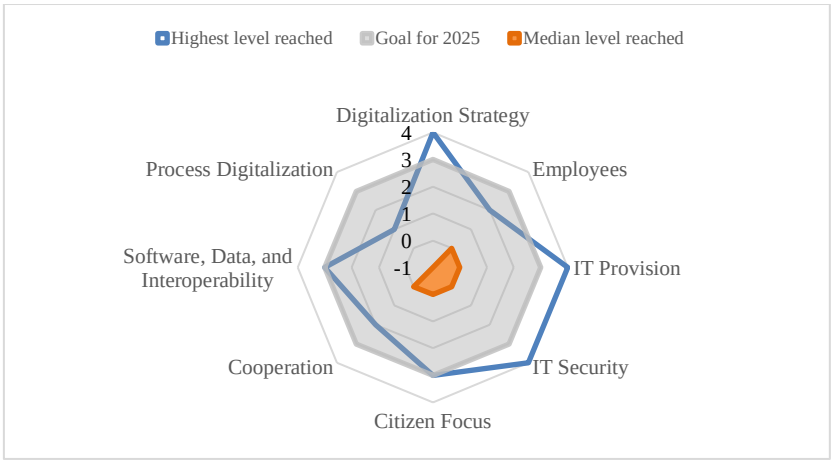
Table 3. Number of institutions by the professional background of the head of the office

	Medical	Legal	Commercial	Project Management/Digitalization Staff	Health-economic	Psychological
Professional Background	298	19	14	6	12	3

* The data were evaluated manually. 14 institutions did not provide any information.

4 Results of the Current Digital Maturity Status Nationwide

The current nationwide state of digital maturity of German PHAs and related institutions is shown in Figure 1. The lowest level of digital maturity is level 0. This level was achieved on the median across all participating institutions in five dimensions. In three dimensions ("digitalization strategy," "process digitalization," and "software, data, and interoperability"), no digital maturity level at all was achieved in the median nationwide, meaning that the digitalization in these dimensions is at the very beginning.



Note. -1 = no level achieved.

Figure 1. Overview of the results of the first survey wave

A more detailed breakdown of the results is provided in Table 4, which indicates the percentage and absolute number of participating institutions that have reached the respective maturity level for the dimensions. The proportion of participating institutions

that have not yet reached a level is highest for "process digitalization" at 89.6 %. Level 0 was most frequently achieved in the "employees" dimension.

Table 4. Count and percentage of the 366 institutions by level per dimension

Dimension		Levels reached					
		No level	Level 0	Level 1	Level 2	Level 3	Level 4
Digitalization strategy	Quantity	237	104	22	2	0	1
	Percentages	*64,8 %*	*28,4 %*	*6,0 %*	*0,5 %*		*0,3 %*
Employees	Quantity	126	214	24	2	0	0
	Percentages	*34,4 %*	*58,5 %*	*6,6 %*	*0,5 %*		
Process digitization	Quantity	328	28	10	0	0	0
	Percentages	*89,6 %*	*7,7 %*	*2,7 %*			
IT security	Quantity	165	98	59	32	7	5
	Percentages	*45,1 %*	*26,8 %*	*16,1 %*	*8,7 %*	*1,9 %*	*1,4 %*
IT provision	Quantity	160	81	68	38	17	2
	Percentages	*43,7 %*	*22,1 %*	*18,6 %*	*10,4 %*	*4,6 %*	*0,5 %*
Citizen focus	Quantity	94	188	82	1	1	0
	Percentages	*25,7 %*	*51,4 %*	*22,4 %*	*0,3 %*	*0,3 %*	
Cooperation	Quantity	44	193	120	9	0	0
	Percentages	*12,0 %*	*52,7 %*	*32,8 %*	*2,5 %*		
Software, data, and interoperability	Quantity	184	117	48	15	2	0
	Percentages	*50,3 %*	*32,0 %*	*13,1 %*	*4,1 %*	*0,5 %*	

5 Results of the Exploratory Component Analysis

Once we analyzed the baseline level of digital maturity, we delved deeper into the intricate interplay between the practices of the dimension, aiming to comprehend how they mutually influence each other. We were particularly interested in these interrelations as the dimensions of the PHAMM are formative constructs, meaning that they are fully defined and influenced by their respective subdimensions and practices (cf. Freeze et al. 2007). Though, interviews with PHAs and the content of some practices imply that some practices might also influence practices from other dimensions. For example, improved interoperability could lead to better cooperation internally and externally. Given the interconnected nature of the content of practices across different dimensions, enhancing one area could potentially have a ripple effect, influencing others. This interconnection presents an opportunity: instead of viewing the challenge of advancing digitalization projects to impact two maturity levels in two dimensions as a hurdle, we can see it as a chance to aim for practices that could have broader, multi-dimensional effects. Therefore, these interrelations might hint at other higher-level latent and reflective constructs influenced by the practices (Freeze et al. 2007). Thus, we conducted an exploratory analysis to gain insight into the relations between the different practices. Hence, we provide insights on how (1) relations between dimensions might be assessed

and (2) give a first idea of how to address several dimensions using these higher-level constructs. To assess if there are overarching fields of action (components) within the PHAMM, we calculated a PCA using SPSS (IBM Corp. 2021). To conduct the PCA, we used 354 of the 355 PHAMM practices (we excluded one practice due to its lack of variance) and used a Varimax-rotation method. Practices were all rated on a three-point Likert Scale from 0 (does not apply), and 1 (is being implemented) to 2 (applies). Moreover, we used the Scree-Test (Bortz et al. 2011) to identify the correct number of components. This criterium describes the right number of components as the point where the Scree-Plot shows a kink, meaning that the following components have substantially less eigenvalue than the ones before. For the interpretation and analysis of the retrieved components, we used the common cut-off point of .300 for retaining the criteria in a respective component (Field 2013). The Kaiser, Meyer, and Olkin (KMO) criteria, the Bartlett-Tests as well as the inverse correlation matrix could not be calculated due to the high number of variables and the comparatively small number of cases.

Conducting the PCA, we identified six higher-level components that account for a total of 28,58 % of the explained variance and that can be interpreted as follows: (1) digitalization potentials awareness, (2) security awareness, (3) resource usability, (4) rule awareness, (5) IT efficiency, and (6) process and data awareness. For interpreting the components, we considered practices part of the component they loaded the highest on. Table 5 gives an overview of the six components, their means, standard deviation **Table 5**, eigenvalues, and variance explained by them. A more detailed overview, including components, loadings for respective practices of the PHAMM, and their full text, can be seen in the online attachment.

Table 5. Overview of the six components (comp.)

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6
Min	-1,49	-2,36	-2,39	-3,33	-3,46	-2,46
Max	5,97	3,12	2,74	2,28	1,99	2,94
Initial Eigenvalue	48,57	16,23	11,03	10,21	8,17	6,97
Total variance explained (%)	13,72	4,58	3,12	2,89	2,31	1,97

Note: n = 322; mean for all components = 0; SD for all components = 1

Component 1 − Digitalization Awareness. The central theme of this component is enhancing awareness of digitalization and its potential. For this component, practices of the dimensions "digitalization strategy", "process digitization", and "employees" load most heavily, such as the practice *"Individual, organizational units derive short-, medium- and long-term digitization measures from the digitization strategy"* from the dimension digitalization strategy. Applying this strategy leads to enhanced digitalization awareness. For example, through applying the digitalization strategy employees visit *"Regular workshops on digitalization"*.

Component 2 −Security Awareness. This component primarily contains practices from the "IT security" dimension. The central theme is to increase security awareness,

e.g., by *"Defining, establishing and propagating a procedure for handling and evaluating security incidents"* and *"Selecting authentication mechanisms on an as-needed basis according to the need for protection"*. Although this component mainly includes practices of the "IT security" dimension, it also spans practices of other dimensions with the potential to enhance security awareness.

Component 3 – Resource Usability. As in component 2, component 3 includes practices mostly from one dimension (IT provision). This component's central theme is enhancing resource usability by providing appropriate and retrievable resources for the tasks at hand. In this regard, this component spans practices that allow scaling up resources if required, such as *"Storage for large amounts of data is kept ready"* in case of necessity, and also focuses on practices that provide those resources with the potential to support all specialist applications best.

Component 4 – Rule Awareness. Practices from several dimensions load on this component. The central theme of this component is to enhance rule awareness so that digitalization potential can be leveraged. In this regard, "*Reporting channels for safety-relevant events are defined and adhered to"* (IT security), *"The requirements of the federal government and the state concerning digitalization are specified in the digitalization strategy"* (digitalization strategy), and "*The IT service processes according to ITIL standard are known to the person responsible for IT"* belong to this component.

Component 5 – IT Efficiency. This component mainly includes practices from the dimension "software, data, and interoperability" and, to a smaller extent, the dimensions "IT security", "citizen focus," and "IT provision". The central theme of this component is IT efficiency in the sense that practices need to allow efficient employment of the whole software system and digital technologies used in the organization. In this regard, *"informal or formal processes to report features and new ideas for enhancing business applications"* help to make IT more efficient so that the IT and, in particular, *"(...) specialist applications best support business processes"*.

Component 6 – Process & Data Awareness. This component spans several dimensions, including "software, data, and interoperability" as well as "process digitalization", "cooperation", and "digitalization strategy". The central theme of this component is to enhance awareness of processes and data and how to use them best. In this regard, *"Reporting/data is used for forecasting and decision support"* and *"A (partially) automated production of daily metrics"* occurs.

To get a deeper insight into the components, we calculated the correlations of the components with each PHAMM dimension (see Table 6). Component 1 has the strongest positive correlation with six PHAMM dimensions. This means that an increase in component 1 should lead to an improvement in the six dimensions. The two dimensions that do not correlate with component 1 correlate most strongly with components 2 and 3. Component 2 (security awareness) correlates most strongly with "IT security" and component 3 (resource usability) with "IT provision". Component 4 (rule awareness) correlates significantly with all PHAMM dimensions. This hints that awareness of compliance with rules and documentation positively affects all eight dimensions and seems to play a role in improving digital maturity. Component 5 (IT efficiency) correlates most strongly with the dimensions "cooperation", "software, data, and

interoperability", and component 6 (process & data awareness) correlates significantly only with the dimension "cooperation" ($p < .001$).

Table 6. Correlations between components and dimensions of the PHAMM

Dimension of the PHAMM	Component 1		Component 2		Component 3		Component 4		Component 5		Component 6	
Digitalization Strategy	0,30	***	-0,05		0,12	*	0,45	***	-0,16	**	0,13	*
Employees	0,36	***	0,06		0,13	*	0,53	***	-0,03		0,04	
Process Digitalization	0,37	***	-0,04		0,10		0,22	***	0,07		0,06	
IT Security	0,09		0,53	***	0,05		0,53	***	0,04		-0,11	*
IT Provision	0,08		0,20	***	0,60	***	0,28	***	0,11		-0,08	
Citizen Focus	0,22	***	-0,05		0,10		0,34	***	0,12	*	0,14	**
Cooperation	0,21	***	0,11	*	0,26	***	0,15	**	0,21	***	0,27	***
Software, Data, and Interoperability	0,26	***	0,06		0,31	***	0,30	***	0,33	***	0,14	**
Overall Digitalization Status	0,34	***	0,24	***	0,4	***	0,59	***	0,16	**	0,08	

*Note. *** = $p < .001$; ** = $p < .01$; * = $p < .05$.*

6 Discussion

The results suggest that, referring to RQ1, PHAs are at the beginning of their digitalization journey and that the most potential for development is in the dimensions of "process digitization", "digitalization strategy", and "software, data, and interoperability". Also, the results show above-average participation in the survey and, thus, the willingness to develop digitally. Some institutions have already achieved PHAMM levels 3 and 4 for individual or several dimensions, thus demonstrating the feasibility of digitalization. Achieving PHAMM-level 3 in all dimensions by 2025, as agreed on as a mid-term digitalization goal for PHAs by the federal states, is considered achievable and desirable. This survey will continue until 2026 so that improvements in digital maturity can be addressed in subsequent phases. This survey also revealed that PHAs needed to involve experts from the institutions in which they are embedded, especially for the dimensions of IT security, IT provision, and digitalization strategy. These areas are often managed by other administrations, and advancing in them thus often requires actions in governmental institutions outside the PHAs.

Furthermore, using an exploratory PCA to address RQ2 allowed identifying six higher-level action fields (components) that can be seen as overarching perspectives of PHA digitalization. These perspectives offer an additional lens on implementing and combining MM practices in digitalization projects. As an overarching construct, the concept of 'awareness' was identified. A related concept is situation awareness, defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley, 1995, p. 37). Comparing this definition with the characteristics of MMs and the specific requirements of PHA digitalization, the perception of awareness can be transferred to and even included in the conceptual operation mode of MMs. In

contrast to existing research that considers *digitalization awareness* as an initial maturity level, thereby labeling it as a temporally closed element to overcome (Klötzer et al. 2017), our results hint towards the importance of maintaining digitalization on all maturity levels and dimensions during the digitalization process (Figure 2). Considering the definition of situation awareness, the PHA management needs to identify and understand the related elements of digitalization (i.e., strategy, processes, employees) and what their effects are in its current and future state. Given the sensitive character of health data and the respective processes, the components of *security* and *rule awareness* mirror the responsibility related to the maturation process of a PHA. Like MMs, which focus on cyber security (Yigit et al. 2021) or information security (Spruit et al. 2014; Mijnhardt et al. 2016), both perspectives focus on necessary elements of a secure and reliable PHA environment. However, in contrast to models which focus merely on security as the primary objective within organizations, the PHAMM incorporates security as an underlying perspective in different dimensions. The remaining components, which are relevant for the provision of necessary resources (*resource usability*), the functionality of the IT infrastructure (*IT efficiency*), and the productivity and efficiency of organizational tasks (*process and data awareness),* can be understood as providing the infrastructural components necessary for a PHA to operate digitally.

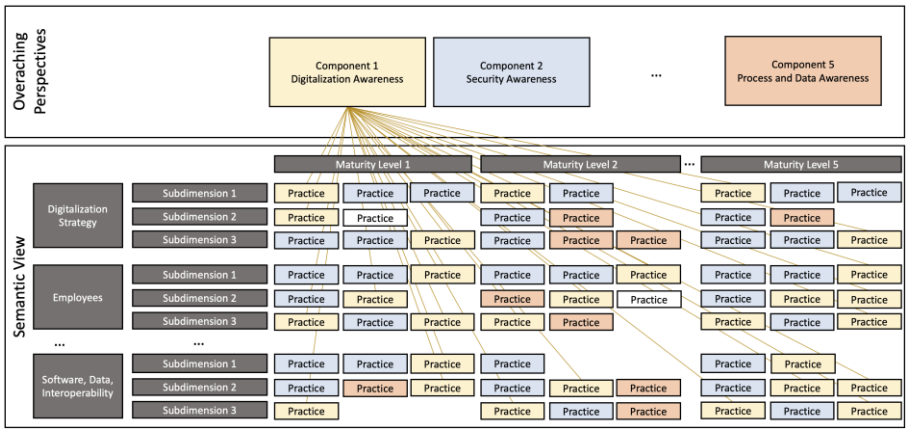


Figure 2. Conceptual overview of PHAMM's dimensions and components perspectives.

Thus, our results strengthen digitalization as a multifaceted phenomenon (Park et al. 2020). By conducting a PCA, we included a perspective for the derivation of actions on a managerial level and comprised elements of the situation awareness theory (Endsley 1995). We keep the dimensional PHAMM structure, characterized by many items depicting the complexity of PHAs, but add six awareness perspectives to guide managerial decisions. For example, when developing a project to achieve specific PHAMM practice, PHA's management could evaluate the project before implementation using the six perspectives. Suppose a project aims to model essential processes in the PHA. In that case, the management could consider how the six perspectives can be integrated into the project, widening the project's impact. The management could take into

account, e.g., what particular security aspects need to be considered (*security awareness*) or if and how a specific process modeling software can be used best (*resource usability* and *IT efficiency*), or how IT artifacts can be aligned more efficiently with the processes (*IT efficiency)*. Considering the different perspectives is necessary due to highly interrelated and interdependent processes, technologies, and stakeholders.

7 Conclusion

Digitalizing PHAs is a socially relevant and complex issue. To support the PHAs in digitalization, we developed the PHAMM. Using this MM, the current digital maturity of the PHAs nationwide was measured in the Summer of 2022. This study presents the results of this measurement. Furthermore, we analyzed the data to find higher-level perspectives between the PHAMM practices using a PCA leading to six components. Taking these six components into account in digitalization projects might help to reduce the complexity of digitalization to the necessary extent and make digitalization particularly efficient. This study thereby increases the knowledge about the digital maturity of PHAs as part of the public administration and proposes concrete components to simplify digitalization. We, thus, answer the call for research by (Mendoza-Silva 2021) for MMs that balance theory and practical applicability.

However, our study has some limitations. Regarding the data assessment, some PHAMM practices did not apply to other public healthcare institutions other than PHAs. Thus, our data might have some minor distortions. Though, they should not compromise our results too much, as we conducted our analyses on an aggregated level. Also, not all PHAs participated in this self-assessment survey. It is conceivable that the level of digitalization influences participation. The self-assessment could also lead to misjudgments if the person doing it is not fully informed about all areas. We tried to minimize this by advising PHAs to include relevant stakeholders in the assessment process. Furthermore, the survey was linked to financial support, and some PHAs might have assessed their digital maturity more conservatively to achieve funding.

Regarding the PCA, it should be noted that these are the preliminary results of an exploratory method, which should be interpreted and used cautiously until validated with a more confirmatory method (e.g., confirmatory factor analysis; CFA). The KMO criteria, the Bartlett-Test, and the inverse correlation matrix could not be calculated. This means that the data set is not ideal for performing a PCA. From our point of view, however, the PCA yielded interpretable results but must be carried out again in the future with more cases. A new calculation is especially important as our sample is relatively small, considering the number of items (practices), our factors only account for a rather small percentage of the total variance explained, and practices of higher levels were only reached by a few institutions causing little variance within them. As the recording of the digital maturity of PCAs continues until 2026, we are confident to use a more significant sample soon to apply more reliable analysis methods. We encourage future research to evaluate the possibility of finding overarching perspectives within MMs to help theory and practice better understand what needs to be addressed to achieve a coherent digitalization. Also, future research should consider evaluating our

six overarching perspectives within other governmental institutions to test if those perspectives can be used as general principles when implementing eGovernment projects.

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