Bus Inf Syst Eng
https://doi.org/10.1007/s12599-024-00897-0

RESEARCH PAPER

Boosting Multi-Professional Collaboration in Palliative Care Through Digital Technologies: An Action Design Research Study

Moritz Wöhl · Henner Gimpel · Oliver Meindl · Christoph Ostgathe · Sarah Peuten · Werner Schneider · Tobias Steigleder

Received: 22 September 2023 / Accepted: 31 July 2024

Abstract The success of palliative care requires collaboration among multiple professions within a sensibly digitized work system. The diverse perspectives and expertise of team members inform their collective endeavor, often leading to differing interpretations and priorities in patient care. This diversity necessitates a continual exchange of knowledge and information. Current technologies, including the hospital information system, do not foster such collaboration, particularly in palliative care. This study explores digital enhancements that can promote multi-professional collaboration (MPC). The authors employed action design research and used a work system theory lense to examine the palliative care work systems in two hospital wards in Germany. Through extensive on-site observations and interventions with practitioners, the study identified challenges that arose during MPC. This paper presents the proposed organizational and technical solutions. The paper provides design principles and guidelines for a collaboration support system to maximize MPC. Theoretical contributions include insights into the challenges of MPC and design knowledge about collaboration support. This work can inform practitioners about common challenges and offers potential solutions and guidance for implementing a collaboration support system.

Keywords Multi-professional collaboration · Palliative care · Work system · Collaboration support system · Action design research

Accepted after two revisions by Alexander Maedche.

M. Wöhl · H. Gimpel · O. Meindl (✉)
FIM Research Center for Information Management, Augsburg, Germany
e-mail: oliver.meindl@fit.fraunhofer.de

M. Wöhl
e-mail: moritz.woehl@fim-rc.de

H. Gimpel
e-mail: henner.gimpel@uni-hohenheim.de

M. Wöhl · H. Gimpel · O. Meindl
Branch Business and Information Systems Engineering, Fraunhofer Institute for Applied Information Technology FIT, Augsburg, Germany

M. Wöhl · O. Meindl
University of Augsburg, Augsburg, Germany

H. Gimpel
Chair of Digital Management, University of Hohenheim, Stuttgart, Germany

C. Ostgathe · T. Steigleder
Palliativmedizinische Abteilung, Comprehensive Cancer Center CCC Erlangen-EMN, Universitätsklinikum Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany
e-mail: christoph.ostgathe@uk-erlangen.de

T. Steigleder
e-mail: tobias.steigleder@uk-erlangen.de

S. Peuten · W. Schneider
Chair of Sociology, University of Augsburg, Augsburg, Germany
e-mail: sarah.peuten@phil.uni-augsburg.de

W. Schneider
e-mail: werner.schneider@phil.uni-augsburg.de

Published online: 24 September 2024

1 Introduction

Digital transformation is both a major opportunity and a societal challenge in healthcare (Agarwal et al. 2010; Kraus et al. 2021). Healthcare has a broad range of specific requirements for digitalization. For instance, European medical devices and digital technologies are categorized into risk classes to better account for patients' vulnerability (European Union 2023). In addition, administrative tasks such as documenting patient status or billing therapies must also be possible and traceable in the digital world. Moreover, access to information needs to be managed and secured. These requirements are relevant to medical device-dependent and digital-savvy areas of healthcare, such as intensive care. Yet, there are areas that are only slightly or hardly digitalized to which these requirements apply as well. Palliative care differs from technology-driven intensive care in that palliative care practitioners value 'low-tech' and 'high-touch' (Grimminger et al. 2023). It requires a multi-professional team that delivers highly individualized care during a patient's last phase of life when the aim is no longer to cure but rather to alleviate suffering. Palliative care helps terminally ill patients and their families (Cassell 1998; Abraham et al. 2006; Oishi and Murtagh 2014). It understands pain or suffering as a complex multidimensional experience (i.e., 'total pain' approach) considering the patient's physical condition, psyche, spirituality, and social environment (Saunders 2000; Krawczyk and Richards 2018). There is a low tolerance for human and technological errors and a constant need for ethical or moral considerations and team cohesion, which – besides fulfilling the digitalization requirements – makes it even more challenging to introduce supporting digital technologies. Nevertheless, palliative care is one area of healthcare where multi-professional collaboration is necessary and might be supported through digital technologies. The insights gained in this field help advance related fields.

Indeed, palliative care is one of the least digitized areas of healthcare, although potential benefits of digitalization are anticipated regardless of the maturity of the underlying healthcare system (Nkhoma et al. 2021; Schröder et al. 2024; Stanley et al. 2024). Palliative care practitioners tend to be more skeptical than others about digitalization (Keenan et al. 2021; Wöhl and Gimpel 2024). This behavior is historically conditioned, reflects the special framework conditions in this area of work, and roots in the practitioners' lack of technology acceptance (Dünnebeil et al. 2012) and their negative experiences (Kent et al. 2015; Califf et al. 2020). The paucity of digitalization means the acceptance hurdle for technical solutions is high. Since the COVID-19 pandemic, some practitioners are gradually rethinking their attitudes regarding the application of digital technologies (Stanley et al. 2024). In any event, these technologies must eventually enter this field (Mills et al. 2021) and improve the quality of care (Ferreira et al. 2023).

Palliative care is one area of healthcare that heavily relies on the principle of multi-professional collaboration (MPC), integrating various competences, perspectives, and knowledge to provide person-centered, holistic care for patients and their relatives (German Guideline Program in Oncology 2015; Cherny and Portenoy 2021; Payne et al. 2022). In a hospital inpatient palliative care ward, not only doctors from various specializations and nurses work together, but also psychologists, social workers, physiotherapists, music therapists, spiritual carers, and volunteers. In addition to profession-related organizational structures and differences, which, among others, manifest themselves in different work practices, hierarchies, and modes of communication, the respective (case) knowledge of the various team members is a decisive factor in creating a shared understanding of the patient's situation and needs in the multi-professional team (Senot et al. 2016). Therefore, managing information and knowledge among all the stakeholders is a major success factor in palliative care, requiring team coordination, trust, and exchange (Wickramasinghe and Davison 2004; Jünger et al. 2007; Oishi and Murtagh 2014). Information is, in principle, available to everyone. However, not all information is relevant to all members, and the abundance of information can cause selection and recency bias. Furthermore, knowledge is bound to individuals, and the team must create a joint base by pooling both objective information and subjective knowledge (Oishi and Murtagh 2014; Schneider and Stadelbacher 2020).

A sensibly digitalized work environment that meets the needs of a multi-professional team can improve collaboration and quality of care. The literature discusses MPC's challenges in healthcare and proposes some solutions (see Sect. 2). Digital technology can improve the efficiency and quality of MPC to enhance patient care (Gopal et al. 2019). By facilitating targeted information sharing and by fostering a common understanding among team members, digital support helps overcome barriers to effective collaboration and enhances communication (Anders 2016; Stanley et al. 2024).

The limited use of digital technologies and the need to pursue digital transformation present opportunities to explore digital support for MPC (Nguyen et al. 2020; Sheng et al. 2020). We conducted action design research (ADR) in the palliative care wards of two German hospitals, with the research goal being to improve the MPC in palliative care. Our goals included sharing experience and knowledge about specific cases and palliative care in general (process optimization) and transitively enhancing

the quality of patient care (outcome optimization). Our overall objective was as follows:

> *Develop design principles and design guidelines for a collaboration support system to foster multi-professional collaboration in palliative care.*

Relying on the work system theory as a guiding socio-technical lens throughout our ADR study, we identified 24 challenges of multi-professional collaboration in palliative care grounded in ethnographic fieldwork. We evaluated the current state and developed a target state of a work system for palliative care. In this context, we formulated six prescriptive design principles detailed in 21 concrete design guidelines for a collaboration support system fostering MPC. In doing so, we contribute to both theory and practice. From a theoretical perspective, we advance research on holistic work systems that support MPC by presenting a nascent design theory with organizational and technical-oriented design principles. From a practical standpoint, our study raises awareness of the challenges of multi-professional collaboration in the palliative care unit and presents ways to overcome them. These insights are not only relevant specifically for palliative care but may ultimately have implications for other healthcare areas with similar multi-professional settings.

2 Research Background

2.1 Challenges of Multi-Professional Collaboration in Healthcare

Collaboration is required when professionals with different backgrounds work together (Lorenz et al. 1999). In healthcare, the convergent framework is the shared goal of all professionals to help the patient. *"Collaboration is a process in which autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide […]; it is a process involving shared norms and mutually beneficial interactions"* (Thomson and Perry 2006). Although the definition of collaboration is universal, MPC is special because different professional backgrounds increase the effort required to establish rules, structures, and norms. Each profession has its own systematic body of theory, professional authority, community acquiescence, code of ethics, and culture (Greenwood 1957). In palliative care, the usual professionals are physicians, nurses, therapists (e.g., physiotherapy, music therapy, animal-assisted therapy, and art-therapy), spiritual carers, and social workers.

An organization is an institution in which knowledge resources are integrated, processed, and applied (Grant 1996). Knowledge exchange implies information exchange. It is crucial to know how – and from whom – to obtain information (Cross et al. 2002; Melender et al. 2020; Bennardi et al. 2021; Hökkä et al. 2021; Mertens et al. 2021). In MPC, information exchange among different professions is essential to achieve joint knowledge. When similar professionals collaborate, less professional expertise must be explicitly explained. Grant (1996) stated that joint knowledge encompasses language, symbolic communication, commonality of specialized knowledge, shared meaning, and recognition of individual knowledge domains. Palliative care wards have a weekly meeting where the multi-professional team discusses all patients. This weekly team meeting is essential for building shared knowledge as the whole team analyses and plans the course of treatment.

We identify seven challenges regarding MPC in the literature. They include communication between professional groups and their different views of identity (Schoop 1999; Daly 2004; Jünger et al. 2007; Zwarenstein et al. 2009; Rose 2011; Klarare et al. 2013; Oishi and Murtagh 2014; Jones and Thistlethwaite 2019; Melender et al. 2020; Bennardi et al. 2021; Kanai and Kumazawa 2021; Kesonen et al. 2022; Llop-Medina et al. 2022; Ahuja 2023) as well as differences in their decision-making power and their philosophies about care (Schoop 1999; Daly 2004; Jünger et al. 2007; Zwarenstein et al. 2009; Martin and Finn 2011; Oishi and Murtagh 2014; Jones and Thistlethwaite 2019; Kanai and Kumazawa 2021; Kesonen et al. 2022). Team members need to be willing to collaborate and be part of a multi-professional team, which means trusting other professionals and coordinating their efforts (Jones and Thistlethwaite 2019; Melender et al. 2020; Bennardi et al. 2021; Hökkä et al. 2021; Suikkala et al. 2021). Another aspect repeatedly mentioned in literature which indirectly affects collaboration is limited financial and time resources (Oishi and Murtagh 2014; Jones and Thistlethwaite 2019; Bennardi et al. 2021; Hökkä et al. 2021; Mertens et al. 2021; Kesonen et al. 2022; Llop-Medina et al. 2022). For example, a staff shortage – whether for financial reasons or a shortage of skilled workers – means the team has less time for activities that go beyond the minimum. Physicians tend to prioritize evidence-based work over patient interaction, whereas nurses tend to focus on patient interaction and are reluctant to challenge doctors (Senot et al. 2016). Additionally, intensive documentation of a patient's condition, treatment, and care processes is required in the hospital IS. Typically, the hospital IS is used for administrative tasks such as billing and reviewing cases such as malpractice suits; it contributes to treatment to a lesser extent (Reichertz 2006; Chow et al. 2012). The hospital IS offers an information and communication medium but does not serve a networking or mutually action-relevant,

information-recording purpose (Bennardi et al. 2021). Hence, professional groups tend to use workarounds (Beerepoot and van de Weerd 2018) and may find it challenging to use the documentation used by other professionals (Pirkko Nykanen 2014). Tacit knowledge is often exchanged in personal conversations rather than being a formal part of meetings or documentation (Yoo et al. 2019). Table 1 summarizes the challenges of MPC.

2.2 Fostering Multi-Professional Collaboration in Healthcare

The first step in MPC in palliative care is establishing a multi-professional team (Schoop 1999; Wickramasinghe and Davison 2004; Sørensen et al. 2018). Including only one or two professions to avoid the challenges of MPC is unhelpful, as palliative care requires several professions. As summarized in Table 2, team members need an understanding of the 1) *team*, 2) *its processes and values*, 3) *good interpersonal relationships*, 4) *collaborative skills*, 5) *communication structures*, and 6) *knowledge transfer*.

The 1) *team* must have clear understanding of its 2) *roles, goals, tasks, and responsibilities* (incl. proxies) so that all members know their autonomy to act (Amabile et al. 2001; Jünger et al. 2007; Gamondi et al. 2013; Palliative Care Competence Framework Steering Group 2014; Sørensen et al. 2018; Jones and Thistlethwaite 2019; Kesonen et al. 2022). A strong team orientation in which everyone knows they are part of a team is important for making good decisions (Isabella and Waddock 1994). The team must also have a clear philosophy and a shared understanding of procedures and identification with the work (Amabile et al. 2001; Jünger et al. 2007; Kesonen et al. 2022). This means professionals may need to sacrifice some aspects of their identity, power, territory, and expertise, and they might become non-experts in certain situations (Rose 2011). Leadership is essential to unite the team (Klarare et al. 2013). 3) *Good interpersonal relationships* are crucial for building the team's self-image. Such relationships require openness, trust, and respect as the foundations for successful collaboration (Amabile et al. 2001; Jünger et al. 2007; Gamondi et al. 2013; Sørensen et al. 2018; Kesonen et al. 2022). Team members also need 4) *collaborative skills*, such as sharing knowledge, allowing others to influence decisions, appreciating everyone's efforts, and trusting everyone's skills (Amabile et al. 2001; Gamondi et al. 2013; Palliative Care Competence Framework Steering Group 2014; Sørensen et al. 2018; Jones and Thistlethwaite 2019; Kesonen et al. 2022). Value-creating 5) *communication* among all team members should result from the previous aspects. The exchange can be formalized in regular meetings among the professionals (Amabile et al. 2001; Gurses and Xiao 2006; Klarare et al. 2013; Ishikawa et al. 2018; Sørensen et al. 2018). In palliative care, the weekly multi-professional team meeting is a fixed component where patient-related structured and unstructured data from the last week is compiled (DIMDI 2020). Other formats, such as bilateral exchanges, are also suitable if team members have enough time for reflection and mutual learning (Wickramasinghe and Davison 2004; Gamondi et al. 2013; Palliative Care Competence Framework Steering Group 2014; Sørensen et al. 2018). Regarding the tension between physicians and nurses, Senot et al. (2016) propose that an expert from one group directly collaborates

Table 1 Challenges of multi-professional collaboration reported in literature

Challenge	Supporting literature
Effort to exchange information in a structured manner and create joint knowledge	Grant (1996); Cross et al. (2002); Yoo et al. (2019); Melender et al. (2020); Hökkä et al. (2021); Mertens et al. (2021)
Communication between professional groups	Schoop (1999); Daly (2004); Jünger et al. (2007); Zwarenstein et al. (2009); Rose (2011); Klarare et al. (2013); Oishi and Murtagh (2014); Jones and Thistlethwaite (2019); Bennardi et al. (2021); Kanai and Kumazawa (2021); Kesonen et al. (2022); Llop-Medina et al. (2022)
Diverse professional identities and decision-making power	Schoop (1999); Daly (2004); Jünger et al. (2007); Zwarenstein et al. (2009); Martin and Finn (2011); Klarare et al. (2013); Jones and Thistlethwaite (2019); Kanai and Kumazawa (2021); Kesonen et al. (2022); Ahuja (2023)
Differing philosophies of care between professions	Daly (2004); Zwarenstein et al. (2009); Oishi and Murtagh (2014); Senot et al. (2016); Jones and Thistlethwaite (2019)
Collaborative skills and willingness to collaborate	Jones and Thistlethwaite (2019); Melender et al. (2020); Bennardi et al. (2021); Hökkä et al. (2021); Suikkala et al. (2021); Kesonen et al. (2022)
Limited resources (time, finances, etc.)	Klarare et al. (2013); Oishi and Murtagh (2014); Bennardi et al. (2021); Mertens et al. (2021); Kesonen et al. (2022); Llop-Medina et al. (2022)
Misfit of IT systems in the ward for collaboration Competence to use health technology	Reichertz (2006); Chow et al. (2012); Pirkko Nykanen (2014); Beerepoot and van de Weerd (2018); Bennardi et al. (2021); Suikkala et al. (2021)

Table 2 Approaches known to foster multi-professional collaboration

Approach for fostering MPC	Supporting literature
1) Establish a multi-professional team	Schoop (1999); Wickramasinghe and Davison (2004); Sørensen et al. (2018)
2) Establish team understanding of roles, joint goals, and procedures	Isabella and Waddock (1994); Amabile et al. (2001); Jünger et al. (2007); Rose (2011); Gamondi et al. (2013); Palliative Care Competence Framework Steering Group (2014); Sørensen et al. (2018); Jones and Thistlethwaite (2019); Kesonen et al. (2022)
3) Build good interpersonal relationships	Jünger et al. (2007); Gamondi et al. (2013); Sørensen et al. (2018); Kesonen et al. (2022)
4) Develop collaborative skills	Amabile et al. (2001); Gamondi et al. (2013); Sørensen et al. (2018); Jones and Thistlethwaite (2019); Kesonen et al. (2022)
5) Establish a structured exchange of information	Schoop and Wastell (1999); Amabile et al. (2001); Wickramasinghe and Davison (2004); Gurses and Xiao (2006); Gamondi et al. (2013); Klarare et al. (2013); Senot et al. (2016); Ishikawa et al. (2018); Sørensen et al. (2018)
6) Enable knowledge transfer through a powerful process and IT infrastructure	Teng et al. (1994); Berg (2003); Wickramasinghe and Davison (2004); Walker et al. (2005); Schweiger et al. (2007); Raghupathi and Tan (2008); Pohjola and Korhonen (2014); Sørensen et al. (2018); Kanai and Kumazawa (2021)

with someone from a lower hierarchical level of other group. Schoop and Wastell (1999) propose making communication more explicit through documentation systems that can translate specific aspects of communication from senders to receivers. Lastly, infrastructure is necessary for successful 6) *knowledge creation* and *transfer*. Information can be shared within the team (Berg 2003; Pohjola and Korhonen 2014; Sørensen et al. 2018; Kanai and Kumazawa 2021) if there is an adequate infrastructure (Berg 2003; Wickramasinghe and Davison 2004). A high level of interoperability in health information technology (IT) is desirable because it allows for efficient processes, extensive exchange of information, and a high quality of care, all of which reduce operating costs (Walker et al. 2005; Schweiger et al. 2007). The level of mediation determines the required level of interoperability. When activities directly contribute to the process outcome, the level of mediation is low. When there are further intermediate activities, the level is high. The level of collaboration also matters in terms of the frequency and intensity of information exchange and mutual adjustments (Teng et al. 1994; Raghupathi and Tan 2008).

2.3 Work System Theory

"A work system is a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products/services for specific internal and/or external customers" (Alter 2013). Our research uses the theoretical lens of work systems which helps to better understand the real world during action research projects (Alter 2013, 2018a, b). Beyond pure understanding, a work system perspective has been shown to help think about system design, specifically at the interface of organizations and technology (Alter 2010). For instance, normative principles and fundamental axioms for generic work systems have been developed (Alter 2004, 2017, 2024).

In addition to its methodological compatibility with ADR, work systems theory is promising for analyzing and designing MPC settings. The broader horizon, away from a purely technical perspective, allows greater consideration of the works system context and avoids a disjunctive view of people and technology (Alter 2003). With work systems as the unit of analysis, a strong focus can be placed on information and knowledge within the organizational context (Alter 2010). While shaping digital transformations and potentially introducing new or increasingly automated information systems (IS), context-related work practices can be taken into account to avoid cultural misfits (Alter 2003, 2024; Gimpel et al. 2020). Thereby, the concept of a work system allows researchers to understand what shapes a work environment and to pinpoint possible changes in the work system (Karsh and Alper 2005; Carayon et al. 2006). For example, Johnsen et al. (2016) applied the work system theory to evaluate the health information exchange processes that occur when patients are transferred. While there are existing approaches to enhance MPC, there has been no comprehensive perspective across these approaches using a work system lens. To close that gap, our research provides an integrated view and proposes design knowledge to improve MPC.

Although we have continuously considered the context, the main subject of this research is the inner core of a work system, composed of the four primary elements 'participants', 'technologies', 'information', and 'processes and activities.' While participants are users and non-users of information technology performing work within the work system, technologies include dedicated or shared tools to operate the work systems such as – but not limited to –

soft- or hardware. Work systems utilize informational entities, called information. These are processed in various ways (e.g., creation, usage, capturing, transmission, storing, manipulation, update, or deletion) through processes and activities to produce products or services for its customers. (Alter 2013).

3 Research Methodology

3.1 Action Design Research: Aim and Context

This study resulted from a three-year research project PALLADiUM funded by the Bavarian Research Institute for Digital Transformation. A published study protocol outlines the research objectives (Grimminger et al. 2023). The research aimed to create design knowledge for the collaboration support systems problem class. We sought to iteratively develop and evaluate design knowledge based on practitioners' perspectives, which meant that ADR was helpful for shaping ensemble artifacts (Sein et al. 2011). The ADR approach effectively explores new digital technologies or complex socio-technical phenomena in practical settings (Danneels and Viaene 2022).

With this study's reciprocal shaping of the ensemble-artifact between theory and practice, the core IT artifact comprises a nascent design theory (Gregor and Hevner 2013). It encompasses a broad range of potential artifacts (Baskerville et al. 2018) and guides future actions in MPC (Hevner et al. 2004), focusing on palliative care and the outlook to apply it beyond. We designed and let emerge the ensemble artifact through co-creation within our ADR context (Sein and Rossi 2019), comprising two German palliative care wards, the main focus Ward 1 (University Hospital of Erlangen) and the accompanying Ward 2 (University Hospital of Augsburg) which provided targeted feedback and offered an extended practice perspective. Our research team comprised two professors with backgrounds in sociology and IS, two researchers in sociology, and one in IS. The academic research team intervened in-situ with four practitioners and senior members of Ward 1 to form the ADR team. One was a professor of palliative care, two were senior physicians specializing in palliative care, and one was a postdoc with a nursing science background. The ADR team held mutually influential roles (Mullarkey and Hevner 2019). Our empirical research steps received a positive ethics vote from the Ethics Committee of University Hospital of Erlangen under the number 168_21B.

We iteratively designed and evaluated our artifacts in the form of a prototype, supplemented by organizational interventions, with practitioners and potential end users adhering to a work system perspective (Alter 2006, 2013, 2018b; Gimpel et al. 2020). Reflective analysis of our interventions led to co-creation between research and practice (Iivari and Venable 2009). Hence, the IT artifact is a set of operational design principles technically instantiated in a prototype, which can improve the MPC in palliative care wards (Collatto et al. 2018; Bojer and Møller 2022).

Figure 1 outlines our interventions in the ADR context. Following the framework proposed by Sein et al. (2011), our research process had four stages: *1) problem formulation*; *2) building, intervention, and evaluation*; *3) reflection and learning*; and *4) formalization of learning*. We additionally considered the rationale of a scenario-based design and successively analyzed the 'as is' work system (Rosson and Carroll 2002). Then, we designed the 'to be' work system, which is suitable to find solutions for digital work (Richter et al. 2018). Finally, we prototypically realized and evaluated an instantiation within Ward 1. We also investigated 'collaboration workflows.' This umbrella term encompasses processes, activities, routines, and the corresponding collaboration support. Our approach aligns with transformational initiatives in the context of work systems, such as Gimpel et al. (2020) and vom Brocke et al. (2018). It combines technological and organizational innovation to foster MPC.

3.2 Action Design Research Process

1) Problem formulation. The research followed the principles of ADR with a practice-inspired approach. Over a two-year span, the research team met monthly with the four senior team members, who were connected with other palliative care practitioners through professional societies, workshops, and collaborations. They shared insights on how they perceived situations in other settings based on their experiences and networks. The purpose was to identify and articulate the problem context for MPC. The problem formulation was not limited to practical insights. After reviewing existing research on MPC (see Sect. 2), we embedded the research in theory (Sein et al. 2011). This approach ensured a balanced perspective that combined empirical observations and theoretical foundations to provide a detailed understanding of MPC's challenges.

2) Building, intervention, and evaluation. In developing the collaboration support system, we pursued an IT-dominant approach to create an innovative technological design combined with organizational interventions.

We began with the α *phase*, which focuses on behavioral research. We used ethnographic fieldwork to access the team's implicit knowledge (which cannot be directly inquired about) and routine collaboration practices, which are often difficult to understand (O'Reilly 2012; Hammersley and Atkinson 2019). Two researchers skilled in

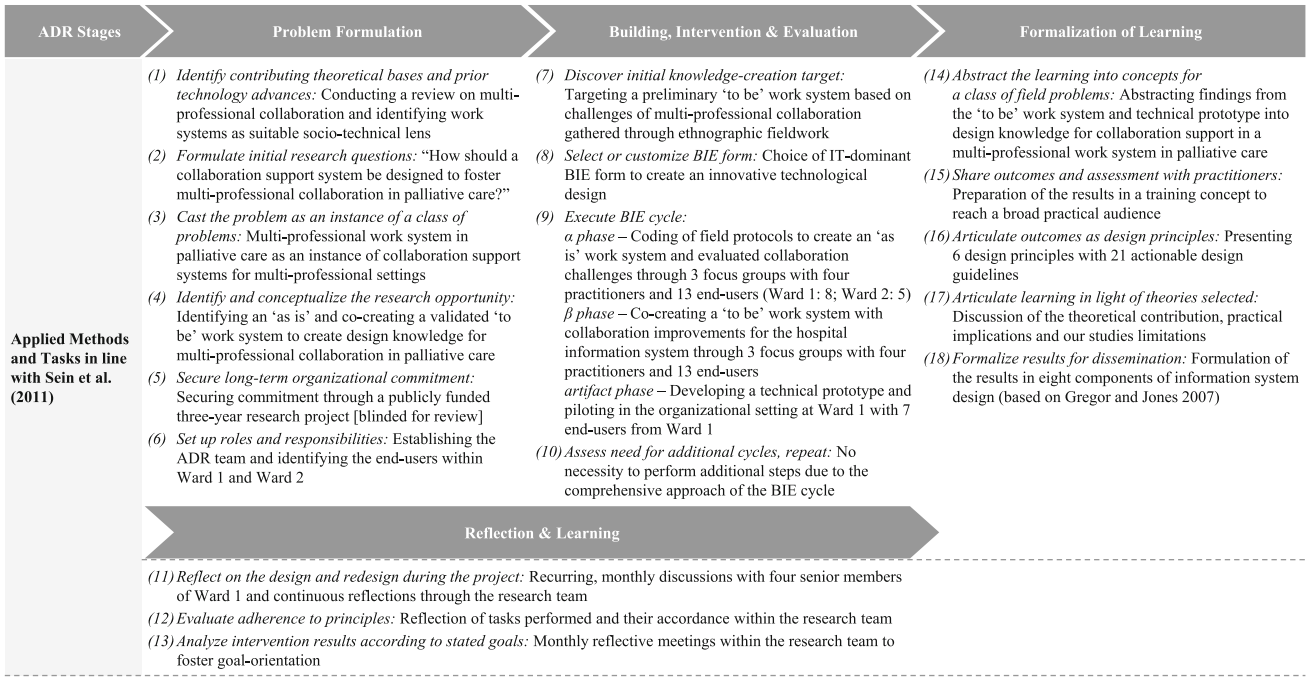

Fig. 1 Research process and our interventions in this study

qualitative social science conducted field observations of the team interactions over four 14-day cycles on the ward. Detailed field notes were elaborated into field protocols (Emerson et al. 2011). These observations provided insights into the workflows, tools, competencies, information requirements and the professional and personal knowledge of the members of the multidisciplinary team. Although structured interviews were not part of the investigation, spontaneous conversations with the observers were also recorded in the field notes. All ward employees were incorporated into the study, but their identities have been kept anonymous. The field protocols were then coded using MAXQDA (VERBI Software 2022) and qualitatively analyzed. The qualitative data collection and analysis were carried out according to grounded theory, which is characterized by an iterative approach that alternates between data collection and analysis (Glaser and Strauss 2017). We used grounded theory to produce empirically based knowledge with relevant theoretical concepts identified from the data (cf. Appendix; available online via http://link.springer.com). Grounded theory is not a specific method but a research perspective that follows certain principles and is consistently oriented towards the respective field of research in its approach (Kelle 2007). The key elements are ongoing conceptualization through open, axial, and selective coding; comparison; theoretical sampling; and memo writing (Strauss and Corbin 1997; Bryant and Charmaz 2007; Corbin and Strauss 2008). Grounded theory aims to develop or generate context-specific theories that provide knowledge and potential for improvement in overcoming practical problems in the respective field of action. In other words, no existing theory is applied or tested; instead, theory is highly empirically grounded. Initially, open coding identified the work system. This was followed by axial coding to establish connections between codes, refining them into key categories (Corbin and Strauss 1990). Despite the decidedly inductive approach, prior knowledge (literature, professional, and personal experience) and respective given knowledge (gained in the course of the current research) are understood as central resources and are also reflected in the use of 'sensitizing concepts' (Bowen 2006). Because coding was continuous, data from previous cycles was often re-examined and recoded in light of new insights. The coding procedure is systematic but does not correspond to quantitative logic (such as intercoder reliability). The collected data material was coded independently by at least two researchers, who discussed it in internal project interpretation sessions and research workshops with other social science researchers. The focus is on intersubjective comprehensibility and a transparent, research-led approach. The process enabled us to first identify challenges in collaboration. Additionally, during interactions with the team members of the ward, the researchers critically examined the work system and its challenges. To ensure our development was based on user needs, we triangulated and validated the findings regarding the works system and its challenges with the team members in focus groups (Stewart and Shamdasani 1999; Flick 2002). Although individual interviews might have yielded more extensive case data,

our research was focused on collaboration, which meant that team dialogues offered more nuanced insights. They fostered a deep comprehension of the team dynamics. The first focus group lasted 75 min and included five participants in Ward 1. Its purpose was to triangulate the challenges with the participant observations. Two more focus groups were then held to validate the intermediate results; each lasted 45 min and included any team members from the ward. Three team members participated in Ward 1, and five in Ward 2. Except for art therapy and animal-assisted therapy, all professions were represented. Participation was voluntary and based on informed consent. Although the focus groups were held mainly for triangulation and confirmation (Caillaud and Flick 2017), a moderator's guide was developed for each group. This guide delineated topics, essential questions, and activities. It facilitated rather than controlled the group's discussion to maximize the group's potential. During these sessions, we introduced our work system model and explained the challenges in MPC. Participants were encouraged to ask questions before they were asked to modify, comment on, or annotate the work system model and its challenges. All focus groups were recorded, and their content was transcribed and input into MAXQDA for (re-)coding. The output from the α phase is a snapshot of the 'as is' work system (Alter 2013; Gimpel et al. 2020) and related challenges. It is presented in Sect. 4.1.

In the *β phase*, we proposed changes to the work system. Drawing from the challenges, coupled with justificatory knowledge (cf. Section 2.2), the author's domain knowledge in IS (design), discussions with the ward senior executives, and observations, including comments or wishes from team members, the research team pinpointed potential enhancements to the current work system. The improvements were formulated (where applicable) as potential new capabilities of the hospital IS. We organized three focus groups with a total of 13 participants from all professional categories to triangulate the results. The sessions were held in both hospital wards, including one 90-min and two 45-min focus group meetings. The sessions began with a presentation of the suggested modifications and then an open floor for discussion. Participants were encouraged to voice any concerns and envision how the modifications might bolster their day-to-day workflows. The culmination of this phase offers a snapshot of the envisaged 'to be' work system, facilitating a direct comparison with the existing 'as is' model. The β phase outcome synthesized organizational shaping and practitioners' feedback rather than merely a preliminary design. The project was positioned to adapt and innovate according to MPC's real-world needs and challenges, effectively meeting the ADR principle of guided emergence.

During the *artifact phase*, we crafted the final ensemble artifact for the organization. This involved developing a technical prototype while piloting organizational strategies that encapsulated the ratified enhancements from the beta cycle. The prototype emulated the hospital IS, providing team members with a physical model. Seven people were invited to a 150-min focus group session at Ward 1 to evaluate the prototype. After a short introduction to the new system, team members were given hands-on access to the prototype, enabling them to provide feedback. The research team presented anonymized cases to enrich this evaluation, spotlighting challenges encountered in the MPC (see Sect. 5).

3) Reflection and learning. parallels the former two stages (Sein et al. 2011). Our approach was marked by continuous integration of feedback from practitioners (i.e., senior ward members) and end users (i.e., team members), as well as repeated analysis and re-coding of the data. This approach ensured the design resonated with practice and aligned with the research objective. Dialogues with senior ward members facilitated continuous reflection. The findings informed the research by rooting it in the reality of clinical practice. The external perspective on the processes in the ward enabled us to question the existing work processes of collaboration and ultimately redesign them sensibly. The prototype's supportive framework helped to identify and break away from undesirable patterns to some extent.

4) The formalization of learning. stage was focused on formalizing the insights and learnings gathered during the research process, in line with the ADR principle of achieving generalized outcomes. Our objective was to create design principles (DPs) that support MPC. These principles should apply to fostering MPC in other contexts, as well as to the specific wards.

4 Design Knowledge for Collaboration Support in Palliative Care

4.1 Challenges of Multi-Professional Collaboration in Palliative Care

The multi-professional work system of palliative care focuses on the collaboration between professions to deliver the main service of patient care. A secondary service provides information to hospital administrators for billing purposes and retrospective reprocessing. This work system sees the multi-professional team and hospital administration as customers. Patients and relatives are also customers; they receive care and benefit from successful collaboration. Details on the participants, technologies, information,

processes, and activities in the work system are outlined in Table 4.

We summarize the challenges in the work system with Table 3 comprising *1) team workflows; 2) team decisions*; *3) differing* perspectives among *team members*; *4) documentation*; *5) breaks in information flow*; *6) hardware*; and *7) financial pressure*.

1) Team workflows are one of the biggest challenges, requiring collaborative skills (Sect. 2.1). Several handovers within and across the professions must occur due to 24/7 presence and multiple shifts. Different opinions exist regarding the attendees and timing of the meeting (Challenge C1-1. ; Amabile et al. 2001). In addition, team members struggle to find time to discuss relevant issues. Some information must not be documented but still needs to be communicated (C1-2.). Such implicit workflows and relevant tacit knowledge challenge new team members to become aware of the team's joint knowledge (Grant 1996). Professions have physically separated rooms, meaning information and knowledge exchange often happen in unstructured ways and places such as hallways, nurses' stations, and individual offices (C1-3). Despite the exchange in the team, situations arise in which team members may not know whether another member plans to visit the patient, which causes unclear communication with the patient (C1-4).

2) Decision-making is major workflow of the team. It is essential for all team members, especially in the weekly multi-professional team meeting, to know what decisions were made and why (C2-1). Our observations identified room for improvement in this regard. It is not always clear whether an aspect is a decision or a discussion when people come together (C2-2). Hence, the actual decision – even if it is to 'wait and see' – is not always clearly and comprehensibly documented, and the resulting to-dos might remain unclear (C2-3). Further, when making decisions, members tend to be prone to recency bias, which means their most recent impressions of the patient dominate the discussions. Older impressions play a more minor role. Additionally, a hierarchy bias and thematic focus on medical issues were observed in the discussions (Daly 2004; Martin and Finn 2011). The doctors' responsibility for treatment decisions made these biases somewhat legitimate, but sometimes the team found the decisions incomprehensible. This situation leaves room for objectifying the decision-making process (C2-4) The above challenges align with the literature on exchanging information and diverging professional identities (see Sect. 2.1).

3) Differing team members' perspectives and relevancies pose a challenge, as the required information and knowledge differ for each profession to proceed with the treatment (C3-1); Daly 2004). Hence, the individual demand for information must be met, and finding a common language among team members remains challenging (C3-2); see also communication between professional groups and differing philosophies of care in Sect. 2.1).

4) Documentation is a challenge for team members, along with decision-making. The healthcare system heavily relies on documentation, which is time-consuming. Although traceability is essential for billing and accountability, it takes time away from patients and is a delicate balance. While some degree of documentation is inevitable, the status quo in many health systems has numerous inefficiencies (Carayon et al. 2006). In the ward, there are multiple IT systems in use in parallel, each for a different purpose (e.g., billing, nursing, resource planning), leading to redundantly documented information (C4-1). And the system barely supports collaboration explicitly (C4-2); Iakovidis 1998; Kuhn and Giuse 2001). Along with multiple IT systems, team members have to log in with multiple credentials, causing discomfort (C4-3). Consequently, relevant information tends to be spread across the IT systems and lacks structure, requiring numerous clicks to retrieve information (C4-4). The available documentation devices are stationary and commonly accessible. Although a few laptops are available, staff find them unwieldy to carry around (C4-5). Hence, for most documentation, staff walk back and forth, which takes time. If time is insufficient, documentation may be missing (C4-6). These challenges correspond to the literature on misfit systems in the ward (cf. Sect. 2.1). Documentation is often done only at the end of the shift, which can lead to recall bias and selective documentation (C4-7). Some information might be needed urgently by other professionals, and a lag in documentation means that information is communicated verbally before it is written down, which leads to redundancy. The combination of plentiful data and too little time often leads to unread documentation despite its relevance (C4-8).

5) Breaks in the information flow occur that are related to team workflows and documentation. Events that affect subsequent treatment can happen at any time. Such information needs to be spread to all team members to create information symmetry for relevant information (instead of every team member being informed about everything). Relevant information includes, among other things, patient appointments and changes to appointments, results from visits with the patient, agreements with relatives, and patient preferences. The team usually receives this information, but there is no structural guarantee (C5-1).

6) Hardware presents a challenge, especially regarding its availability. It became apparent that devices and network connectivity throughout the ward were limited, although a few portable devices were in use (C6-1). The team reported that proficiency in handling digital devices

Table 3 Overview of challenges in MPC

ID	Context	Challenge
C1-1	Team processes	Meeting attendance
C1-2		Verbal exchange (esp. on must-not documentation)
C1-3		Separated rooms
C1-4		Transparency on planned patient visits by team
C2-1	Team decisions	Recording of decisions
C2-2		Distinction of decision and discussion
C2-3		Transparency of decisions and resulting to-dos
C2-4		Objectivity in decision-making
C3-1	Perspectives in team	Individual information and knowledge requirements
C3-2		Common language
C4-1	Documentation	Redundancy of documentation (multiple systems)
C4-2		Missing fit of current systems to collaboration
C4-3		Multiple credentials
C4-4		Missing structure of information, numerous clicks
C4-5		Physically bound devices for documentation
C4-6		Missing or too brief documentation
C4-7		Lag in documentation
C4-8		Unread documentation
C5-1	Breaks in information flow	Information symmetry in the team
C6-1	Hardware	Availability of devices
C6-2		Proficiency with device handling
C6-3		Print outs of information
C6-4		Hands-free during treatment
C7-1	Financial pressure	Financial pressure and employee shortage

varied greatly (C6-2). To date, a typical pattern is that team members have their printouts of a patient list enriched with personal notes. They update their printouts daily by transferring relevant notes onto the new exemplar. Besides the environmental aspect, this costs time (C6-3). An aspect mentioned across all professions is that during the treatment, people's hands need to be free (C6-4).

7) Financial pressure is omnipresent for many hospitals, which manifests in employee shortages and, therefore, time availability plays a role in all the aspects mentioned above (C-7, cf. Sect. 2.1).

4.2 Design Principles for a Collaboration Support System in Palliative Care

Based on our analysis of the 'as is' work system and its challenges, we recommend design principles to change the system to achieve the desired 'to be' state (see Table 4). Achieving this state would involve implementing organizational and technical measures based on the suggested improvements (Wöhl and Gimpel 2024). In the spirit of ADR, we propose specific DPs to contribute to theory and guide practitioners in transforming their work systems. The DPs are rooted in knowledge and grounded in a prototypical implementation. The recommendations focus on processes, activities, and technologies in the work system without any changes to customers, products/services, and participants. Relevant information is not substantially changed. Available information is processed differently. Specifically, the design of the changes would minimize necessary but non-value-adding time efforts and would maximize value-adding time spent with patients. Nevertheless, writing down and reading information forms the foundation for MPC.

For guidance on the effective and actionable formulation of DPs, we refer to Gregor et al. (2020). The aim of the DPs aligns with points discussed in the introduction, namely fostering MPC in palliative care through collaboration support. From a technical perspective, implementers are software developers, such as manufacturers of hospital IS (modules) used by teams in the ward. Organizational measures are designed with implementers and users as a multi-professional team. The context is MPC, focusing on healthcare, specifically inpatient palliative care. The following sections present the underlying mechanisms and rationales for the collaboration support system through the organizational and technical measures.

Table 4 Snapshot of the palliative care work system

<table>
<tr><td>Customers</td><td>Products / Services</td></tr>
<tr><td>• Multi-professional team and hospital administration in the sense of building on the information and services provided by the work system
• Patients and relatives</td><td>• Care, treatment, and accompaniment of patients and relatives
• Provision of information to the team and administration</td></tr>
<tr><td colspan="2">Major Activities & Processes</td></tr>
<tr><td colspan="2">• Patient admission (registration, coordination with pre-care, room preparation, initial assessment)
• Treatment of the patient
o Supply with food, drinks, medication, bandage
o Perform medical examinations and treatments (wound care, physiotherapy, music therapy, etc.)
o Faster and easier documentation (treatment, therapy, medication, etc.) [C2-3, C4-1, C4-6, C4-7, C6-4]
o Conversations (doctor's check-up, family meeting, information on a patient decree, etc.)
• Treatment planning/coordination among the professions
o Determination and re-evaluation of the therapy goal, treatments, and tasks (per profession)[3] [C1-4, C2-1, C2-2, C2-4]
o Requests, appointments, and discussions with specialists and external services
o Gathering of information required for own work (efficient reading of profession-specific and cross-professional documentation) [1] [C1-1, C1-2, C3-1, C3-2, C4-6, C4-7, C4-8, C5-1]
o Automated and targeted documentation sharing and requesting with/from colleagues
o Conversations and asynchronous exchange (meetings and time might vary between wards; for example):
▪ Morning meetings (esp. physicians and nursing), nursing handover (3x per day), medical handover (daily 3 p.m.), handover of further professions (Tuesdays), team meeting (Thursdays), ward rounds (daily), chief physician rounds (usually on Thursdays) [C1-1]
▪ Weekly multi-professional team meeting (Tuesdays, replacing morning meeting)
▪ Unplanned, informal, unstructured, or random among team members in the team room [C1-2, C1-3]
• In case of death (visits, initiation of formalities, benediction, etc.)
• Patient discharge (coordination with follow-up care, doctor's letter, concluding conversation, etc.)</td></tr>
<tr><td>Technologies</td><td>Participants</td></tr>
<tr><td>• Software [C4-1, C4-2, C4-3]
• Hospital IS [C4-4], nursing IS, and laboratory IS
• Enterprise Resource System
• Shared network drive, Microsoft Office
• Quality Management Portal
• Palliative care collaboration system
• Hardware (printer, phone, computer, notebooks, pager, tablets, smartphones) [C4-5, C6-1, C6-2, C6-4]
• Print-outs of occupation plan [C6-3]</td><td>• Physicians
• Nursing staff
• Psychologists
• Physiotherapists
• Social workers
• Spiritual carers
• Case managers
• Music, art, animal-assisted therapists</td></tr>
<tr><td colspan="2">Information</td></tr>
<tr><td colspan="2">• Master or metadata (relatives, visiting arrangements, power of attorney, patient decree, insurance status, and relevant prior arrangements; e.g., health insurance, hospital, relatives)
• (Changes in) patient's condition[1,2]:
o Physical (general condition, underlying or secondary diseases, diagnoses, pain, functional status, mobility, cognition, bowel / bladder functions, swallowing ability, alcoholism, risk of falling, disorientation, skin status, wounds, laboratory values, vital parameters)
o Psychological (need for autonomy, habits, diagnoses, e.g., suicidality, wishes, preferences, anxieties, worries, dislikes)
• (Changes in) treatment planning
o New admission, need for isolation, room occupancy
o Therapy goal[2,3] and planning, prior diagnoses, and assessment by colleagues, ward-round feedback
o Medication (changes particularly relevant): effectiveness, availability, adverse effects, dosage, etc.
o Discharge: post-care provider, planned date, necessary physical condition
• Interpersonal aspects (social background, relationship with family members and/or friends, faith, spirituality, personal crises, possible fields of conflict, is it allowed to talk about illness, dying, death)
• In case of death (relevant agreements with stakeholders, room occupancy)
[1] Preparation of documentation on the patient's condition regarding professional information requirements
[2] Symptom-oriented and historical development of the patient's condition (graphically depicted)
[3] Team-agreed discussion and decision protocol</td></tr>
</table>

Legend: 'as is' state (plain text), 'to be' state (***bold, italic***), challenges of MPC (*italic*)

Table 5 Design guidelines for regular multi-professional meetings

#	Design Guideline	Addressed Challenges
1.1	Hold regular meetings with the whole multi-professional team (depending on availability)	C1-2, C2-3, C5-1
1.2	Ensure continuous exchange among professions close to the patient	C1-2, C2-3, C5-1
1.3	Implement regular meetings for professionals focusing on the patient's well-being (a generally non-medical perspective)	C2-1, C3-2, C5-1
1.4	Establish a common space for spontaneous exchange of knowledge	C2-1, C1-3, C5-1

4.2.1 Organizational Measures

The organizational measures we propose focus on the processes and activities of the multi-professional work system. They consist of regular multi-professional meetings and objective information. Both points have already been implemented in the ward but have been reinforced through this study. Successful MPC relies on routine and regular communication among team members rather than sporadic interactions (Jones and Thistlethwaite 2019; Bennardi et al. 2021). While this point does not present new knowledge, it remains a cornerstone for MPC in palliative care. Hence, our first DP (DP1) is as follows:

DP1 *Provide the work system with regular multi-professional meetings to enable team members to build consensus on future actions.*

This DP manifests in various forms, summarized in the design guidelines (DGs), which expand on the DP (see Table 5). The weekly multi-professional team meeting is already an established practice in palliative care, and it remains crucial (Kesonen et al. 2022). The weekly meeting facilitates collective reflection on the patient's status and a cooperative determination of the next steps in treatment (DG1.1, which addresses challenges C1-2, C2-3, C5-1). In addition, healthcare professionals are constantly close to the patient and ensure ongoing knowledge transfer by handing over essential information between their shifts (DG1.2, addressing C1-2, C2-3, C5-1). An innovative development at the ward is a new meeting format to accommodate professionals with less regular contact with the patient, such as social workers and music therapists. They meet separately once a week to discuss treatment from their perspectives – a practice that has proven valuable for momentarily stepping away from a strictly medical focus (DG1.3, addressing C2-1, C3-2, C5-1). Beyond the formal meetings, creating a common gathering space, such as a room where all team members can congregate (DG1.4, addressing C2-1, C1-3, C5-1) would be helpful. This space would facilitate accessible interaction among the team members and promote the sharing non-written information and knowledge. Altogether, DP1 aligns with what the literature proposes about the structured exchange of information and knowledge transfer. It contributes to building interpersonal relationships (cf. Sect. 2.2).

MPC in palliative care often faces challenges stemming from hierarchical biases. As physicians bear the primary responsibility for treatment, they tend to take a dominant role. However, every profession has a legitimate contribution to the treatment process, as articulated in DP2:

DP2 *Provide the work system with mechanisms to discuss objective information for team members to collaborate equally.*

The DP is elucidated through the following guidelines. First, palliative care is oriented to alleviating the patient's suffering, which implies that treatment planning usually focuses on symptoms. Hence, when the team convenes to discuss a patient, the symptoms and individual suffering should be the primary concern. The meeting formats discussed in DP1 follow a similar pattern: people who recently interacted with the patient start the discussions by sharing their impressions. This means physicians and nurses play a crucial role, addressing recent patient observations and potentially overlooking earlier ones. However, in palliative care, symptoms are typically assessed using the HOPE Symptom and Problem Checklist (Stiel et al. 2012) or the MIDOS (Stiel et al. 2010) or IPOS (Schildmann et al. 2016) instruments. Initiating a discussion with a visual representation of the symptoms (DG2.1, addressing C2-3, C2-4, C3-2) can thus be helpful. Such visualizations could include current-status radar charts or historical line charts and would provide all team members with an understanding of the current symptoms. By tracking symptom progression, the team can determine if observations are transient or continuous. Additionally, symptoms can be categorized into psychological, social, spiritual, and somatic dimensions. Each has varying significance to different professions. This systematization also helps all members to contribute and shifts the focus from specific instances to overall symptomatology. Such a method helps foster discussion and participation (DG2.2, addressing C2-

Table 6 Design guidelines for equal collaboration

#	Design guideline	Addressed challenges
2.1	Visualize the symptoms of the patient. The visualization should include the current status and history. Additionally, focus on or highlight symptoms regarding the psychological, social, spiritual, and somatic aspects	C2-3, C2-4, C3-2
2.2	A symptom-centered discussion includes all team members and democratizes the conversation and improves speaking orders	C2-3, C2-4, C3-2
2.3	Use 'thinkLets' for consensus-building in the multi-professional team	C1-2, C2-3
2.4	Document decisions and even non-decisions comprehensively	C1-1, C2-1, C2-2, C2-3

3, C2-4, C3-2). Consensus-building and minimizing biases in decision-making contribute to participative treatment by all professions (Daly 2004; Sørensen et al. 2018). This encompasses two main elements: a structured decision-making process and detailed documentation. First, the team needs a consensus-building mechanism, usually part of the weekly multi-professional team meeting. Major patient treatment decisions are made. Such mechanisms can be informed by Gurses and Xiao (2006) regarding multi-professional rounds, by Senot et al. (2016) on collaboration strategies, and by Weber et al. (2009) on healthcare decision-support tools. In particular, so-called 'thinkLets' from collaboration engineering provides valuable insights (Briggs et al. 2006; Kolfschoten and de Vreede 2007; DG2.3, addressing C1-2, C2-3). For example, 'MoodRing' is geared toward team members anonymously voicing their agreement on topics in real-time. 'Red-Light-Green-Light' serves the same purpose for multi-criteria issues (Briggs and de Vreede 2009). These thinkLets offer the team procedures to find consensus and can be supplemented with ethical considerations (Chatterjee et al. 2009). Although the mechanism for consensus-building itself is not technical, a corresponding system supporting it would be. Second, in terms of documentation, the team should establish and adopt a structured format that covers critical decision aspects, such as the problem, evaluated alternatives, final decisions and justifications, and next steps (Lunenburg 2010). This ensures that decisions are transparent and can be accepted even by absent team members (DG2.4, addressing C1-1, C2-1, C2-2, C2-3). This structure should also encompass scenarios where decisions are deferred. This aspect, which aligns with the literature, contributes to the joint understanding of procedures. Table 6 summarizes the DGs.

4.2.2 Technical Measures

From a technical standpoint, we propose a palliative care collaboration system (PCCS). As an innovative technology within the work system, the PCCS transforms the multi-professional work system by altering processes and activities and the way information is made available. The system was instantiated through a prototypical implementation and realized in Flutter. Flutter is a cross-platform development framework for building apps for multiple operating systems (Android, iOS, and web) using a single code base. The PCCS functionalities were designed according to the challenges outlined in Sect. 4.1. The research team and senior ward members collaboratively developed and discussed these functionalities to enhance MPC within palliative care. The functionalities were then translated into specific features.

We derived DPs by characterizing the PCCS's components. We emphasize that these principles, although drawn from a prototype, can be applied to any system intended to foster MPC. When creating collaboration technology, key factors influencing its use should be considered (Brown et al. 2010). These include social presence, the immediacy of communication (how quickly users can interact), concurrency (performing several tasks at once), computer self-efficacy, and the influence of peers (Brown et al. 2010). Additionally, we adhered to the five DPs for integrated hospital ISs outlined by Jensen (2013). That is, such systems should create direct benefit and should be built on an existing technical base; they should also create a positive momentum of use and have easy functionalities and a modularized infrastructure.

The PCCS serves three purposes, which can be understood as three layers of the PCCS. They represent an infrastructure for knowledge sharing and complement the organizational measures. The layers enable extensive access to information, keep team members informed about relevant information, and allow for the aggregation and filtering of information. The first layer of the PCCS is an information access layer, catering to the team's need for relevant data from the hospital IS. Team members might use more than one system (cf. C3-2), and the PCCS must integrate all sources of information and build upon the existing systems (Jensen 2013). Consequently, DP3 was formulated as follows:

Table 7 Design guidelines for information access

#	Design guidelines	Addressed challenges
3.1	Enable single sign-on for PCCS	C4-all, C5-1, C6-3
3.2	Have a single user interface for all underlying systems	C4-1, C4-2
3.3	Use robotic process automation to create interfaces for systems that lack APIs	C2-1, C2-2, C2-3
3.4	Record and display collaboration-relevant information that is missing from other systems	C3-1, C4-4, C5-1, C6-2
3.5	Allow users to take personal notes so the system becomes the only source of information	C4-3

DP3 *Equip the PCCS with interfaces to all existing ISs so that users only have to operate one system to access relevant information.*

This interface is intended to unify the information available to team members across all underlying systems they use, including patient data, documentation, medication, and more. Users should read from and write to these systems through a single interface and should only need one set of credentials to log in (DG3.1, addressing C4-all, C5-1, C6-3). Information retrieved could be drawn from multiple sources. Conversely, information input is distributed to all relevant locations (DG3.2, addressing C4-1, C4-2). A consolidated graphical interface was created to redesign access to existing unintuitive systems (Iakovidis 1998). Regardless of application programming interfaces (APIs), robotic process automation emerges as a versatile solution that can mimic user interactions without the PCCS (DG3.3, addressing C2-1, C2-2, C2-3). Furthermore, a system that compiles all information lays the groundwork for structuring and recording new information needed by the team but perhaps not yet documented or only verbally communicated (DG3.4, addressing C3-1, C4-4, C5-1, C6-2). For example, appointments or changes to appointments with the family may not be visible to the entire team, but they are significant and should be recorded. Information about which team members (particularly those not in daily contact with the patient) plan to visit on a given day should be visible to enable coordination. Lastly, the PCCS should allow team members to take notes. This feature would centralize the information and reduce the need for printed materials and manual annotation (DG3.5, addressing C4-3). Table 7 summarizes the DGs.

The second layer of the PCCS serves as an update layer, contrasting with the traditional method of information pulling. This layer enables the explicit pushing of information to specific individuals or professions, directing them toward pertinent information. Hence:

DP4 *Equip the PCCS with functionality to push relevant information in order to update users.*

This layer allows team members to receive relevant information in two ways, either through direct communication from another team member or via a trigger that leads to an update. First, the PCCS permits a team member to send, and if needed also to annotate, documentation and a message to chosen recipients (DG4.1, addressing C1-2, C2-3, C4-6, C4-7, C4-8, C5-1). This is not merely a direct message like chat but is an attachment of relevant documentation. The annotated message is logged in the system but remains private between the sender and receiver. This approach fosters personal communication because information can be exchanged asynchronously and does not rely on accidental encounters. The message references specific treatment documentation, thus reducing redundancy and eliminating the need to discuss 'in the hallway' what has already been documented. If a team member requires specific information or documentation, they can request it from colleagues through the PCCS. The system will remind the relevant colleague to document the information or discuss the matter in person. This approach preserves the importance of personal exchange in palliative care. The successful use of such technology is described in the literature as collaborative skills and fosters a structured exchange of information (see Sect. 2.2). Similarly, specific keyword usage could be shared automatically (DG4.2, addressing C3-1, C4-8, C5-1). Members can define these triggers by subscribing to specific keywords, and information retrieval can be tailored to the needs of different professions. Hence, profession-specific information requirements were assessed, and pertinent information is

Table 8 Design guidelines for information updates

#	Design guidelines	Addressed challenges
4.1	Allow team members to share documentation with colleagues, including a personal annotation of the documentation	C1-2, C2-3, C4-6, C4-7, C4-8, C5-1
4.2	Automatically push relevant information to team members based on predefined criteria	C3-1, C4-8, C5-1

pushed to them when available. Table 8 summarizes the DGs.

The third layer of the PCCS functions as an aggregation or filter layer designed to shield users from information overload. This consideration is crucial since the update layer could otherwise inundate team members with information. The rationale is that although access to information has become more straightforward, it needs to be organized to highlight the relevant details to reduce the information density. This point led to DP5:

DP5 *Equip the PCCS with information aggregation and filtering mechanisms, enabling users to retrieve relevant information more easily.*

Several vital aspects underpin this principle. First, the information and update layers must be text-searchable so team members can quickly locate specific keywords or corresponding documentation. Moreover, filtering criteria, such as the type of documentation, should be included to help users find relevant information (DG5.1, addressing C1-4, C4-8). Second, the structure of the information is carefully planned. The more relevant the information to the user, the more prominently it should be displayed. Relevant information may be pushed to the user. If it is pulled, it should be available with a few clicks and highlighted, while less pertinent information remains accessible (DG5.2, addressing C3-1, C4-4, C4-8, C5-1). For example, when a practitioner chooses to view the course of treatment, the first screen would depict the symptoms. The documentation feed would be a second tab that must be selected. This format is not used in the current system (cf. DG2.1). This design requires an assessment of information demand because relevance varies among the team members and professions. Third, aligned with the redesign of the user interface, the patient's documentation history is reorganized. Team members can assign tags to new documentation, allowing an overview of all tags (i.e., relevant treatment threads for a patient). Examples could be family situations or treatment decisions that are repeatedly discussed (DG5.3, addressing C4-4, C4-8, C5-1). Fourth, natural language processing through large language models offers the potential for greater information accessibility. The PCCS will feature a module that enables users to pose questions and receive direct answers rather than sifting through all available information. Similarly, reports can be generated to answer frequently asked questions based on the documentation (DG5.4, addressing C4-4, C4-8). In addition to supporting the decision structure (cf. DP2), natural language processing can create input for team decisions by generating reports about a patient's current and historical condition across various aspects. This would mitigate recency bias within the team (cf. C2-4). Table 9 summarizes the DGs.

Ideally, the PCCS should be available across various types of devices. This compatibility would provide team members flexibility in using the PCCS, allowing them to select the best device within organizational constraints. Hence, DP6 addresses C4-5, C6-1, C6-2, C6-4:

DP6 *Equip the PCCS with responsive functionality, enabling users to use hardware flexibly.*

Relevant factors in end users' preferences include screen size, text size, portability, and familiarity with the specific device (e.g., smartphone, tablet, or notebook). Particularly noteworthy is the accessibility of the PCCS on mobile devices. This enables features such as speech-to-text recognition, biometric authentication for quick login, and compatibility with external hardware like smart pens. Such features can streamline the documentation as team members no longer have to walk to a designated area to type. Instead, they can use a handheld device to dictate their thoughts, saving time. This approach would enhance the availability and quality of documentation and facilitate prompt and detailed record-keeping. This ease and immediacy of documentation would also improve efficiency and lead to accurate and comprehensive records. However, when a responsive design is implemented, two facets are relevant. First, making the PCCS accessible across platforms requires attending to elements such as screen layout, information density, and text size (DG6.1). Second, while web browsers are available on mobile devices, a native application often ensures a more user-friendly experience.

Table 9 Design guidelines for information aggregation

#	Design guidelines	Addressed challenges
5.1	Powerful search and filtering mechanisms simplify the retrieval of information	C1-4, C4-8
5.2	Highly relevant information for a specific user should appear prominently in the system. This could include pushing information, the need for a few clicks, and visual highlights	C3-1, C4-4, C4-8, C5-1
5.3	Documentation feed is structured with tags to provide an overview of aspects of treatment	C4-4, C4-8, C5-1
5.4	Available information is summarized with natural language processing to increase the information accessibility	C4-4, C4-8

Table 10 Design guidelines for responsive design

#	Design guidelines	Addressed challenges
6.1	Design screen layouts considering the available display size of the device type	C4-5, C6-1, C6-2, C6-4
6.2	PCCS should be compatible with various operating systems for user convenience	C4-5, C6-1, C6-2, C6-4

Hence, a PCCS should be compatible with various operating systems to enhance user convenience (DG6.2). Table 10 summarizes both DGs.

5 Evaluation

A fundamental aspect of ADR is the ongoing evaluation of its artifacts. Our development of the suggested artifacts was based on extensive field observations, in-depth qualitative analysis, and the prototypical implementation of a collaboration support system.

In the α *phase*, we identified specific challenges for MPC. To ensure the credibility of the findings, we employed a triangulation method. Participant observations were corroborated through focus groups to ensure the researchers' perceptions accurately mirrored the ward realities. During the qualitative data analysis, two researchers with backgrounds in sociology and expertise in qualitative research first analyzed the data independently. Then, they compared and converged their insights and harmonized their coding methods before re-coding. The second coding was further critiqued and refined in collaboration with qualitative research experts and IS researchers who had not participated in the initial coding to enhance the rigor of the analysis. Ultimately, the consolidated outcomes of the qualitative analysis, specifically the challenges delineated in Sect. 4.1, were validated by senior ward members. The validation was reinforced during discussions with focus groups in the two wards, indicating that the challenges represented those that occur in palliative care wards.

During the β and *artifact phases*, we implemented measures to address the challenges associated with MPC. Organizational measures related to DP1, stemming from years of practice in palliative care, were acknowledged as best practices and did not warrant further evaluation. However, given their importance to MPC, we explain these measures. DG1.3 resulted from a reflective process prompted by this study, where the ward members decided on the meeting format given its perceived value. DG2.1 and 2.2 were introduced on trial but became regular practices because of the marked improvements they triggered. This adjustment refocused the discussions on patient symptoms rather than who initiated the conversation. Documentation activities increased as ward members started using the symptom documentation to illustrate the patient's condition. Finally, although DP2.4 is mandatory practice in palliative care, an improved way to document the decisions formed part of the prototype evaluation.

For the technical evaluation of the collaboration support system, we followed the 'human risk and effectiveness' strategy by Venable et al. (2016). This entailed gradually tackling the challenges identified during the alpha cycle. Development began in a controlled setting, where we assessed the prototype functionalities and then transitioned to a more natural setting. This stage ranged from verbal feature conceptualization to designing mock-ups of the system and, finally, using agile methods to enhance the prototype's functionality. The data that was processed was first artificial and later became real-world anonymized data. To evaluate the prototype's effectiveness, the research team crafted representative vignettes that reflected typical ward situations. Based on the field cycles conducted on the palliative care unit (participant observation) and the subsequent qualitative analysis of observation protocols, three case vignettes (patient trajectory vignettes) were created for 'historically real' patients. These vignettes were supplemented with information from the hospital IS. Of particular interest were cases highlighting typical challenges in multi-professional team collaboration. Each vignette comprises several modules serving as clearly defined units of analysis derived from the combination of the elements of challenge, effects/consequences, and (potential) solutions. The vignettes were first tested within the research team. In a second step, they were used in a focus group setting with six ward members to recreate past situations in which collaboration had not been optimal. The team members used and tested the prototype in a time-compressed situation. Finally, during a four-day on-site test, vignettes representing virtual patients were distributed to nine team members from six different professions during their shifts. This phase ensured that the team used the prototype only to treat virtual patients. However, the temporal separation and desynchronization of work assignments, in contrast to the focus group setting, gave team members the impression that they were using the prototype in a realistic environment. As a result, the smartphone provided with the prototype was picked up at the beginning of their shift and returned at the end. Some team members

picked up the smartphone at the beginning of the on-site test and kept it for four days. This approach ensured that the smartphone could be used freely at any time during the shift. Some participants in the focus groups needed time to get used to the new system. We consider this need normal and expect a rapid and steep learning curve (Sedera and Lokuge 2020) if ward members use the system regularly. The on-site test confirmed this expectation, as team members reported increasing confidence in using the prototype and growing recognition of its value. Jensen (2013) underlines the usefulness of a prototype that creates positive momentum among team members.

A success factor in change management is demonstrating the parallels between an old and a new system. This allows people to gradually recognize the new system's value and break their old habits (Rezazade Mehrizi et al. 2022). Skepticism arose because of the notion that palliative care is human-centric and that patient care and collaboration would be disturbed by technology. We addressed these reservations by highlighting the aim of the proposed support system, which is not merely to increase technology but to make the system more efficient and effective. This point aligned with and even promoted the rationale. The vignettes displayed the prototype's tangible benefits. Ward members confirmed the prototype's functionalities and their support for day-to-day operations. Specifically, ward members said recording and displaying who was currently responsible for each patient was valuable. DG3.4 covers this aspect and would be a specific instantiation of the DG. Overall, the evaluation indicated that the prototype was better than the existing ward systems, particularly for boosting collaboration.

With regard to the work system, our characterizations of the 'as is' and 'to be' work systems described in Sect. 4 were based on experience at one palliative care ward and tested for applicability at a second ward. We drew on guidelines from professional societies, our interactions with palliative care practitioners, and their experience with other palliative care wards. The work system we portray in Sect. 4 somewhat represents palliative care wards in other (German) hospitals. Both wards have been running for many years and are consistently updated with advancements in palliative care knowledge. Situated in large university hospitals, these wards are primary providers within the advanced German healthcare system. While Germany might not be the global leader in healthcare, it certainly delivers quality healthcare (Fullman et al. 2018). Hence, we are confident that the 'as is' work system we observed sets a substantive baseline rather than merely paralleling standard practices from other regions. We initiated our study in wards that reflect international excellence, where we sought and appraised areas for enhancement. Both wards are equipped with a hospital IS from globally recognized hospital IS providers, namely, two of the top three providers in the Europe, Middle East, and Africa (EMEA) region (Signify Research 2023). This scenario provided a rigorous technological foundation that broadly indicates the wider sector.

6 Discussion

The context of the PALLADiUM project allowed an in-depth investigation of MPC in the inpatient palliative care ward of the University Hospital of Erlangen in Germany. The unique characteristic here was that it was an environment in which hardly any digital technologies had been used. This allowed for an almost unimpeded observation of the on-site MPC of various palliative care specialists and a rigorous collection of requirements for a future PCCS. We analyzed the 'as is' work system in detail and identified organizational and technical measures to transition to a 'to be' work system. Through our evaluation, we found empirical evidence that our results can boost MPC in inpatient palliative care.

According to vom Brocke et al. (2020), design knowledge, such as the prescriptive insights from our palliative care context (i.e., the work system and its ingrained PCCS), can be generalized. We believe that the results of the work system we developed are applicable to geriatric, inpatient hospice, and outpatient palliative care settings, particularly regarding the impact on working practices. Due to their generic form, we also see our DPs as transferable to other collaboration contexts in healthcare with similar multi-professional characteristics. Particularly, DP3, DP4, and DP6 are relevant for most areas of healthcare. Some abstraction is necessary to apply the findings to contexts such as outpatient care or even contexts beyond healthcare where diverse professional groups collaborate, such as construction or research. DP1, DP2, and DP5 fit more distant contexts of MPC as they address fundamental elements of collaboration, namely communication, in-person exchange, and access to information. Regarding the purely technical aspects, we also see the transferability of the developed PCCS. The PCCS or a similar collaboration system can either stand alone and interface with the hospital IS or be a module within the hospital IS. Nevertheless, further regulatory requirements must be complied with when developing a product, which are either specific to the respective area of use or apply generally to the healthcare sector. For instance, we deem the productive implementation of our prototype to be a medical device, according to the European Union (2023), as it combines patient-specific information and knowledge intended to provide a group or team of healthcare professionals with recommendations for patients.

6.1 Theoretical Contribution

Our research offers theoretical insights into MPC challenges, MPC support, and work system theory. First, we contribute by exploring an empirically grounded picture of 24 challenges for MPC in palliative care. These challenges resonate with previous research findings (cf. Sect. 2.1). We detail the existing body of knowledge and tailor the challenges, based on empirical observations, to the unique characteristics of palliative care, namely the tendency to favor human interaction over technology.

For our second major contribution, we present a nascent design theory for promoting MPC in healthcare using organizational and technological measures gleaned from extensive ADR in a palliative care ward. Gregor and Jones (2007) propose design theories to encompass eight elements. We structured our design theory accordingly. The culmination of our research and its theoretical contributions are summarized in Table 11. Building upon a comprehensive 'as is' work system, our 'to be' work system can be realized through organizational and technological interventions. The design and implementation of a PCCS prototype play a pivotal role in realizing this aspirational work system. The underlying rationale for the generalizable PCCS is to boost collaboration by enhancing communication and reducing intermediary tasks (Walker et al. 2005). While collaboration remains a primary social process in itself, technology improves it by enhancing the accessibility of information for team members and building a basis for successful collaboration. Although the proposed PCCS is an additional technology in the work system, it aims to simplify the technology stack and align it with the work system to achieve a sensible degree of automation (Mertens 1995; Beck et al. 2022). Hence, we propose that the PCCS simplify the process so that team members can access and exchange the necessary information (Cross et al. 2002).

Third, we demonstrate that work systems theory is suitable for investigating highly complex collaboration mechanisms of an 'as is' work system in a multi-professional healthcare context. In digital transformation initiatives (in our case, the design and introduction of a digitally supported 'to be' work system in palliative care), we distinguish between organizational and technical measures, each of them comprising a set of DPs and more fine-grained DGs. Further, the methodological approach is in line with Gimpel et al. (2020) and, to the best of our knowledge, is the first study to demonstrate the value of ethnographic fieldwork while designing work systems.

6.2 Practical Implications

This research offers the following insights for practitioners. First, we identify challenges in MPC to raise awareness among practitioners. People working in multi-professional settings might find that several or perhaps all of the challenges this study identified describe their work systems. Recognizing these challenges helps practitioners identify

Table 11 Components of information system design in this study (based on Gregor and Jones (2007))

Component	Specific description in the current study
Purpose and scope	Develop DPs and DGs for a collaboration support system to foster MPC in palliative care
Constructs	Relating to purpose and scope: work system, MPC, inpatient palliative care
	Relating to DPs: the PCCS (part of the work system's *technologies*), team members (work system *participants*), information, information access, information exchange, information aggregation, information filtering, push of information, consensus building (all *activities and processes* and *information* of the work system)
Principle of form and function	We provide six DPs and 21 more detailed DGs to foster MPC. Two DPs relate to organizational measures; four are related to a technical collaboration support system
Artifact mutability	The instantiation of the organizational measures allows for flexibility in how the team builds consensus
	The instantiation of the technological measures depends mainly on underlying ISs. The proposed DPs allow for flexibility when instantiating them
Testable propositions	The DPs can be implemented in specific organizational measures and a technical system
	Team members consider the proposed measures helpful
	MPC in a work system that implements all DPs is better than in a work system that implement only some or none of the DPs. Here, 'better' means the identified challenges did not occur or occurred to a lesser degree. Team members gain certainty of interpretation and action and thus perceive better collaboration
Justificatory knowledge	The DPs derive from challenges identified through ethnographic fieldwork, literature on challenges in MPC, discussions with senior ward members, a prototypical instantiation, and focus groups with team members from palliative care wards
Principle of implementation	The design of the work system for fostering MPC can be realized by the team agreeing to implement organizational measures for DPs 1 and 2 and a technical instantiation for DPs 3–6
Expository instantiation	A prototypical instantiation of the abstract design has been evaluated with palliative care ward team members

them in their specific contexts, which may reveal overlooked issues. Awareness is fundamental because it is the precursor to tackling these challenges. Second, the DPs developed here directly address those challenges and provide a roadmap to overcoming them. Nevertheless, practitioners must carefully assess these principles and identify any barriers to implementation (Kowatsch et al. 2019). The organizational measures we recommend are particularly pertinent for senior executives in palliative hospital wards. These measures can help structure team collaboration for efficacy, efficiency, and equality. While some of our DGs are already standard practice in palliative care, most highlight best practices for implementation in palliative care wards and other multi-professional hospital wards. Software solution providers in the clinical sphere, especially hospital IS providers, are the primary beneficiaries of the knowledge about technical measures because such systems are already embedded in daily hospital operations and provide access to crucial data. Senior ward executives can also gain insights that enrich their daily collaboration and guide them when selecting new systems. These executives can use our findings to select systems that enhance collaboration. Software that supports collaboration is a primary driver for strengthening the palliative care work system. Financial constraints and limited resources may persist, but minimizing redundant or non-value-creating workflows is crucial and would ensure that the team can focus on the most important aspect, namely, patient care. Third, the advanced functionalities of the PCCS pave the way for enhanced real-time collaboration, allowing for immediacy and simultaneous engagement. Furthermore, as team members integrate the PCCS into their daily routines, the positive influence of peer interactions and the sense of social presence are likely to intensify. Such elements are pivotal in adopting and using collaboration technologies (Brown et al. 2010). In turn, these improvements can optimize patient care, boost collaboration, and curtail operational costs – monetary or otherwise – by enhancing the information symmetry (as referenced by Teng et al. 1994; Walker et al. 2005; Raghupathi and Tan 2008).

Our research provides valuable insights into fostering collaboration in multi-professional contexts, especially given the limited use of digital technologies in palliative care. By identifying the challenges as well as strategies to counteract them within a digital workspace, we pave the way for researchers, practitioners, and health software vendors to develop informed approaches for enhancing MPC in healthcare.

6.3 Limitations and Outlook

Our research is comprehensive but not without limitations. First, our study focuses on palliative care in Germany, highlighting the country's unique regulatory, technical infrastructure, and financial mechanisms. As mentioned in Sect. 5, Germany is a country that delivers high-quality healthcare and is, therefore, representative of global standards. In addition, our findings are based on two specific palliative care wards in German hospitals from which we derived empirical evidence. However, they may be relevant in a broader context (see Sect. 6.1). The design knowledge appears robust in terms of differences between the two wards, as similar results could be drawn from the focus groups. Nonetheless, the applicability of our findings to other palliative care units needs to be further evaluated. Insights from other countries, such as Belgium (Martin et al. 2024) and Australia (Goel et al. 2023), indicate that the data quality can vary. Second, the technical implementation was showcased and assessed with a select group of team members. It existed as a standalone entity without being integrated into live systems. The main reason for not integrating it was that it would be challenging to interface smoothly with the hospital IS at the wards we studied. Real use would affect the palliative care team and the patients indirectly. While we believe the system would bring benefits, the risks of negatively interfering with patient care are high if there are technical issues. In our study, we could not provide professional software of sufficient quality and validation to ensure regulatory sound and prudent use in daily practice. The four-day on-site pilot test yielded promising results. It indicated that even in sensitive contexts, (design science) research is possible despite the difficulty of creating a truly natural setting for evaluation. Transitioning the prototype into real-world settings, within and beyond palliative care, remains to be explored in future work. Third, the value of the prototype could not be quantified in terms of time or cost savings. Again, this was because it lacked integration with existing systems, which prevented the team from using it daily. Nonetheless, the team members' positive intentions to use the prototype reflected their satisfaction with the technology (Brown et al. 2010). This factor is just as relevant as tangible benefits such as savings on time and cost. Fourth, this research focused on the work system's processes, activities, and technologies. In turn, these elements were focused on promoting the MPC of the team. Adjusted services or participants were not considered in the work system. A dedicated investigation is required to determine whether the insights concerning MPC are relevant beyond inpatient palliative care to areas such as geriatrics, intensive care, and outpatient palliative care. Within the context of healthcare, our insights should be relevant, as outlined in Sect. 6.1. Beyond healthcare, some abstraction will be necessary to apply the design knowledge as its fitness for context decreases. Future research should focus on the

specifics of varied multi-professional contexts and abstract the DPs and guidelines.

7 Conclusion

Our study delves into the challenges of MPC, particularly in the context of palliative care. We partnered with practitioners from a palliative care unit in ADR. We conceived and realized a digitally enhanced work system that was customized to suit multi-professional teams, and we deployed technical and organizational measures to bolster team collaboration. It is important to integrate PCCS into existing systems rather than have it exist as a standalone software tool. Integrating data exchange with pre- and post-care providers (Schweiger et al. 2007) would promote MPC in inpatient and outpatient settings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12599-024-00897-0.

Acknowledgments This research project is funded by the Bavarian Research Institute for Digital Transformation (bidt), an institute of the Bavarian Academy of Sciences and Humanities.

Funding Open Access funding enabled and organized by Projekt DEAL.

References

Abraham A, Kutner JS, Beaty B (2006) Suffering at the end of life in the setting of low physical symptom distress. J Palliat Med 9:658–665. https://doi.org/10.1089/jpm.2006.9.658

Agarwal R, Gao G, DesRoches C, Jha AK (2010) Research commentary – The digital transformation of healthcare: current status and the road ahead. Inf Syst Res 21:796–809. https://doi.org/10.1287/isre.1100.0327

Ahuja S (2023) Professional identity threats in interprofessional collaborations. J Manag Stud 60:428–453. https://doi.org/10.1111/joms.12847

Alter S (2003) 18 reasons why IT-reliant work systems should replace "the IT artifact" as the core subject matter of the IS field. Commun Assoc Inf Syst. https://doi.org/10.17705/1CAIS.01223

Alter S (2010) Work systems as the core of the design space for organisational design and engineering. Int J Organ Design Eng 1:5. https://doi.org/10.1504/IJODE.2010.035184

Alter S (2013) Work system theory: overview of core concepts, extensions, and challenges for the future. J Assoc Inf Syst 14:72–121

Alter S (2018) System interaction theory: describing interactions between work systems. Commun Assoc Inf Syst 42:233–267. https://doi.org/10.17705/1cais.04209

Alter S (2024) Re-conceptualizing information system usage as usage by (increasingly automated) work systems. Commun Assoc Inf Syst 54:1094–1123. https://doi.org/10.17705/1CAIS.05446

Alter S (2004) Making work system principles visible and usable in systems analysis and design. In: Proceedings of the 10th Americas Conference on Information Systems, p 190

Alter S (2006) The work system method. Work System Press

Alter S (2017) Service system axioms that accept positive and negative outcomes and impacts of service systems. In: Proceedings of the 38th International Conference on Information Systems

Alter S (2018a) In pursuit of systems theories for describing and analyzing systems in organizations. In: Proceedings of the 26th European Conference on Information Systems, p 25

Amabile TM, Patterson C, Mueller J, Wojcik T, Kramer SJ, Odomirok PW, Marsh M (2001) Academic-practitioner collaboration in management research: a case of cross-profession collaboration. Acad Manag J. https://doi.org/10.2307/3069464

Anders A (2016) Team communication platforms and emergent social collaboration practices. Int J Bus Commun 53:224–261. https://doi.org/10.1177/2329488415627273

Baskerville R, Baiyere A, Gergor S, Hevner A, Rossi M (2018) Design science research contributions: finding a balance between artifact and theory. J Assoc Inf Syst 19:358–376. https://doi.org/10.17705/1jais.00495

Beck R, Dibbern J, Wiener M (2022) Interview with peter mertens and wolfgang könig: "from reasonable automation to (sustainable) autonomous systems." Bus Inf Syst Eng 64:311–315. https://doi.org/10.1007/s12599-022-00753-z

Beerepoot I, van de Weerd I (2018) Prevent, redesign, adopt or ignore: improving healthcare using knowledge of workarounds. In: Proceedings of the 26th European Conference on Information Systems

Bennardi M, Diviani N, Stüssi G, Saletti P, Gamondi C, Cinesi I, Rubinelli S (2021) A qualitative exploration of interactional and organizational determinants of collaboration in cancer palliative care settings. PLoS ONE 16:e0256965. https://doi.org/10.1371/journal.pone.0256965

Berg M (2003) The search for synergy: interrelating medical work and patient care information systems. Meth Inf Med 42:337–344. https://doi.org/10.1055/s-0038-1634227

Bojer CS, Møller C (2022) Towards a scheme for contribution in action design research. In: Drechsler A et al (eds) The transdisciplinary reach of design science research. Springer, Cham, pp 376–387. https://doi.org/10.1007/978-3-031-06516-3_28

Bowen GA (2006) Grounded theory and sensitizing concepts. Int J Qual Meth 5:12–23. https://doi.org/10.1177/160940690600500304

Briggs RO, de Vreede G-J (2009) Thinklets: building blocks for concerted collaboration. University of Nebraska

Briggs RO, Kolfschoten GL, de Vreede G-J, Douglas D (2006) Defining key concepts for collaboration engineering. In: Proceedings of the 12th Americas Conference on Information Systems

Brown SA, Dennis AR, Venkatesh V (2010) Predicting collaboration technology use: integrating technology adoption and

collaboration research. J Manag Inf Syst 27:9–54. https://doi.org/10.2753/MIS0742-1222270201
Bryant A, Charmaz K (eds) (2007) The SAGE handbook of grounded theory. Sage, Thousand Oaks. https://doi.org/10.4135/9781848607941
Caillaud S, Flick U (2017) Focus groups in triangulation contexts. In: Barbour RS, Morgan DL (eds) A new era in focus group research. Palgrave Macmillan, London, pp 155–177. https://doi.org/10.1057/978-1-137-58614-8_8
Carayon P, Schoofs Hundt A, Karsh B-T, Gurses AP, Alvarado CJ, Smith M, Flatley Brennan P (2006) Work system design for patient safety: the SEIPS model. Qual Saf Health Care 15:i50–i58. https://doi.org/10.1136/qshc.2005.015842
Cassell EJ (1998) The nature of suffering and the goals of medicine. Loss Grief Care 8:129–142. https://doi.org/10.1300/J132v08n01_18
Chatterjee S, Sarker S, Fuller M (2009) A deontological approach to designing ethical collaboration. J Assoc Inf Syst 10:138–169. https://doi.org/10.17705/1jais.00190
Cherny NI, Portenoy RK (2021) Core concepts in palliative care. In: Cherny NI et al (eds) Oxford textbook of palliative medicine. Oxford University Press, pp 44–54. https://doi.org/10.1093/med/9780198821328.003.0006
Chow SKY, Chin W-Y, Lee H-Y, Leung H-C, Tang F-H (2012) Nurses' perceptions and attitudes towards computerisation in a private hospital. J Clin Nurs 21:1685–1696. https://doi.org/10.1111/j.1365-2702.2011.03905.x
Collatto DC, Dresch A, Lacerda DP, Bentz IG (2018) Is action design research indeed necessary? Analysis and synergies between action research and design science research. Syst Pract Action Res 31:239–267. https://doi.org/10.1007/s11213-017-9424-9
Corbin JM, Strauss AL (1990) Grounded theory research: procedures, canons, and evaluative criteria. Qual Sociol 13:3–21. https://doi.org/10.1007/BF00988593
Corbin J, Strauss A (2008) Basics of qualitative research: techniques and procedures for developing grounded theory. Sage. https://doi.org/10.4135/9781452230153
Cross R, Borgatti SP, Parker A (2002) Making invisible work visible: using social network analysis to support strategic collaboration. Calif Manag Rev 44:25–46. https://doi.org/10.2307/41166121
Daly G (2004) Understanding the barriers to multiprofessional collaboration. Nurs Times 100
Danneels L, Viaene S (2022) Identifying digital transformation paradoxes. Bus Inf Syst Eng 64:483–500. https://doi.org/10.1007/s12599-021-00735-7
DIMDI (2020) Non-surgical therapeutic measures - complex treatment: 8–982. In: German Procedure Classification for the Encoding of Operations, Procedures and General Medical Measures
Emerson RM, Fretz RI, Shaw LL (2011) Writing ethnographic fieldnotes. University of Chicago Press
Flick U (2002) Qualitative research: state of the art. Soc Sci Inf 41:5–24. https://doi.org/10.1177/0539018402041001001
Fullman N, Lozano R, Murray CJL (2018) Measuring performance on the healthcare access and quality Index for 195 countries and territories and selected subnational locations. Lancet 391:2236–2271. https://doi.org/10.1016/S0140-6736(18)30994-2
Gamondi C, Larkin P, Payne S (2013) Core competencies in palliative care: part 2. Eur J Pall Care 20:140–145
German Guideline Program in Oncology (2015) Evidenced-based guideline: palliative care for patients with incurable cancer. https://www.leitlinienprogramm-onkologie.de/fileadmin/_migrated/content_uploads/Guideline_Palliative_Care_Short_Version_01.pdf. Accessed 16 Jul 2024
Gimpel H, Kerpedzhiev G, König F, Meindl O (2020) Teaching an old work system new tricks: towards an integrated method for work system transformation in times of digitalization. In: Proceedings of the 28th European Conference on Information Systems
Glaser BG, Strauss AL (2017) The discovery of grounded theory: strategies for qualitative research. Routledge, London. https://doi.org/10.4324/9780203793206
Goel K, Sadeghianasl S, Andrews R, ter Hofstede A, Wynn MT, Kapugama Geeganage D, Leemans SJ, McGree J, Eden R, Staib A, Eley R, Donovan R (2023) Digital health data imperfection patterns and their manifestations in an Australian digital hospital. In: 56th Hawaii International Conference on System Sciences
Gopal G, Suter-Crazzolara C, Toldo L, Eberhardt W (2019) Digital transformation in healthcare: architectures of present and future information technologies. Clin Chem Lab Med 57:328–335. https://doi.org/10.1515/cclm-2018-0658
Grant RM (1996) Toward a knowledge-based theory of the firm. Strateg Manag J. https://doi.org/10.1002/smj.4250171110
Greenwood E (1957) Attributes of a profession. Soc Work 2:45–55
Gregor S, Hevner AR (2013) Positioning and presenting design science research for maximum impact. MIS Q 37:337–355. https://doi.org/10.25300/misq/2013/37.2.01
Gregor S, Jones D (2007) The anatomy of a design theory. J Assoc Inf Syst 8:312–336
Gregor S, Chandra Kruse L, Seidel S (2020) Research perspectives: the anatomy of a design principle. J Assoc Inf Syst 21:1622–1652. https://doi.org/10.17705/1jais.00649
Grimminger S, Heckel M, Markgraf M, Peuten S, Wöhl M, Gimpel H, Klein C, Ostgathe C, Steigleder T, Schneider W (2023) Palliative care as a digital working world (PALLADiUM): a mixed-method research protocol. BMC Palliative Care. https://doi.org/10.1186/s12904-023-01173-w
Gurses AP, Xiao Y (2006) A systematic review of the literature on multidisciplinary rounds to design information technology. J Am Med Inform Assoc 13:267–276. https://doi.org/10.1197/jamia.M1992
Hammersley M, Atkinson P (2019) Ethnography: principles in practice. Routledge, Milton Park
Hevner AR, March S, Park J, Ram S (2004) Design science in information systems research. MIS Q 28:75. https://doi.org/10.2307/25148625
Hökkä M, Melender H-L, Lehto JT, Kaakinen P (2021) Palliative nursing competencies required for different levels of palliative care provision: a qualitative analysis of health care professionals' perspectives. J Palliat Med 24:1516–1524. https://doi.org/10.1089/jpm.2020.0632
Iakovidis I (1998) Towards personal health record: current situation, obstacles and trends in implementation of electronic healthcare record in Europe. Int J Med Inform 52:105–115. https://doi.org/10.1016/s1386-5056(98)00129-4
Iivari J, Venable JR (2009) Action research and design science research: seemingly similar but decisively dissimilar. In: Proceedings of the 17th European Conference on Information Systems
Isabella LA, Waddock SA (1994) Top management team certainty: environmental assessments, teamwork, and performance implications. J Manag 20:835–858. https://doi.org/10.1177/014920639402000407
Ishikawa M, Eto K, Haraikawa M, Sasaki K, Yamagata Z, Yokoyama T, Kato N, Morinaga Y, Yamazaki Y (2018) Multi-professional meetings on health checks and communication in providing nutritional guidance for infants and toddlers in Japan. BMC Pediatr 18:325. https://doi.org/10.1186/s12887-018-1292-7

Jensen TB (2013) Design principles for achieving integrated healthcare information systems. Health Inform J 19:29–45. https://doi.org/10.1177/1460458212448890

Johnsen HM, Fruhling A, Fossum M (2016) An analysis of the work system framework for examining information exchange in a healthcare setting. Commun Assoc Inf Syst 39:73–95. https://doi.org/10.17705/1CAIS.03905

Jones M, Thistlethwaite J (2019) Interprofessional practice in palliative care. In: MacLeod RD, van den Block L (eds) Textbook of palliative care, vol 60. Springer, Cham, pp 527–539. https://doi.org/10.1007/978-3-319-77740-5_41

Jünger S, Pestinger M, Elsner F, Krumm N, Radbruch L (2007) Criteria for successful multiprofessional cooperation in palliative care teams. Palliat Med 21:347–354. https://doi.org/10.1177/0269216307078505

Kanai H, Kumazawa A (2021) An information sharing system for multi-professional collaboration in the community-based integrated healthcare system. Int J Inform Inf Syst Comput Eng. https://doi.org/10.34010/injiiscom.v2i1.4862

Karsh B-T, Alper SJ (2005) Work system analysis: the key to understanding health care systems. In: Henriksen K, et al (eds) Advances in patient safety: from research to implementation, Rockville

Keenan J, Rahman R, Hudson J (2021) Exploring the acceptance of telehealth within palliative care: a self-determination theory perspective. Health Technol 11:575–584. https://doi.org/10.1007/s12553-021-00535-9

Kelle U (2007) The development of categories: different approaches in grounded theory. In: Bryant A, Charmaz K (eds) The Sage handbook of grounded theory. Sage, London

Kesonen P, Salminen L, Kero J, Aappola J, Haavisto E (2022) An integrative review of interprofessional teamwork and required competence in specialized palliative care. Omega. https://doi.org/10.1177/00302228221085468

Klarare A, Hagelin CL, Fürst CJ, Fossum B (2013) Team interactions in specialized palliative care teams: a qualitative study. J Palliat Med 16:1062–1069. https://doi.org/10.1089/jpm.2012.0622

Kolfschoten GL, de Vreede G-J (2007) The Collaboration Engineering Approach for Designing Collaboration Processes. In: Haake JM et al (eds) Groupware: design, implementation, and use, vol 4715. Springer, Heidelberg, pp 95–110. https://doi.org/10.1007/978-3-540-74812-0_8

Kowatsch T, Otto L, Harperink S, Cotti A, Schlieter H (2019) A design and evaluation framework for digital health interventions. IT - Inf Technol 61:253–263. https://doi.org/10.1515/itit-2019-0019

Kraus S, Schiavone F, Pluzhnikova A, Invernizzi AC (2021) Digital transformation in healthcare: analyzing the current state-of-research. J Bus Res 123:557–567. https://doi.org/10.1016/j.jbusres.2020.10.030

Krawczyk M, Richards N (2018) The relevance of 'total pain'in palliative care practice and policy. Eur J Pall Care 25:128–130

Kuhn KA, Giuse DA (2001) From hospital information systems to health information systems. Meth Inf Med 40:275–287. https://doi.org/10.1055/s-0038-1634170

Llop-Medina L, Fu Y, Garcés-Ferrer J, Doñate-Martínez A (2022) Palliative care in older people with multimorbidities: a scoping review on the palliative care needs of patients, carers, and health professionals. Int J Environ Res Publ Health. https://doi.org/10.3390/ijerph19063195

Lorenz AD, Mauksch LB, Gawinski BA (1999) Models of collaboration. Prim Care Clin off Pract 26:401–410. https://doi.org/10.1016/s0095-4543(08)70013-7

Lunenburg FC (2010) The decision making process. Natl Forum Educ Admin Superv J 27

Martin N, Gielen I, Bergs J (2024) Process mining using electronic health records data: quo vadis? In: 57th Hawaii International Conference on System Sciences, pp 3707–3716

Martin GP, Finn R (2011) Patients as team members: opportunities, challenges and paradoxes of including patients in multi-professional healthcare teams. Sociol Health Illn. https://doi.org/10.1111/j.1467-9566.2011.01356.x

Melender H-L, Hökkä M, Saarto T, Lehto JT (2020) The required competencies of physicians within palliative care from the perspectives of multi-professional expert groups. BMC Palliat Care 19:65. https://doi.org/10.1186/s12904-020-00566-5

Mertens P (1995) Wirtschaftsinformatik: Von den Moden zum Trend. In: König W (ed) Wirtschaftsinformatik '95, vol 25. Physica, Heidelberg, pp 25–64. https://doi.org/10.1007/978-3-642-57873-1_2

Mertens F, Debrulle Z, Lindskog E, Deliens L, Deveugele M, Pype P (2021) Healthcare professionals' experiences of inter-professional collaboration during patient's transfers between care settings in palliative care. Palliat Med 35:355–366. https://doi.org/10.1177/0269216320968741

Mullarkey MT, Hevner AR (2019) An elaborated action design research process model. Eur J Inf Syst 28:6–20. https://doi.org/10.1080/0960085X.2018.1451811

Nguyen M, Fujioka J, Wentlandt K, Onabajo N, Wong I, Bhatia RS, Bhattacharyya O, Stamenova V (2020) Using the technology acceptance model to explore health provider and administrator perceptions of the usefulness and ease of using technology in palliative care. BMC Palliat Care 19:138. https://doi.org/10.1186/s12904-020-00644-8

Nkhoma KB, Ebenso B, Akeju D, Adejoh S, Bennett M, Chirenje M, Dandadzi A, Nabirye E, Namukwaya E, Namisango E, Okunade K, Salako O, Harding R, Allsop MJ (2021) Stakeholder perspectives and requirements to guide the development of digital technology for palliative cancer services: a multi-country, cross-sectional, qualitative study in Nigeria. Uganda and Zimbabwe BMC Palliat Care 20:4. https://doi.org/10.1186/s12904-020-00694-y

O'Reilly K (2012) Ethnographic methods. Routledge, Milton Park

Oishi A, Murtagh FEM (2014) The challenges of uncertainty and interprofessional collaboration in palliative care for non-cancer patients in the community. Palliat Med 28:1081–1098. https://doi.org/10.1177/0269216314531999

Payne S, Harding A, Williams T, Ling J, Ostgathe C (2022) Revised recommendations on standards and norms for palliative care in Europe from the European Association for Palliative Care (EAPC): a delphi study. Palliat Med 36:680–697. https://doi.org/10.1177/02692163221074547

Pirkko Nykanen AK (2014) Usefulness of nursing documentations in multi-professional collaboration and information exchange in Finland. J Nurs Care. https://doi.org/10.4172/2167-1168.1000184

Pohjola P, Korhonen S (2014) Social work as knowledge work: knowledge practices and multi-professional collaboration. Nord Soc Work Res 4:26–43. https://doi.org/10.1080/2156857X.2014.926285

Raghupathi W, Tan J (2008) Information systems and healthcare XXX: charting a strategic path for health information technology. Commun Assoc Inf Syst. https://doi.org/10.17705/1CAIS.02328

Reichertz PL (2006) Hospital information systems: past, present, future. Int J Med Inform 75:282–299. https://doi.org/10.1016/j.ijmedinf.2005.10.001

Rezazade Mehrizi MH, van den Hooff B, Yang C (2022) Breaking or keeping the habits: exploring the role of legacy habits in the process of discontinuing organisational information systems. Inf Syst J 32:192–221. https://doi.org/10.1111/isj.12341

Richter A, Heinrich P, Stocker A, Schwabe G (2018) Digital work design. Bus Inf Syst Eng 60:259–264. https://doi.org/10.1007/s12599-018-0534-4

Rose J (2011) Dilemmas of inter-professional collaboration: can they be resolved? Child Soc 25:151–163. https://doi.org/10.1111/j.1099-0860.2009.00268.x

Rosson MB, Carroll JM (2002) Scenario-based design. In: Jacko JA, Sears A (eds) The human-computer interaction handbook: fundamentals, evolving technologies, and emerging applications. Lawrence Erlbaum, Mahwah, pp 1032–1050

Saunders C (2000) The evolution of palliative care. Patient Educ Couns 41:7–13. https://doi.org/10.1016/s0738-3991(00)00110-5

Schildmann EK, Groeneveld EI, Denzel J, Brown A, Bernhardt F, Bailey K, Guo P, Ramsenthaler C, Lovell N, Higginson IJ, Bausewein C, Murtagh FE (2016) Discovering the hidden benefits of cognitive interviewing in two languages. Palliat Med 30:599–610. https://doi.org/10.1177/0269216315608348

Schneider W, Stadelbacher S (2020) Palliative Care und Hospiz. In: Kriwy P, Jungbauer-Gans M (eds) Handbuch Gesundheitssoziologie. Springer, Wiesbaden, pp 481–509. https://doi.org/10.1007/978-3-658-06392-4_28

Schoop M, Wastell DG (1999) Effective multidisciplinary communication in healthcare: cooperative documentation systems. Meth Inf Med 38:265–273. https://doi.org/10.1055/s-0038-1634421

Schoop M (1999) An empirical study of multidisciplinary communication in healthcare using a language-action perspective. In: 4th International Workshop on the Language Action Perspective on Communication Modelling, pp 59–72

Schröder J, Riiser K, Holmen H (2024) Healthcare personnel's perspectives on health technology in home-based pediatric palliative care: a qualitative study. BMC Palliat Care 23:137. https://doi.org/10.1186/s12904-024-01464-w

Schweiger A, Sunyaev A, Leimeister JM, Krcmar H (2007) Information systems and healthcare XX: toward seamless healthcare with software agents. Commun Assoc Inf Syst. https://doi.org/10.17705/1CAIS.01933

Sedera D, Lokuge S (2020) Does it get better over time? A longitudinal assessment of enterprise system user performance. Inf Technol People 33:1098–1123. https://doi.org/10.1108/ITP-01-2019-0005

Sein MK, Rossi M (2019) Elaborating ADR while drifting away from its essence: a commentary on Mullarkey and Hevner. Eur J Inf Syst 28:21–25. https://doi.org/10.1080/0960085X.2018.1527189

Sein MK, Henfridsson O, Purao S, Rossi M, Lindgren R (2011) Action Design Research. MIS Q 35:37. https://doi.org/10.2307/23043488

Senot C, Chandrasekaran A, Ward PT (2016) Collaboration between service professionals during the delivery of health care. J Oper Manag 42–43:62–79. https://doi.org/10.1016/j.jom.2016.03.004

Sheng Z, Li K, Griffin M, van Vulpen E, Desai A (2020) How digital collaboration is shaping the future of healthcare and education

Signify Research (2023) Dedalus & Oracle Cerner Occupy Top Spot for 2022 EHR Revenues in EMEA. https://www.signifyresearch.net/digital-health/dedalus-oracle-cerner-occupy-top-spot-for-2022-ehr-revenues-in-emea/. Accessed 12 Sep 2023

VERBI Software (2022) MAXQDA: software für qualitative Datenanalyse, Berlin. maxqda.com

Sørensen M, Stenberg U, Garnweidner-Holme L (2018) A scoping review of facilitators of multi-professional collaboration in primary care. Int J Integr Care. https://doi.org/10.5334/ijic.3959

Stanley S, Finucane A, Thompson A, Nwosu AC (2024) How can technology be used to support communication in palliative care beyond the covid-19 pandemic: a mixed-methods national survey of palliative care healthcare professionals. BMC Palliat Care 23:40. https://doi.org/10.1186/s12904-024-01372-z

Stewart DW, Shamdasani PN (1999) Focus groups: theory and practice, vol 20. Sage, Thousand Oaks

Stiel S, Matthes ME, Bertram L, Ostgathe C, Elsner F, Radbruch L (2010) Validierung der neuen Fassung des minimalen Dokumentationssystems (MIDOS^2) für Patienten in der Palliativmedizin: Deutsche Version der Edmonton Symptom Assessment Scale (ESAS). Schmerz 24:596–604. https://doi.org/10.1007/s00482-010-0972-5

Stiel S, Pollok A, Elsner F, Lindena G, Ostgathe C, Nauck F, Radbruch L (2012) Validation of the symptom and problem checklist of the german hospice and palliative care evaluation (HOPE). J Pain Symptom Manag 43:593–605. https://doi.org/10.1016/j.jpainsymman.2011.04.021

Strauss AL, Corbin J (1997) Grounded theory in practice. Sage, Thousand Oaks

Suikkala A, Tohmola A, Rahko EK, Hökkä M (2021) Future palliative competence needs: a qualitative study of physicians' and registered nurses' views. BMC Med Educ 21:585. https://doi.org/10.1186/s12909-021-02949-5

Teng JT, Grover V, Fiedler KD (1994) Business process reengineering: charting a strategic path for the information age. Calif Manag Rev 36:9–31. https://doi.org/10.2307/41165753

Thomson AM, Perry JL (2006) Collaboration pocesses: inside the black box. Publ Admin Rev 66:20–32. https://doi.org/10.1111/j.1540-6210.2006.00663.x

European Union (2023) Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices, amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC (Text with EEA relevance)Text with EEA relevance. http://data.europa.eu/eli/reg/2017/745/oj. Accessed 16 July 2024

Venable J, Pries-Heje J, Baskerville R (2016) FEDS: a framework for evaluation in design science research. Eur J Inf Syst 25:77–89. https://doi.org/10.1057/ejis.2014.36

vom Brocke J, Maaß W, Buxmann P, Maedche A, Leimeister JM, Pecht G (2018) Future work and enterprise systems. Bus Inf Syst Eng 60:357–366. https://doi.org/10.1007/s12599-018-0544-2

vom Brocke J, Winter R, Hevner A, Maedche A (2020) Accumulation and evolution of design knowledge in design science research: a journey through time and space. J Assoc Inf Syst 21:520–544. https://doi.org/10.17705/1jais.00611

Walker J, Pan E, Johnston D, Adler-Milstein J, Bates DW, Middleton B (2005) The value of health care information exchange and interoperability. Health Affairs. https://doi.org/10.1377/hlthaff.w5.10

Weber S, Courtney KL, Benham-Hutchins M (2009) Decision support in multi-professional communication. J Med Syst 33:59–65. https://doi.org/10.1007/s10916-008-9164-6

Wickramasinghe N, Davison G (2004) Making explicit the implicit knowledge assets in healthcare. Health Care Manag Sci 7:185–195. https://doi.org/10.1023/b:hcms.0000039381.02400.49

Wöhl M, Gimpel H (2024) Boosting multi-professional collaboration in palliative care through digital technologies: a work system analysis. In: 57th Hawaii International Conference on System Sciences

Yoo KH, Zhang Y-A, Yun EK (2019) Registered nurses (RNs)' knowledge sharing and decision-making. Int Nurs Rev 66:234–241. https://doi.org/10.1111/inr.12488

Zwarenstein M, Goldman J, Reeves S (2009) Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD000072.pub2sss