Knowledge co-creation in MDTs: An intellectual capital perspective

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Abstract

As work becomes more complex, organizations more and more rely on professionals from multiple disciplines coming together to work in a team. Such multidisciplinary teams (MDTs) collaborate with the goal to co-create knowledge, i.e. together develop new knowledge based on the combination of different perspectives, that they can apply to reach the goals of the team and project. In this process MDTs benefit from the diverse knowledge available to them, however, also face the challenge of bridging the gaps arising from the differences between disciplines. Research has not sufficiently understood how teams approach these unique dynamics to collaboratively develop knowledge. The question stands how MDTs collaborate to successfully overcome these challenges and co-create knowledge. This study explores this question building on Fong's (2006) knowledge co-creation model, insights about multidisciplinary collaboration (MDC) from the field of healthcare, and intellectual capital theory as a theoretical foundation. Applying a multi-case study strategy, 18 interviews within nine cases have been conducted with members and managers of multidisciplinary teams. The data analysis leads to a three-phase model encompassing the processes MDTs follow to co-create knowledge, the factors enabling them to achieve this, and the context in which it is done. The model begins with the knowledge of the individual members (human capital), which is then mobilized in team interactions and dynamics (social capital), and lastly retained in the knowledge bases of the individual, team, and organization. The insights of this study contribute to intellectual capital theory and extend the theory of knowledge co-creation in the multidisciplinary setting to better encompass its complexity.

Keywords: Knowledge co-creation, Multidisciplinary teams (MDTs), Intellectual capital theory, Multidisciplinary collaboration (MDC)

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1. Introduction

As work becomes more complex and new inventions, such as artificial intelligence (AI), require a combination of various niche expertise (Piorkowski et al., 2021), multidisciplinary teams (MDTs) have grown in relevance across various sectors. An MDT is commonly defined as a team of multiple professionals from different disciplinary backgrounds working together towards a common goal (Saint-Pierre et al., 2017). The concept of MDTs was first established in the field of healthcare along the 1970s (Griffiths & Crookes, 2006), where different professionals from two or more disciplines work together to provide the best possible care for patients (Soukup et al., 2018). Since then, the concept has been adapted by a broad variety of industries and is commonly seen as a way to adapt to change and complex needs.

MDTs collaborate to co-create knowledge (Fong, 2008) that they can apply on the short-term to achieve goals or develop products and services and embed and retain in their knowledge bases on the long-term to draw upon at a later stage. Knowledge co-creation here builds on the social constructionism view of knowledge and refers to a collaborative and "communicative process which takes place within a shared practice" (Regeer & Bunders, 2009, p.63) leading to new shared knowledge. Knowledge plays a central role in MDTs, as the benefit of such teams lies in their knowledge diversity (Fong, 2006). Profiting from the ability to draw on knowledge and perspectives across the various disciplines, the multidisciplinary setting allows the members to combine specialized knowledge to co-create new knowledge and insights that they would have not been able to produce independently. Furthermore, by learning from each other's expertise, members are able to expand and improve their own knowledge and understanding (Kauppi et al., 2020). Literature has repeatedly proven the effectiveness of the multidisciplinary team practice, showing effects of improved patient care and coordination (Saint-Pierre et al., 2018; Soukup et al., 2018) and increased creativity and innovation (Alves et al., 2007; Langley et al., 2018).

While the inherent knowledge diversity is what makes MDTs unique and effective, the diversity in the members' professional backgrounds also leads to challenges hindering successful knowledge co-creation. Group dynamics related to power struggles (Oborn & Dawson, 2010), lack of trust across disciplines (Nguyen & Mougenot, 2022; Piorkowski et al., 2021), members' perceptions of role boundaries (Jones, 2006; Twomey et al., 2010), and knowledge and language barriers can hinder effective communication and co-creation. An expert of one discipline may not share the same language (e.g., works with highly specialized terminology) as a member of their MDT coming from a different background and is therefore met with the challenge to translate their knowledge in such a way that it becomes understandable to the team. Additionally, the highly specialized roles within the team lead to enhanced task interdependence as members are not necessarily able to aid each other with individual responsibilities. Furthermore, knowledge co-creation builds on an agreed upon common goal in the team (Regeer & Bunders, 2009), however in practice members often view the goal from the perspective of their own discipline and might follow differing focuses.

The question stands how MDTs can overcome these challenges to effectively co-create knowledge. Collaborative processes are used to navigate the interrelated dynamics, roles and expertise in MDTs, are, however, yet to be sufficiently understood. The concept of knowledge co-creation in the MDT setting has not widely been researched with Fong (2006) providing primary research. Research on the topic remains fragmented. Although there has been increasing interest and usage of MDTs in the business sector, the vast majority of research conducted on the topic is still coming from the field of healthcare (e.g., Supper et al., 2014; Saint-Pierre et al., 2018). Furthermore, research and theory remains fragmented with many studies focusing on individual aspects (e.g., role boundaries (Oborn & Dawson, 2010)), highly specialized fields (e.g., cancer care (Soukup et al., 2018; Winters et al., 2021)) or distinct levels of the process (e.g. team

communication (Piorkowski et al., 2021)). Furthermore, prior research on MDTs and knowledge co-creation has widely focused on newly formed teams (e.g., Fong, 2006), although the comparison between newly formed teams and teams that have been working together for a longer time could provide interesting insights. A general conceptualization is needed that reflects the knowledge-intensive practices and purposes of such teams. It is important to better understand what collaboration for knowledge co-creation in MDTs entails and is influenced by as more and more organizations rely on such teams to reach their goals. A lack of understanding of collaboration in the team hinders the concept from reaching its full potential in practice. It is essential to look beyond the effects of MDTs and towards how such teams can reach their potential and best benefit from their knowledge diversity to successfully cocreate knowledge.

This study aims to develop a framework of collaboration for knowledge co-creation in MDTs building on intellectual capital theory, Fong's knowledge co-creation model and insights from research on collaboration. The following research question is explored: *How can MDTs collaborate to successfully co-create knowledge?* Answering this research question addresses the gap in literature regarding collaboration for knowledge co-creation in MDTs. To understand how the collaboration unfolds in practice and learn from the experiences of the team, interviews with members of multidisciplinary teams have been conducted exploring their challenges, strategies and perceptions. As knowledge lies at the center of the benefits, struggles and processes of MDTs, Intellectual capital (IC) theory provides a good theoretical lens to explore the topic as it is a comprehensive framework of the sum of all knowledge in a body, such as a MDT, and their interrelations. The theory discusses three streams of knowledge: human capital, knowledge embedded in the individual, social capital, knowledge embedded in interactions and relations, and organizational capital, knowledge embedded in the organizational structures (e.g., guidelines and manuals) (Kang & Snell, 2009). According to Dahiyat et al. (2020), research on IC and Knowledge management (KM) has largely focused on the capitals as independent components. The authors discuss the need for "integrative models that examine their [the dimensions'] interconnection" (p.2067) and refer back to Salinas-Ávila et al.'s (2020) call for empirical research into such interrelationships examining IC's influence on knowledge generation. This study answers to this, applying an IC lens to understand the relationships and processes of collaboration for knowledge co-creation in MDTs.

The results contribute to both theory and practice by providing a clear understanding of processes of knowledge co-creation, the factors enabling them, and dynamics of multidisciplinary collaboration as practiced by team members. The provided framework furthers MDT theory, specifically in the business context, through the established understanding of core components and empirical insights into the processes. Combining the domains of knowledge co-creation and multidisciplinary collaboration it provides a unique perspective on the teamwork in MDTs. More specifically the findings show the importance of interrelations in the team, adjusted communication, and clear roles and goals. The developed three-phase model can be used to further investigate collaboration for knowledge co-creation in MDTs in different settings and contexts. Furthermore, the study contributes to intellectual capital theory both by providing an example of building on intellectual capital theory as a theoretical base and by furthering the theory with insights from the findings. Practitioners will be able to utilize the insights to enrich their understanding and guide their approach in supporting MDTs and facilitating successful collaboration. Teams are recommended to invest into their relationships and work to align on core aspects early on. Additionally, the experiences of the interviewed MDT members can provide insights into various ways to approach challenges and highlight essential processes.

The study is structured as follows. Firstly, an introduction to the topic and rationale has been given. Secondly, relevant literature is reviewed, and the underlying theories are presented. In the

third chapter, the research methodology, interview procedure and data analysis process is described. The fourth chapter then presents the findings of the data analysis. Key conclusions and directions for future research are developed in chapter 5.

2. Literature review

This section begins with an overview of the debate surrounding team terminology. Secondly, intellectual capital theory is introduced and applied to the MDT context. Then, the knowledge co-creation model by Fong (2006) is introduced and viewed through the IC lens. Lastly, a model of collaboration in MDTs is developed based on the IC lens of knowledge co-creation and literature of collaboration in MDTs from the healthcare sector.

2.1 MDT terminology

There has been some debate surrounding the terminology of multidisciplinary teams (MDTs) in healthcare. Scholars have called for unified terminology in literature on teams involving multiple disciplines and some attempts at distinct definitions have been made (e.g., Martin et al., 2022). However, to date terms such as multidisciplinary or interprofessional are often still used interchangeably (Martin et al., 2022).

In their study on healthcare teams terminology, Martin et al. (2022) analyzed literature to expand on the recently published definitions in the "Proposed Lexicon for the Interprofessional Field" (Khalili et al., 2021 as cited by Martin et al., 2022, p.765) and derive standardized definitions and characteristics of different team terminology (see Table 1).

Table 1: "Key Characteristics of Healthcare Teams" (Martin et al., 2022, p.768)

	Unidisciplinary	**Multidisciplinary**	**Interprofessional**	**Transdisciplinary**
Alternative terms	*Uniprofessional, intradisciplinary, intraprofessional*	*Multiagency*	*Interdisciplinary, interprofessional collaboration, cross-disciplinary*	*Transprofessional, supra-professional*
Team members	One single professional	Professionals from multiple disciplines	Professionals from multiple disciplines; patient-centered	Professionals from multiple disciplines; patient-centered
Communication	May communicate with colleagues	Communicate via the leader	Frequent communication	Frequent communication
Collaboration	Work independently	Work independently	Work interdependently; share decision-making	Share roles, skills, tasks, and decision-making
Leadership	Single professional directs care	Leader is the highest-ranking professional, usually the physician	Members hold equal status; designated leader to oversee care	Members share responsibility; may be a designated leader to oversee care
Professional boundaries	Strict professional boundaries	Strict professional boundaries	Maintain professional boundaries; advanced understanding of other's roles	Blur professional boundaries (share knowledge and skills); advanced understanding of other's roles
Patient assessment, treatment, goals	Discipline-specific	Discipline-specific; patient goals may be conflicting	Discipline-specific assessment and treatment; coordinated treatment plans; shared goals	Integrate elements of assessment and treatment; one unified plan; shared goals

Based on their distinction, MDTs involve multiple disciplines working independently with a clear structure build on communication through a leader. In contrast, a transdisciplinary team (TDT) emphasizes shared responsibility and blurred boundaries. Martin et al.'s definitions allows research to place teams on the classification. For the purpose of this study, an umbrella view of the MDT term has been used building on Saint-Pierre et al.'s (2017) definition of an MDT as "a group of professionals from two or more disciplines who work on the same project" (p.132). An

umbrella view is often used as MDTs, interprofessional teams and TDTs entail the multidisciplinary characteristic.

Making distinctions between the different forms of teams is important for a variety of reasons. Firstly, to ensure that the results are interpretable by both future research and practice it is important to be clear about the characteristics of teams as this context likely influences the gained insights. It has been proposed that using the described classifications allows practitioners to more clearly derive implications based on similarities between the researched teams and their own teams and processes (Martin et al., 2022; Øvretveit, 1996). Furthermore, researchers are able to learn from the insights and situate the findings into particular situations (Øvretveit, 1996).

2.2 Intellectual Capital Theory

Intellectual Capital Theory revolves around the knowledge embedded in organizations and has been applied in a variety of research fields such as HRM's impact on innovation (e.g., Subramaniam & Youndt, 2005), agile teamwork (e.g. Wiedemann & Weeger, 2017) and nursing knowledge in healthcare (e.g. Covell & Sidani, 2013). The theory comes from economic theorists and has gained attention due to growing rise of a knowledge-based view of organizations (Martín-de-Castro et al., 2010). Intellectual Capital (IC) is defined as "the combined knowledge that organizations can draw on to create a competitive advantage" (Wiedemann & Weeger, 2017). Three dimensions are most commonly used: Human capital, Social capital and Organizational capital.

Human capital refers to the knowledge residing in the individual, including the individual's skills, knowledge, and expertise. In the subject of organizational learning and ambidexterity, the distinction has been made here between specialist and generalist HC (Kang & Snell, 2009; Wiedemann & Weeger, 2017). Specialists are highly knowledgeable in a specific domain or field, whereas generalists possess expertise across multiple domains, being described as 'multi-skilled'. This distinction is interesting for the MDT context, as one could argue that over the course of a team working together the initial specialist HC of the members might develop into more generalist HC through learning and knowledge exchanges with other domains and disciplines within the team.

Social capital (SC) describes the knowledge embedded in social interactions, relations and networks. Here, the distinction between external SC and internal SC is often made. External SC describes relationships and interactions with external parties outside the firm, whereas internal social capital (ISC) is defined as "the linkages among individuals and groups within an organization that are grounded in dynamics of individual and collective behaviors that facilitate cooperation and provide access to new business opportunities" (Sanchez-Famoso et al., 2020). For this study, the focus is set on ISC, more specifically the dynamics and interactions within groups (i.e., MDTs).

The third dimension is organizational capital (OC), which describes the institutionalized knowledge embedded in manuals, guidelines, or other forms of codified, organization-wide knowledge. Organizations tend to invest strongly into their human capital but overlook the importance of transforming such knowledge into organizational capital (Dahiyat et al., 2020). In case, employees leave the organization or team, codified knowledge is one way to ensure their knowledge stays within the organization. Furthermore, OC is a great means for the organization to communicate rules, regulations, and principles.

The stocks and flows perspective of Intellectual Capital views the capitals as stocks, which are transformed and facilitated through flows. As IC stocks are created through knowledge flows (e.g., knowledge creation), organizations need to invest not only into their HC but further into SC and knowledge transfer to facilitate knowledge flows and thereby make usage of the static HC (Dahiyat et al., 2020). Knowledge creation is here defined as a "a natural outcome of a social learning process that highly depends on social interactions and exchanges among knowledge-possessing individuals (i.e. HC)" (Dahiyat et al., 2020, p.2068). In short, the knowledge embedded in the individuals is transformed into institutionalized organizational capital through the processes of social capital (e.g., collaboration) and knowledge transfer.

In the context of MDTs, it can therefore be argued that the human capital of each team member is utilized and transformed through the collaborative processes (SC) leading to co-created knowledge. Learning is here centered as an important facilitator of the process (Dahiyat et al., 2020; Fong, 2006). Through the team's and individuals' learning processes, knowledge is not only applied to reach current project goals, but also integrated into the knowledge bases of the organization, team, and individual (Fong, 2008).

2.3 Knowledge co-creation in MDTs

Knowledge co-creation is the core purpose of MDTs. Knowledge co-creation refers to the collaborative process of creating new knowledge and can be defined as a result of "complex interactions between the various network actors, and even resource integration" (Ruoslahti, 2020, p.229). As this study uses co-created knowledge as an outcome of collaboration in MDTs, it is important to understand how these teams co-create knowledge through processes and interactions. Here, Fong (2006) developed a model of knowledge co-creation in MDTs and prescribed to the social construction view of knowledge as "a set of shared beliefs that are constructed through social interactions and embedded within the social contexts in which knowledge is created" (p.42). Through the model's focus on knowledge embedded in interactions the central importance of social capital is evident.

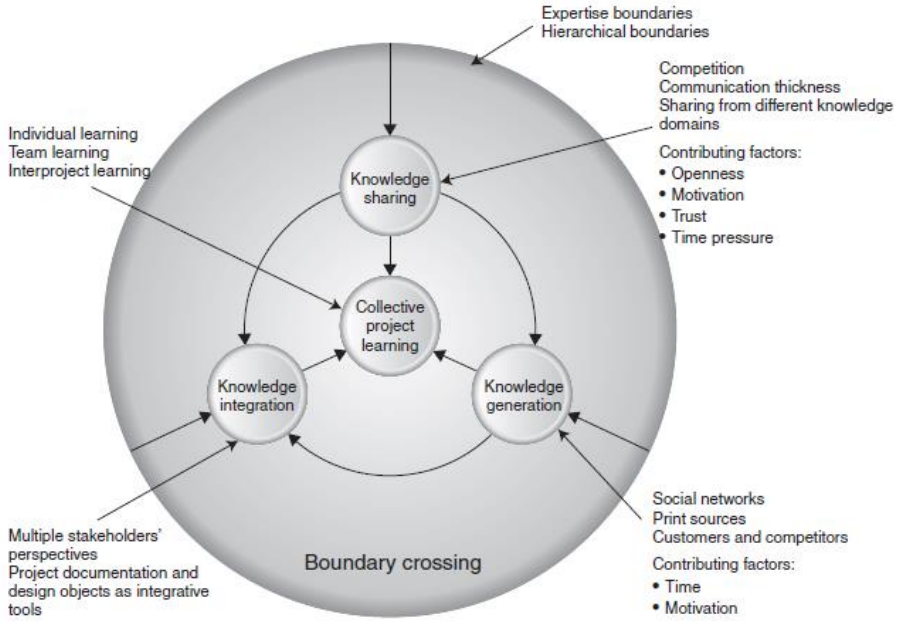


Figure 1: "The interrelationships between multidisciplinary knowledge-creation processes" (Fong, 2006, p.52)

Knowledge co-creation has primarily been discussed outside of the context of multidisciplinary teams. For example, Greenhalgh et al. (2016) proposed knowledge co-creation as a beneficial approach for research in healthcare defining it as 'the collaborative generation of knowledge by

academics working alongside stakeholders from other sectors" (p.393). In the context of MDTs, Fong (2006) studied two cases of multidisciplinary project teams and developed a model with five 'interwoven' processes of boundary crossing, knowledge sharing, knowledge generation, knowledge integration and collective project learning. Figure 1 depicts those processes, which in the following will be examined through the lens of intellectual capital theory.

Boundary crossing is described as a prerequisite of the other processes and involves the effect of expertise and hierarchy boundaries on knowledge creation (Fong, 2006). Expertise boundaries are the boundaries between the different disciplines and were crossed through knowledge redundancy and boundary objects (e.g., drawings). In terms of intellectual capital terminology, this process could be described as members going past the boundaries of their own human capital and into the domain of other disciplines, thereby potentially enriching their own human capital. This can be related back to the argumentation of potential progress from specialist HC to generalist HC. Hierarchical boundaries, on the other hand, describe the boundaries between different hierarchical levels in the team and could only be crossed by the members "consciously breaking down any barriers by valuing the expertise of others" (Fong, 2006, p.49). This process is essential as it directly addresses one of the core challenges of MDTs regarding power dynamics (Oborn & Dawson, 2010). In fact, Langley et al. (2018) argue that knowledge co-creation has the potential to "level hierarchies" (p.3), which could come from the process of boundary crossing described by Fong.

The second process, knowledge sharing, sees knowledge being shared through the members' views and experiences. This process is reflected in Langley et al.'s (2018) model of knowledge co-creation (called collective making here), where the authors describe this as the identification and sharing of different forms of knowledge. Assumptions, constraints and knowledge gaps are identified through dialogue and discussion. Arguably, this, and the following knowledge processes, fall under the dimension of social capital. Fong (2006) distinguishes here between sharing without language (socialization) and sharing with language (externalization). While externalization is necessary to share the individual discipline's expertise, socialization is especially important for MDTs as it provides a way to bridge the lack of a common language and foster trust in the team. In terms of intellectual capital, human capital is communicated, enhanced, and utilized through social interactions. This means the human capital is embedded and exchanged in team interactions (social capital).

The third process, knowledge generation, describes the teams creating new knowledge through interaction and drawing on social networks (internal social capital) to fill gaps in knowledge identified earlier. Here, the team draws on the various capitals available to them (i.e., the HC of the members, SC available through members' networks, and provided codified resources, i.e. organizational capital) to fill the gaps. In multidisciplinary teams members might draw on outside resources from their disciplinary background to fill knowledge gaps.

Once sufficient knowledge is possessed, the teams then combine the collective knowledge in the fourth process, knowledge integration. Here, the different perspectives and knowledge domains are integrated and negotiated leading to the output of a collective, co-created knowledge. Active participation of the various disciplines is essential here as it helps to co-create the knowledge (Ruoslahti, 2020). Documentation and objects are used in these discussions to integrate a variety of inputs with the goal to fulfill stakeholder needs and reach project goals. Co-creation of knowledge "need[s] facilitation and cooperation tools" (Ruoslahti, 2020, p.229). As discussed earlier, this is where the first half of the outcome of collaboration in MDTs comes into play focusing on the utilization of collective knowledge to reach immediate project goals. In summary, this process combines the knowledge available to the team through the member's

human capital with the knowledge embedded in the team interactions (i.e., social capital) to co-create new knowledge and integrate it.

The fifth process of collective project learning relates to the second half, the embedment and retention of knowledge into the various knowledge bases through learning processes. Knowledge co-creation here allows members to gain additional knowledge (Kauppi et al., 2020). Fong (2006) only describes this process in terms of HC and SC, stating that "a lot of the emergent knowledge accessed by individual team members or the team as a whole will be learnt, absorbed and turned into valuable experience that may be used again in the future" (p.53). The learned knowledge here is embedded in the knowledge base of the individual, team and taken into the next project. However, it is likely that this learning process also involves an integration of the learned knowledge into the organizational capital, although this process has received less attention.

Fong's model provides a comprehensive understanding of knowledge co-creation, positioning the described processes in loops, where members refer back to previous processes throughout the project. However, the focus on the knowledge processes leads to an underappreciated aspect in the model regarding the influences of the relationships between members and the individual's background and beliefs.

2.4 Collaboration in MDTs

Based on the above insights from intellectual capital theory and Fong's model of knowledge co-creation in MDTs, a general overview of the process in MDTs can be derived. The knowledge domains of the individuals from different disciplines (HC) are combined through interactions and knowledge exchanges in the team (SC) leading to co-created knowledge, which is a) applied to reach the specific project goal(s) and b) integrated into the knowledge bases to be accessible to the team (and others) and to be retained in the organizational knowledge (OC). Figure 2 shows a simplified overview of this process. This section describes these three phases and insights from literature on multidisciplinary collaboration relevant to them.

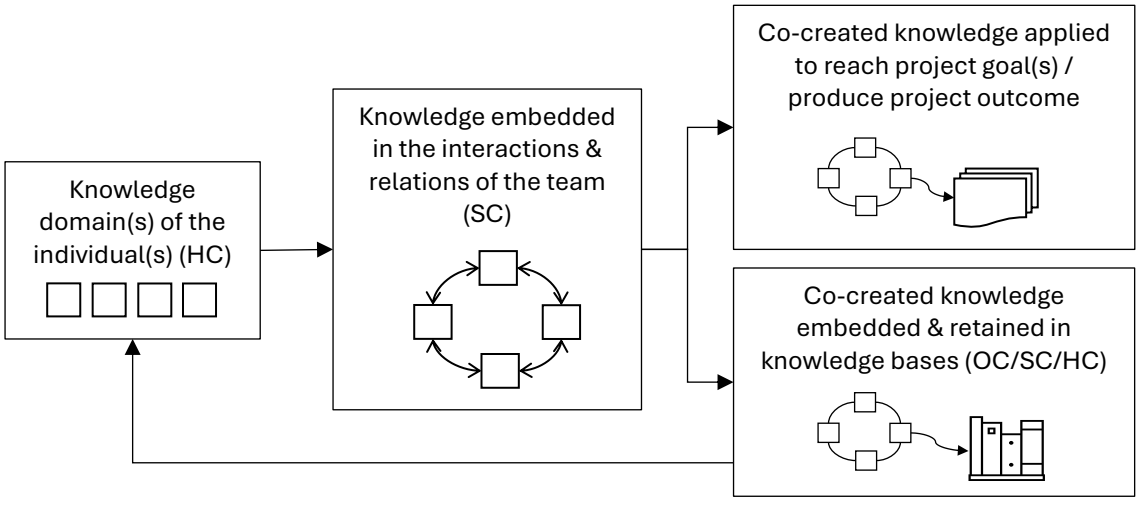


Figure 2: Simplified overview of collaboration process in MDTs

In the initial stage of the process, the team is created with individuals from different disciplines coming together. This stage revolves around the human capital of the team members. Literature discusses two main aspects here, professional socialization and individual beliefs as influenced through history of collaboration. Professional socialization describes the alignment and identification of the individual with their discipline or profession through their experience and proximity through the associated values throughout e.g., their education and work experience

(Bronstein, 2003; Liberati et al., 2016). This impacts the collaboration and team composition as it influence the individual's approach and idea of boundaries and boundary crossing. If the member very strongly aligns themselves with their profession, they might be more likely to defend their expertise boundary. The influence of individual beliefs describes the member's idea of collaboration as e.g., something beneficial or effective and has been highlighted in research as it constitutes their approach to collaboration (Supper et al., 2014). The individual's history of collaboration, whether through training and education in multidisciplinary collaboration or prior experience working in such teams, strongly influences these beliefs as it determines the member's view (Bronstein, 2003).

In the second phase, the individual knowledge is mobilized and combined through collaboration (social capital). Here, three knowledge process described earlier (i.e., sharing, generation, and integration) happen. Power dynamics play a key role in this as Oborn and Dawson (2010) argue that the privileging of individual knowledge into group practice is dependent on power. This aspect highly relates to boundaries within the team and if strong tension exists can even lead to "nested relationships" (Oborn & Dawson, 2010, p.1853), where subgroups form around each discipline. Supper et al. (2014) went as far as stating that "perceived hierarchy is the main conceptual barrier hindering collaboration" (p.724). Especially, in the healthcare field surgeons are often implicitly seen as the dominant discipline, whereas the contributions of nurses, while extremely valuable to patient-centered care, often get undermined. In contrast, mutual commitment, shared responsibility and mutual trust and respect are perceived as strong facilitators of collaboration (Fong, 2006; Saint-Pierre et al., 2018; Supper et al., 2014). Members trusting each other, respecting and appreciating each others' beliefs, and sharing the responsibility for project outcomes ensures that knowledge of one discipline does not dominate discussions and each individual is able to contribute thereby improving outcomes. Lastly, the presence of a shared understanding within the team, defined as "a collective way of organizing relevant knowledge" (Hinds & Weisband, 2003, p.21), is deemed especially important however more challenging in multidisciplinary teams (Bittner & Leimeister, 2014). A shared understanding can help the team operate smoothly, motivate towards a common goal, prevent misunderstandings, and align the team on how to approach processes (Hinds & Weisband, 2003) and ensure decision-making is supported by members (Koskela et al., 2016). For this, members "must have a shared understanding of the goal toward which they are working and the processes that will help them to achieve that goal" ((Hinds & Weisband, 2003, p.21). To illustrate, if members of a team have different understandings of what the goal of the project is, they might set different priorities and disagree on decisions leading to conflict.

In the last stage, co-created knowledge is applied to reach the immediate goals of the project and is integrated into the knowledge bases through individual (HC), team (SC) and organizational learning (OC). This phase sees the team members retain their learned knowledge, therefore having it flow back into the human capital.

3. Methodology

3.1 Research strategy

A qualitative research approach is most suitable for this study as it is commonly used to understand social phenomena and allows the researchers to draw meaning from the perspective and actions of individuals (Baškarada, 2014). As Riger and Sigurvinsdottir (2016) argue such an approach "allow access to meaning in context" (p.35). To explore how MDTs collaborate to successfully co-create knowledge, the research strategy of a multi-case study was chosen. This strategy has been described as following the aim "to conduct an in-depth analysis of an issue, within its context with a view to understand the issue from the perspective of participants"

(Harrison et al., 2017). This aim fits with the goal of this study to explore collaboration for knowledge co-creation in MDTs based on the view and experiences of team members. Case studies can produce a strong understanding of a phenomenon and the context its situated in making it a good strategy to examine complex phenomena (Harrison et al., 2017). Collaboration for knowledge co-creation, especially in a multidisciplinary setting, is a highly complex phenomenon due to the associated social interactions and variety of influential factors and backgrounds. Additionally, multi-case studies are a suitable research strategy where only few studies have explored a concept (Cha et al., 2015). Based on these arguments, the choice was made to conduct a qualitative multi-case study as this can best answer the research question posed.

3.2 Case selection and description

Before searching for teams to conduct the case studies with, a set of selection criteria were defined. These include that the teams have to be working in a multidisciplinary setting and are able to provide access to their members. For the criteria of a multidisciplinary setting the definition of a MDT was used. This means the teams had to include two or more disciplines that work together to achieve a common goal (Saint-Pierre et al., 2017). The participants had to be able to speak in either English or Dutch to allow the researchers to conduct interviews. Furthermore, to capture the teamwork across various contexts and be able to better generalize, teams from different industries were sought out. To research MDTs in different contexts and increase generalizability nine cases within three organizational contexts were selected.

Through purposive sampling and based on the selection criteria, nine teams in three companies were found. Two companies were reached through initial contacts of the supervisor of this study. The third company was reached through an initial contact of the co-researcher. To examine whether the discussed teams fit the selection criteria and aim of this research, meetings were held with the initial contacts to ask general questions about potential participants, the company, and work in MDTs. After it was determined that the teams fit the research design, participants of further teams were then sampled. The initial contacts themselves agreed to participate with their teams. Additionally, they were willing to spread the invitation in their internal network and provided contacts to further teams.

Two cases were done at company A, a large Dutch defense company with teams working in their marketing department. The company was chosen due to the variety of disciplines in the available teams. Specifically the contrast between a military and marketing background made these cases especially interesting for this research. Furthermore, due to the large size of the company it could be assumed that multiple teams would be available for interviews. Five teams operate in company B, a large global company in the semiconductor industry, where most teams interviewed worked in the learning and development domain. This company provided a unique context for research on knowledge co-creation as the learning and development field directly works with knowledge processes and, as the initial meeting showed, had multiple structures set in place to support knowledge sharing and collaboration. The contrast between the engineering and learning discipline furthermore provided a good context to research how teams overcame differences between disciplines. The last two cases were done at company C, which is a large construction company including maintenance and development projects with project teams consisting of multiple engineers from different disciplines (e.g., civil engineering, mechanical engineering, electrical engineering). As the first two companies provided teams where disciplines came from quite different backgrounds, the third company was chosen to contrast this. While company C still worked with multidisciplinary teams, the involved disciplines shared a more similar background of engineering.

3.3 Data collection

For the data collection, the researcher collaborated with a co-researcher working on a similar research project on the management of MDTs. Here, data was collected by conducting semi-structured interviews with members of multidisciplinary teams. As the goal of this study is to build a comprehensive understanding of how multidisciplinary collaboration unfolds in MDTs, members of these teams provided the greatest opportunity for the research. Interviews allow researchers to investigate a phenomenon by allowing relevant participants to share and reflect on their experiences and views (Winwood, 2019). Semi-structured interviews are especially appropriate for research of social studies, as the less formal nature creates more room for natural discussion thereby providing a more comfortable atmosphere for interviewees to share their thoughts and, sometimes, very personal experiences (Adeoye-Olatunde & Olenik, 2021). Another benefit is the researcher's ability to ask further questions (Winwood, 2019), e.g., if the researcher feels inquiring more into a described situation might yield a deeper understanding of the topic or if an interviewee brings up a point the interviewer has not uncovered yet (Adams & Cox, 2008).

As the multidisciplinary nature is integral to the research, it was important to interview professionals from different disciplinary backgrounds. Furthermore, to understand the evolution over time, members with differing amount of experience working in multidisciplinary teams were included. Multidisciplinary teams from the three organizational contexts were researched, specifically interviewing between one to three professionals from different disciplines within one team. The most teams were interviewed in company B with five teams, whereas both company A and company C provided two teams. It is important to note that in four teams it was only possible to conduct an interview with one member, which limits the analysis of these teams. In total 18 interviews with members and managers from nine teams were conducted. Out of the 18 all but two interviews were conducted in English. The two interviews in Dutch were conducted by the co-researcher, who transcribed and translated them into English to be used in this research. One interview was conducted individually due to sickness of the co-researcher. The other 15 interviews were done by both researchers together.

Participants were identified through purposive sampling, one way to ensure the participants included represent the overall situation of multidisciplinary teams (Robinson, 2014). The initial contacts at each company provided interview participants within their team and contacts of other interested teams within the company. Therefore, participants were reached through processes of referral sampling and direct contacting. To reach more contacts, interviewees were asked if they knew of other potential participants at the end of the interviews or via email afterwards. This allowed participants to recommend other members of their team or provide additional contacts.

Due to the participants' availability and geographical distance of the companies, all interviews were conducted virtually via Microsoft Teams. The interviews lasted between 45 minutes to an hour and a half. After agreeing to participate in the research, interviewees were given a consent form to ensure that they agree with the data collection and are aware of how data will be used, stored, and their ability to e.g., withdraw from the interview at any point. Additionally, they received a further introduction to the research at the beginning of the interview to provide relevant context and thereby help the interviewees understand the research and approach the questions accordingly (Adams & Cox, 2008). As common with semi-structured interviews (Winwood, 2019), an interview guide was developed (see Appendix A), which functioned as a base structure. As the interviews were conducted together with the co-researcher, a structure was followed where combined (general) questions were asked first and then questions regarding the topics of first the focus of this study and secondly the focus of the co-researcher were asked.

To answer the research question of this study questions were asked surrounding the topics of 1) teamwork 2) knowledge processes and 3) relations in the team. The guide depicts both core questions, which were consistently asked throughout the interviews, and examples of follow-up questions meant to clarify or explore a direction mentioned by the interviewee. Throughout the interview the interviewers followed the general outline of the guide, however, were free to add further inquiries or address a novel direction. Both researchers asked follow-up questions within each part of the interview thereby keeping the loose structure of semi-structured interviews and allowing in-depth investigation.

3.4 Data analysis

The transcripts produced by Microsoft Teams were cleaned and reviewed based on the video recordings. This process was split between the researchers with researcher A transcribing seven and researcher B transcribing eleven interviews. The data analysis and coding of the interviews was then done independently by each researcher, however three meetings and continuous communication between the researchers allowed them to compare impressions and receive feedback. Feedback revolved around whether the coding process and structure and was used to ensure an accurate and clear story was developed. For this study, the interviews were analyzed using ATLAS.ti and following the approach of reflexive thematic analysis (TA) (Braun & Clarke, 2021). Reflexive TA focuses on the development of "themes as patterns of shared meaning, cohering around a central concept" (Braun & Clarke, 2021, p.331). Reflexive TA is suitable for this study as it allows for both a more deductive and more inductive process (Braun & Clarke, 2021). The methodology prescribes an open coding process, where no prior codebook is used, and codes and themes are revisited throughout the process. Six phases are included: 1. Familiarizing yourself with the dataset, 2. Coding, 3. Generating initial themes, 4. Developing and reviewing themes, 5. Refining, defining and naming themes, 6. Writing up (Joy et al., 2023).

Based on this process first the transcripts were read in total, and some notes were taken to familiarize oneself with the entirety of the collected data. Then the coding stage focused on the micro aspects, which entailed line-by-line labelling of single ideas in the transcripts. Throughout the initial coding a clear correlation to the three phases outlined in the literature review became apparent. Interviewees spoke of the importance of their initial approach and personal background, the interaction and relationships with their team members, and the ways they made use of the created knowledge in their further work. These themes seemingly correlated with the phases described in the literature review. Based on this realization, the researcher approached the coding again with the three phases in mind. Clustering the assigned labels (codes) and building on the researcher's knowledge and context, initial themes were then generated. The choice was made to structure the codes based on the three phases as a comparison with the initial coding showed a strong fit with the three phases. Structuring the coding in this way further made sense for this study as it allowed the researcher to draw clear relations to intellectual capital theory, the theoretical lens of this study. In the phases 2 and 3, the developed codes and themes were continuously compared between the three cases and differences and similarities between the companies were noted. In the fourth phase these themes were then evaluated and revised. Due to the multi-case study strategy of this study it was especially important to ensure the developed themes adequately and correctly captured the reality of teams in all three cases. To ensure this the researcher's written notes on the differences and similarities were taken into account and the themes were applied to the teams of each case independently. The fifth stage then focused on ensuring a compelling story has been built asking questions such as how the themes contribute to the overall picture and if there is clear distinction between themes. Table 2 depicts the final coding structure. Lastly, the developed themes and storyline were written down into a final version of the findings of the analysis.

Table 2: Coding scheme

Exemplary quote	First-order code	Second-order code	Aggregate dimension
"Then the altitude grows, so we need more people to bring more expertise to arrive to the solution." (10)	Team formation	Team composition	**Individual knowledge domains**
"It's not that people that fall under me as very hierarchically [team] but are doing things in marketing and we also trying to coordinate that as a virtual team." (2)	Management structures		
"I do have experience with the multiple disciplinary." (11)	Past experiences with MDC	Individual background	
"I like to learn a lot and I like to figure out how things work. Umm, so some of the stuff, maybe comes naturally to me that I'm naturally curious." (8)	Personality		
"I really enjoy working with people who are much, much smarter and more experienced than I am in certain areas." (7)	Beliefs about MDC		
"[At the old company] the role clarity is there, but for here let's say it feel like we are all over the place and we are wearing different hats." (11)	Role clarity	Project clarity	
"I think it all improved when the project became a bit more concrete" (10)	Goal clarity		
" You have to have trust that everyone has the best intentions." (8)	Relations of trust	Developing shared understanding	**Knowledge embedded in interactions**
"OK, what are the goals? What do we want to do? Again aligning on priorities." (3)	Goal as compass		
"We explained the story from the very beginning" (10)	Storytelling		
"When you have an opportunity or when I think it's relevant, sharing this knowledge with the team." (3)	Knowledge sharing	Knowledge processes	
"We do have access to this network when we ask." (3)	Knowledge generation		
"When you hear contradictions, because you can pick them out, and ask further questions and make sure you actually bring all those details together." (15)	Knowledge integration		
"I really like it in this project that I can go really in depth and learn a lot about technology as well." (8)	Learning domain knowledge	Learning processes	
"I learn on the daily basis, [...] also about how to collaborate together." (8)	Learning how to collaborate		
" I'm trying to use the methods the approaches in other projects which are similar." (10)	Application to other projects	Knowledge retention	**Retention of co-created knowledge**
"In our organizational team we have bi-weekly meetings where one part of this meetings is also knowledge sharing. So we're telling the stories about... Yeah, some interesting stories about our projects." (3)	Sharing learning with network		

3.5 Validity and reliability

This section discusses the validity of this study on the levels of the research strategy, data collection, and data analysis used. To begin with it is important to make the distinction between internal validity and external validity. External validity describes "how generalizable the results of the study are beyond the sample that is actually studied" (Baldwin, 2018, p.31), whereas internal validity answers the question whether the research "actually measur[es] what it is supposed to measure" (Alshenqeeti, 2014, p.43). In case studies, the **research strategy** of this study, external validity, i.e., the issue of generalization, has often been a topic of concern (Yin, 2013). Yin (2013) here proposes analytic generalization as one way to generalize findings of the cases to a larger population and other situations. Yin (2013) defines analytic generalization here as "the extraction of a more abstract level of ideas from a set of case study findings" (p.325). By providing a general model based on the themes found in the data analysis, this study follows this approach of generalization. Yin (2013) furthermore suggests connecting the findings to theory and other literature to increase external validity. Therefore this study strengthens its validity through a theoretical base of intellectual capital theory and knowledge co-creation and a comparison to research from those theories and other fields in the discussion.

To address the validity and reliability of the **data collection** method, semi-structured interviews, a few strategies were followed. For one, semi-structured interviews provide a good base as they allow the interviewer to clarify misunderstood questions and answers thereby increasing the accuracy of the collected data (Alshenqeeti, 2014). Conducting interviews with multiple members of a team further allowed the researcher to draw from different perspectives on one shared phenomenon (i.e., knowledge co-creation). To ensure the quality of questions and that they can be used to accurately examine the teamwork, the developed interview guide was reviewed by the supervisor and co-researcher and refined based on the received feedback. Lastly, the reliability of the data collection method was addressed. Alshenqeeti (2014) proposes four techniques here: "avoiding asking leading questions", "taking notes", "conducting a pilot interview", and "giving the interviewee a chance to sum up and clarify the points they have made" (p.44). These techniques were used to increase the reliability, however instead of a pilot interview the researchers instead reviewed and refined the interview guide and approach after the second interview.

When it comes to the **data analysis** a strong concern with qualitative research and thematic analysis revolves around the role and subjectivity of the researcher (Riger & Sigurvinsdottir, 2016). Reflexivity is commonly used to counteract potential bias and is defined as a "process of critical reflection by researchers about their impact on their research" (Riger & Sigurvinsdottir, 2016, p.37). This process includes reflecting on choices made in the methodology of the study and reflection on own assumptions and personal background. To further increase the validity of the analysis, the coding process included multiple review and discussion moments with the supervisor and co-researcher. This helped both to reflect on the process and compare it to the view of the co-researcher who was part of the data collection, as well as to refine the coding to ensure it accurately presents the reality of the data and presents a clear story.

4. Findings

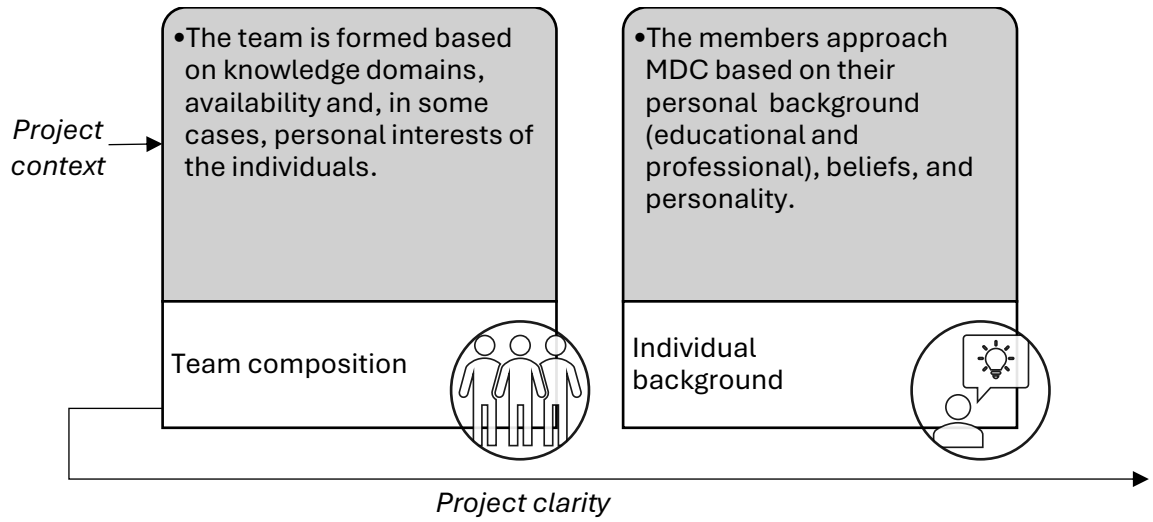
The interviews with members and managers of MDTs provided essential insights into the collaboration and inherent knowledge processes of these teams. This section presents these findings. Through the data analysis, three themes correlating to three phases became apparent. The themes are the individual knowledge domains, the knowledge embedded in interactions, and the retention of co-created knowledge. As teams described the process of going from the initial set-up of individuals from different domains to collaborating with the team and lastly finalizing the project and learning from its lessons, these themes can be presented as phases. To

summarize, the co-creation described three phases where (1) the project team was formed around the knowledge and background of the individuals, (2) this individual knowledge was mobilized and integrated into project outputs through team interactions, and (3) the thereby co-created knowledge was retained in knowledge bases and the project was finalized. Through the interviews it became apparent that the context in which the project and knowledge processes are situated in holds great importance to its success and smoothness. Therefore, the sections not only describe how the processes play out but also the different aspects influencing them. Altogether, the teams' approach regarding the enabling factors for and their challenges with knowledge co-creation in a multidisciplinary setting is presented.

4.1 Phase 1: Knowledge domains of the individuals

In phase 1 the project is defined, and a team is formed around the individual's expertise and background. **Figure 3** depicts the three core aspects of the process, namely the context the project is situated in, the composition of the team, and the individual member's background. Throughout the phase, and importantly, also leaning into the further phases, project clarity influences the way members understand the project, contribute their knowledge, and approach the collaboration.

Figure 3: *Model of Phase 1*



4.1.1 Team composition

Firstly, the project context differed widely between the different teams interviewed. Two out of the three companies were undergoing or had undergone changes in their environment (e.g., moving from fixed offices to an open space area) or workload. Interviewee 18 describes, for example, how their company has recently been taking on much larger projects and consequently the project needs have shifted:

> *"That's also a lot for our company, so a lot happened the last five years because our employee number did not really expand that much. So we're doing a lot more than we used to and it's sometimes a struggle, let's be honest."*
> (Interviewee 18)

The organizational context further includes organizational culture impacting how interviewees approached the collaboration with each other. To illustrate, company 2 strongly valued challenging each other and interviewees reported following this value and how it led them to be open and critical in discussions across disciplines. This is just one of the examples of how the

context of the organization, whether in regards to culture, structures, leadership principles or priorities, affected MDTs in their approach and focus.

Related to the context, most interviewees spoke of the importance of project clarity; an aspect that often progressed throughout the project but in most cases was a crucial point of discussion in the initial project set-up. On the one hand this involved the question of how clear the goal and scope of the project was to the team. Some projects were built around a set goal (e.g., developing a learning solution), whereas other teams developed the scope and direction of the project over the course of multiple months. On the other hand, project clarity regarded how clear roles and associated responsibilities were. Here, some teams began the project with clearly defined roles and boundaries between the members. Again a difference between the companies can be noted. In company 2 every MDT member interviewed held more than one role, meaning they were present in more than one project. In contrast, company 1 was not structured project-based but function-based, which meant teams mostly worked together in one role across projects. Interviewee 11 explains their experience switching from a very structured environment to their current company:

> *"If you are talking when I was working at [other company], it's very, very structural. The role clarity is there, but for here [company 2] let's say it feel like we are all over the place and we are wearing different hats. At this project we are this role, for the other project we are the other role."*
> (Interviewee 11)

Evidently, the context of the project is highly relevant to collaboration in MDTs. This context also plays into the **team composition**. Whether teams were formed around set goals or built around the task of developing such a scope, most of the teams interviewed were formed based on the needs of the project. Therefore, in the decision of who to include in the team, mostly the discipline and professional knowledge of the individuals were considered. Only one interviewee reported their prior experience with MDC playing a role in their hiring process. Some projects required the input of multiple disciplines working closely together, whereas others combined the perspectives of only two domains. Interviewee 10 describes how the current team is developing the scope and based on this will then introduce more members to the team:

> *"So now we are maybe a few people working on defining the goal of the current project. But then when we define the goal, it's going to be a start of something bigger and the altitude grows, so we need more people to bring more expertise to arrive to the solution."*
> (Interviewee 10)

In some cases personal interests also played a role. Either through the employee bringing up such interests and development hopes to their manager and their manager placing them based on this into a team or by employees joining projects upon hearing about them and showing interest. The latter was common in one team, which followed agile methodology allowing a smooth transition and for people to join only for a limited part of the project.

4.1.2 Individual background

While the team is mostly formed around the member's knowledge domains, their **individual background** matters by determining their approach to the collaboration. The interviewees' prior experiences working in a multidisciplinary team and their personality shaped their beliefs about MDC thereby influencing interviewees' approach. Interviewees who had prior experience working in a multidisciplinary setting, either through their educational or professional background, had more realistic expectations. They saw more clearly the benefits but also challenges of MDTs and

had experience in how to approach such teamwork and communication. In team 4 colleagues, who had prior experience working in MDTs, from the beginning on expected challenges regarding the different languages spoken between the disciplines. Interviewee 8 however, for whom the current project was the first experience extensively working in an MDT, expressed going in with expectations that they soon discovered did not represent the reality of MDC:

> *"When we started out, they told me, yeah but this will also become quite challenging because, you know, we speak two different languages and it's like, yeah, I know we speak English and we speak Dutch, right? But we all know this is the goal we're working towards; we will be fine. And then in the first couple months we struggled quite a bit because we found out we were really speaking two different languages."*
> (Interviewee 8)

Personality also played a big role as it impacted the way members approached the processes and each other. In particular, some expressed the need for an open and curious personality. This meant they approach the project with an eagerness to understand and learn from each other through open and honest interaction. As Interviewee 10 states "you also have to have that setup that you want to understand the other person and how they work".

> *"I'm naturally curious and I also always get [told] that I'm very enthusiastic about the work that I do, and I personally feel like that also has helped me in this project."*
> (Interviewee 8)

Combined, prior experiences and personalities influenced the members' initial beliefs regarding collaboration. More specifically, seeing the benefit in multiple disciplines working together was seen as a prerequisite for successful collaboration. Most viewed the multidisciplinary nature as necessary and beneficial as they profit from the different perspectives and the possibilities incorporating those perspectives early on provided. While challenges were noted a positive view on the multidisciplinary setting laid the groundwork for smoother processes later on. Interviewee 7 summarizes their approach:

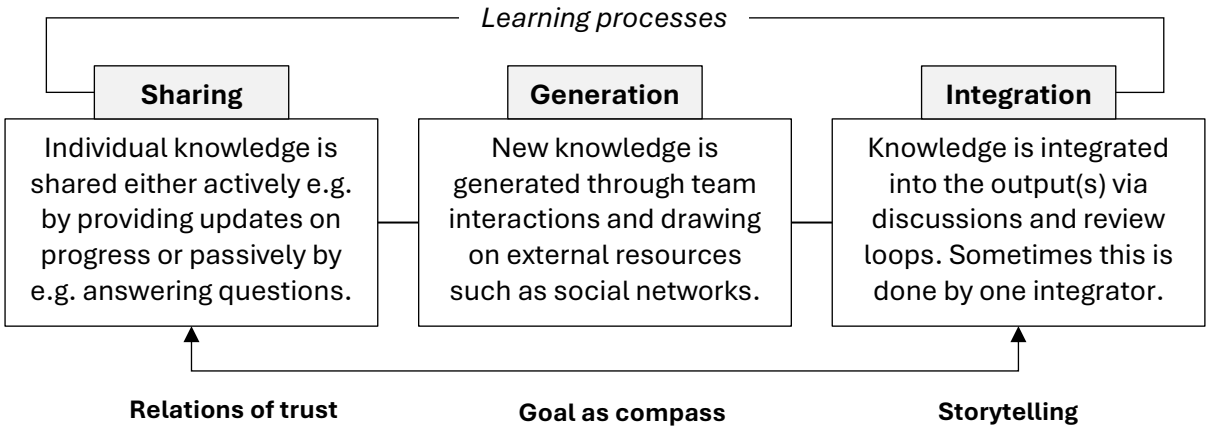
> *"I really enjoy working with people who are much much smarter and more experienced than I am in certain areas. That doesn't mean that they're better than me, or that I'm lesser, it just means that I really value when people are good at something that they do. So obviously it means that you are dividing and conquering, meaning that you're not trying to all do the same thing, but you basically each have your own thing that you can focus on and make work and then discuss with others if you need help, or if there's anything that you can link to. For me personally, what I see is and what I enjoy about it as well is that that means that you can build on each other. So instead of all working on the same step on the stairs, so to speak, you can work on your own step and then you get further."*
> (Interviewee 7)

In summary, the individual knowledge flowing into the teamwork relied on the composition of the team. Furthermore, the members' initial approach towards the MDC, as influenced by their individual background and beliefs, set the foundation for the collaboration. Once the teams were formed and the initial scope defined, the collaboration towards creating knowledge and achieving the project goals began. Here the individual knowledge of the members was used in interactions, which leads to phase 2.

4.2 Phase 2: Knowledge embedded in interactions

In the second phase the team cocreates the knowledge; an interactive process enabled by the team developing a shared understanding. This shared understanding builds on their relationships, alignment on goals, and (newly) developed methods of communication. As Figure 4 shows, the phase can be clustered according to the three knowledge processes of knowledge sharing, generation, and integration with the aforementioned enabling factors impacting the processes throughout. In other words, the individual knowledge from each member is mobilized, enriched, and engrained in various project outputs. This section first explains the way the team mobilized their knowledge in interactions through knowledge and learning processes. Then, the factors enabling these processes are presented under the theme of developing a shared understanding.

Figure 4: Model of Phase 2



4.2.1 Knowledge processes

As the projects built on the combination of different knowledge into one output, successful **knowledge sharing** within the team was integral to the projects' success. Most interviewees saw the value of knowledge sharing and reported on various strategies to facilitate this process. Knowledge was shared either actively by updating team members on progress or sharing relevant domain expertise or passively by responding to questions and help requests. As members often worked on tasks from separate domains independently, updating each other on current work became incredibly important but difficult. Being aware of what everyone is working on allowed members to reach out to the right people with their questions and raised awareness of the project context and timeline. To achieve this, regular meetings were set in place by most teams, where the (sub)team came together to update each other on individual progress and align on where intersections between the domains were necessary. In addition to the meetings, teams used Jira boards, Gantt charts, PowerPoint slides, or other forms of tracking progress as a base to align on and sort out interdependencies.

> *"I think the biggest challenge is to keep providing everyone with sufficient information. The moment a certain discipline somewhere changes something, how is that communicated to other disciplines who might also have an impact on that? That's really tricky, to avoid being in a consultation culture that you have to consult with everything. Of course, we have also pulled different consultations apart, with everyone doing the same thing for their own discipline. And this does give rise to the risk of doing things in parallel, and that one discipline does know and that this is not communicated properly. Or that they indeed have an assessment, oh well, you know this is only relevant for me*

and later it turns out that even more people had an impact on it. And then it is often too late, then you have made two designs with both assumptions that you are doing a good job, and together it doesn't add up. I do think that's a challenge within discipline working and multidisciplinary working, providing the information."
(Interviewee 15)

"So a lot of information is missing because everyone tends to be overloaded and they are not keeping each other informed enough."
(Interviewee 11)

Many teams met weekly for this purpose, whereas others, especially those who followed agile methodologies, had daily stand-ups. Such structures were seen as beneficial and allowed members to exchange information regarding their parts as well as created opportunities to combine knowledge. In those same meetings and in informal interactions in the team, domain knowledge was explicitly shared between the disciplines if it became relevant for the task or context at hand or informed the individual's perspective on a decision. Interviewee 8 describes this:

"Something like 'hey, we have this task but actually I already tackled it. In the previous project we did this, this and this or I did it in this way, maybe it is something we can also implement here.'"
(Interviewee 8)

Especially, in the active knowledge sharing processes the question of what knowledge was shared heavily dependent on what the individual deemed important and relevant. This sometimes could mean that the full story was lost, and one party ended up missing relevant information to both understand the other's perspective and the subsequent decision.

"Sometimes I also notice that sometimes they don't even think that it is something worth communicating. And it also can create some struggles."
(Interviewee 3)

In many cases passive knowledge sharing occurred when knowledge was proactively asked for or collected by an individual in order to e.g., inform a task they were executing. Interviewee 8 expands on this knowledge sharing through questions stating:

"So you ask a lot of questions. Sometimes I think I posed my question very clearly, but apparently not clear enough. So you learn to ask questions in different kinds of types of ways."
(Interviewee 8)

In specific cases where a team member encountered challenges related to a different discipline's domain, knowledge was shared in the context of help requests (i.e., A asks B to help them with a certain task or process).

"If we're stuck somewhere like some help requests some questions to each other so we know who is doing what, and also if there is some help that... we need all the help that we can offer. Then again, it's an exchange on this level."
(Interviewee 3)

If the teams recognized gaps in their knowledge that needed to be filled, they engaged in the process of **knowledge generation.** Here, teams drew upon internal and external resources to produce new knowledge. Internally, knowledge generation ensued through work sessions, where information was combined. Interviewee 9 describes an example where they had initially independently worked on generating knowledge needed for the final output but ended up having a work session instead to combine the different perspectives to generate new knowledge:

"But also I cannot do anything with this [initial input] basically. So we went back to the drawing board. We just had these conversations. It was... I just let them talk and I was writing it with them, and it took a couple of iterations."
(Interviewee 8)

One team even mentioned bringing in an additional member to fill a knowledge gap, while another team brought on people for specific tasks throughout the process. Interestingly, the teams in company 2 strongly emphasized the benefit of being able to access new knowledge through the social networks of other team members or colleagues from their department.

"[I said] if you know someone who can help me or where I can find the information, please let me know and immediately I got the response from a colleague: 'hey this person is working on this task so ask her'."
(Interviewee 3)

Interviewee 9 describes their process of acquiring new knowledge by interviewing members of the target audience of the learning solution, which was met with some hesitation by the other disciplines in the team:

"So I said... I think, and we usually do that it's very important that we actually speak with the people that are part of our target audience. We want to make it a learner centered curriculum and they were very... they were not against it, but they were very... they were holding back. They had a lot of concerns, because they mentioned: Yeah, but those people don't know it yet. So how can they tell you what they need? [...]. And maybe they say something to you. You take it too hard and then you will end up doing the wrong thing. You will not end up doing what is needed, so they were very hesitant. That's maybe the right word, they were very hesitant about it but I pushed through a little bit, I said let me just do the interviews. I will in any case connect with you about what they what they shared. [...] So in any case, it will be very helpful and they were like, yeah, OK. OK. OK. Then let's proceed. So we did the interviews. And then it was the other way around where they were like, yeah, this was really useful."
(Interviewee 9)

One of the most important parts of the MDC related to **knowledge integration**, where knowledge was integrated into the project output(s) through collaborative team sessions and review loops. Some teams closely worked together to integrate the knowledge, while many had one or two members taking over the integrator role. This integrator was tasked to collect information from the different disciplines and integrate it into one output. Interviewee 9, who held this role in the project, described this process:

"And then we also defined... for the learning for the technical content, both one person is doing the integration. Basically, so that's me and that's one person from the other organization and we do a lot of iterations and then when we think OK, now it's a draft version like a minimum viable product."

(Interviewee 9)

Even when only one person was responsible, review loops were essential to ensure knowledge from the different disciplines was sufficiently integrated and considered.

> *"The main thing that I learned is to align on a more than regular basis than you usually would, I think. Because I have to connect my knowledge to a completely different area of expertise, I need to check with them: You know, does this make sense? Is this the right solution?"*
> (Interviewee 9)

Gathering the input from all the different disciplines involved further helped keep the team on the same page as Interviewee 8 expands:

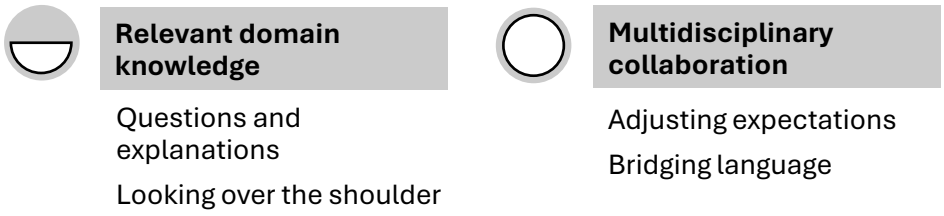
> *"When you bring them along like 'hey I have this idea what do you think?' [...] 'this is the first draft, what do you think?' And it helps to cocreate something even though the input from other people might be quite limited sometimes or its not necessary to have a lot of input, but still it is possible to be on the same page let's say."*
> (Interviewee 8)

Overall, knowledge integration posed a complex process often handled by either one person or a subgroup of two or three members of the different involved disciplines. Interviewees stressed the importance of review loops to ensure accurate integration of all relevant knowledge.

4.2.2 Learning processes

Interviewees explicitly described two themes of learning processes: learning domain knowledge and learning how to collaborate in MDTs. Figure 5 shows these and their associated aspects.

Figure 5: Overview of learning processes



Interviewees varied in their interest to learn disciplinary knowledge. Some explained they were not as involved in the content of the other disciplines as they respected them to be the experts and knew they simply could not reach that level of expertise, while others expressed interest and curiosity. Nevertheless, almost all agreed on the immense value of **learning domain knowledge** relevant for their own work. Where they could translate skills, expertise, and approaches to their own function and role, members were eager to benefit from the diverse expertise in the team. Interviewee 3 explains their reasoning for focusing only on knowledge relevant for their understanding and work:

> *"I prefer to have good experts and to establish the relationship and go to work processes with the experts to gather the information to ask right questions instead of going myself deep in the context. [...] You do remember some of the technical information of course, especially like the high level, which is helpful to understand the processes and the*

company. But again, because it is useful it sticks and because it helps me to make sense of the organization of the processes that are going on and also my target audience. That's why it also sticks and sometimes, like, ok, I do want to learn about it, but again, it is more on high level."
(Interviewee 3)

Such knowledge was attained primarily through processes of asking for explanations and clarifications, as well as "looking over the shoulder". If a member saw or heard something they found useful for their own work, they would approach that person and ask them to explain the process or even share the resources (e.g., presentation slides). Through these clarifications they could then learn knowledge outside their own domain from their member. Interviewee 3 elaborates on their experience with this:

"So basically when I see something that other person did and like 'Ohhh, that's kind of interesting. How did you do this?' Or for example, if I see [...] nice way to present something, I can ask this person like 'hey, how did you do this?'"
(Interviewee 3)

Next to the domain knowledge, an important learning process revolved around the knowledge of **how to collaborate** in a multidisciplinary setting. As interviewee 8 states: "I learn on the daily basis, it's not just about the technology, but also about how to collaborate together". This included strategies of how to approach interactions, ways of communicating (e.g., storytelling), and skills like active listening. Two main processes occurred here: adjusting expectations of each other and the teamwork and learning how to build a bridging language.

Interviewees who had prior experience working in a multidisciplinary setting, either through their educational or professional background, had more realistic expectations. They saw more clearly the benefits but also challenges of MDTs and had experience in how to approach such teamwork and communication. In team 4 colleagues, who had prior experience working in MDTs, from the beginning on expected challenges regarding the different languages spoken between the disciplines. Interviewee 9 however, for whom the current project was the first experience extensively working in an MDT, expressed going in with expectations that they later on discovered did not represent the reality of MDC:

"When we started out, they told me, yeah but this will also become quite challenging because you know, we speak two different languages and it's like, yeah, I know we speak English and we speak Dutch, right? But we all know this is the goal we're working towards; we will be fine. And then in the first couple months we struggled quite a bit because we found out we were really speaking two different languages."
(Interviewee 9)

Indeed they reported learning to adjust their expectations of what multidisciplinary collaboration entails through their interactions with the team. Next to adjusting expectations of the teamwork itself, members also challenged their expectations and assumptions of the other disciplines. For example, interviewee 8 described how there is often a traditional view on what learning is that had to be challenged. It worked the other way around as well:

"Because when I started, I knew additive manufacturing as like the printing plastics that people have at home in their attic for a hobby and not metal high-tech parts that are in our big complex systems. So it [challenging assumptions] was the other way around as well."

(Interviewee 8)

Importantly, members learned how to develop a bridging language. Through getting to know each other and learning about how to communicate with each other to bridge gaps in vocabulary and knowledge members learned how to approach teamwork to create a language that everyone can understand. For example, interviewees learned the benefits of storytelling and how they could use stories to communicate specific domain knowledge to other disciplines.

In general, the learning aspect of multidisciplinary collaboration was highly appreciated by the interviewees. Most understood the teamwork as a learning curve as over time teams learned to work together, understand each other, and draw on the available knowledge to achieve their goals.

4.2.3 Developing shared understanding

The team interactions in which the knowledge of the individual members was embedded built on a shared understanding within the team. Under the theme of developing this shared understanding, interviewees stressed the importance of trustful relationships, using the project goal as a compass and communicating their thinking process through stories. These factors enabled the team to arrive at a shared understanding of essential topics such as the project goals, the contribution of each discipline, and the roles of team members. A shared understanding was deemed essential as it ensured the team was on the same page and prevented misunderstandings between the members.

Open and **trustful relationships** were considered essential to facilitate this. Since the teams had to deal with gaps in knowledge between the disciplines, members could not easily evaluate another discipline's opinion and decide what weight it held. Consequently, the team needed to trust each other and specifically each other's expertise. Where the respect was present, members might still be hesitant if they did not see the value of something based on their own perspective, however trusted each other to make informed decisions in their own domain. In some cases, interviewees expressed from the beginning on simply trusting the other members to be experts in their fields. However, some noted that trust was built through members proving themselves by producing good work. Interviewee 10 explains how this process played out in their team talking about hesitations of other members:

"So if at the beginning there was some questioning for certain decisions, now they are gone because with work... you see the work that is delivered, that is good quality, that is answering the question, the task in question. And yeah, the worries are gone."
(Interviewee 10)

Teams utilized multiple strategies to develop these relations. However, while some teams participated in e.g., team building activities and reflection sessions throughout the year, it became apparent that the most important way of creating a good foundation of relationships was through open and honest discussion. Interviewee 10 expands on this:

"I believe that I work with very competent people. And I know that what they are putting into the project, they have reason for that. If I don't agree with that... I mean it, it hasn't happened not to agree, because that is their professional opinion, which I need to respect. If I have a bit of a different opinion, then we discuss it and I explain myself why I think there might be also another solution. They explain themselves. Then we decide where we meet."

(Interviewee 10)

Personal relationships helped ease such discussions. Here, a good balance of informal and formal communication was needed. This meant that next to the formal work sessions and meetings, informal interactions allowed the members to get to know each other beyond the context of work. Such informal interactions often also allowed the members to get a better understanding of each other's domain and expertise, interdependencies in the team, what the person is currently working on, and potentially struggling with.

"What I've learned is that I need to actively seek out people and talk to them also outside of simply the structured meetings. [...] There's a huge value in just meeting up with people and just chatting with them. More informally, I would say. [...] I've had many, many times where you're just chatting to someone and then all of a sudden you have this light bulb moments of ah, so we're linked in that way and that's something that you can't always achieve with structured meetings."
(Interviewee 7)

Most teams reported developing closer relationships over the course of working together as they got to know each other, increasingly understood others' perspectives and overcame challenges in the project together.

Due to the differences in focus and background, teams sometimes dealt with a misalignment in goals and priorities. To cope with this, members primarily used the project **goal as a compass** and tool to align the team. Conflict could arise as members followed different focuses based on their own (disciplinary) background. For example, members naturally tended to see certain decisions from the perspective of their own discipline. Over time the teams learned how to balance the different views and project needs, however as Interviewee 3 elaborates disagreements still happened:

"If the goals are different of different people, then it can be misalignment. Or for example if I have an idea and I know that it can be realized, but another person sees that OK, we can realize it, but it is quite difficult... It costs quite a lot of time... Shall we go to an easier solution? And this easier solution maybe does not fit my idea then it can be conflict in terms of: OK, I want this, I don't wanna do this, and how to find the common ground."
(Interviewee 3)

Additionally, as the members did not only follow the leadership of the project lead, but often also had what was called an organizational manager, priorities could differ. For example, some interviewees mentioned communicating with their colleagues outside of the project about their department's goals and considering those when working in the project. Outside roles therefore influenced individual priorities within the team. In cases where this was not communicated transparently or clashed with either the project goals or goals of others in the team, misalignment occurred.

"Sometimes there are also political problems because when you have multidisciplinary teams it usually means within the organization these people [are] sitting in different organizational teams. [...] Then they have different managers, and it can also be different KPIs, different focuses, different priorities."
(Interviewee 8)

To overcome this, as Interviewee 8 puts it, members would "translate that [project goal] to [their] own personal vision and mission or team vision and mission". This helped them balance their own function and discipline with the objectives and level of the team. Furthermore, using the goal as a golden compass helped the team align. Teams repeatedly talked about the goal to develop a "shared agreement" (Interviewee 4) on the project direction. This direction guided decision-making. In such discussions members, or often also the manager, would circle back to the core goal and value of the project to get everyone on the same page. The manager played an important role in this. They set and communicated the goal to the team and often played a mediating role when misalignment occurred. Interviewee 4 summarizes their role as a manager in this regard:

> *"It's getting people aligned on what is it that we're trying to achieve and why is that important for the company, for the greater whole, but also, why is that important to each one of us? [...] And then start building from there and from both sides. So what can you bring that adds value? But also, what would you like to take out of this professionally and or personally that gives you the drive to want to engage with this? [...] So having a sense of purpose is a sense of direction and a sense of purpose is the core of anything."*
> (Interviewee 4)

Lastly, throughout the team interactions the interviewees' approach to communication stood out as most learned to communicate in a similar way over the span of their project. This way of communicating can best be named **storytelling** and encompasses members communicating not just their final perspective or decision, but instead taking the team along their entire thought process. The need for this type of reasoning stems from the challenge to understand each other's languages.

> *"I once had this master class from a professor who said it's very interesting we start off as kids and we all speak the same language and we learned together and then we spend a lot of time in high schools and universities to learn a specific language that nobody else fully understands. And then we need to have people who explain to each other what it is that we mean when we're talking about things and everybody thinks: No, what I'm talking about is completely natural and normal. It's really not even within learning, we use so much jargon. So much can get lost in translation."*
> (Interviewee 4)

To bridge this gap members started explaining their entire thought process so that others would be able to follow along even without sharing the same background knowledge. While often the thought process was simply verbally explained, many also reported using presentation slides to better visualize and convey their message. This way of communicating was adopted throughout all three of the knowledge processes. After explaining two cases, where other disciplines were hesitant about a procedure and the team had to deal with a gap of understanding, Interviewee 8 reflects on how over time it has become easier:

> *"We always say learning talks business and business talks learning. So we try to get to speak each other's languages and I think these are two examples of, you know, the hurdles that you take in practice to get to that point. So we had some more of those situations over the past months and now we are at the point where we are really on the same level, and we are fully aligned, and we know... and we understand each other. When we say something, we know what they mean."*
> (Interviewee 8)

Evidently, members learned to express themselves through storytelling, a process that became more natural with a growing understanding of each other's language and the complexity of MDC.

4.3 Phase 3: Co-created knowledge retained

The third phase discusses the team finalizing and presenting the project (outputs), reflecting on the process, and retaining the co-created knowledge based on the learning processes. This section explores these processes and describes the different ways teams finalized their projects.

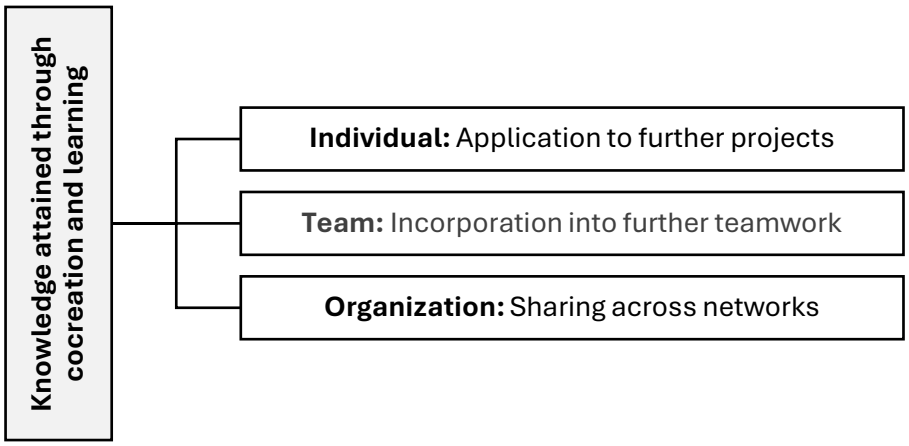
4.3.1 Finalization of project

Teams differed in the way the project or project phase (e.g., development phase) was finalized. In some of the teams the intermediate project outputs with the integrated knowledge were combined into one final output (e.g., an online platform). Others, for example, finalized the project by presenting the milestones and results to core stakeholders. Furthermore, some teams ended their collaboration with the end of the project, whereas others either continued to the next stage in a longer project or moved on to a next project with the same team.

4.3.2 Knowledge retention

In which situation the project was finalized impacted the retention of knowledge. Teams continuing to work with the same team had an easier time retaining knowledge regarding the collaboration, while others focused on translating lessons learned to new contexts. Figure 6 depicts the processes and levels of knowledge retention.

Figure 6: Knowledge retention overview



Cocreated knowledge and lessons learned from the collaboration were retained on three levels: the individual, team, and organizational level. On an **individual level**, members retained knowledge relevant for them and translated the attained knowledge to further projects where possible. Already in the learning process members would think of ways the knowledge available to them through the team could benefit their further development and other work. For example, Interviewee 10 describes applying the knowledge they have gained from collaborating and learning from the education discipline in the team to improve their presentation skills in their own work.

> *"I always liked working with the different background of people because they definitely do not think the way I'm thinking about certain things. […] In this case they are bringing their own skills into the project and it's always nice because I think also for my profession then you have a bigger picture about the topic, which in this case is 3D printing combined with education. I, for example, do presentations very often about 3D*

printing, as one of the tasks that I have, and this kind of view helps me of how I present, how I explain stuff. So personally I learned a lot of things on the project."
(Interviewee 10)

As they knew their upcoming projects would require them to hold presentations communicating their knowledge and work to stakeholders of new projects, they made an effort to learn the relevant knowledge and retain it. Some interviewees approached this retention by incorporating the perspective they learned to understand, while others relied on codified knowledge in forms of notes, databases, or resources their teammates had shared within the project.

In cases where the team would continue working with each other after the completion of the project (stage), knowledge was retained in their interactions, relations, and codified documents (e.g., shared presentations, databases, reports). Teams specifically aimed to built upon the better understanding of each other's perspectives and the knowledge created together in further project (stages). On the **team level**, knowledge was therefore easily retained if the team continued to work together. However, as many teams were project-based, this was not always the case.

Finally, on an **organizational level**, knowledge was retained through individuals sharing the lessons learned across their networks within the organization. When providing advice to colleagues, members would share their experiences from the collaboration in their team. For example, interviewees reported sharing success and challenge stories with colleagues from their own department or field. Some teams even described formal sessions within their department solely for the purpose of exchanging knowledge learned:

"In our organizational team we have bi-weekly meetings where one part of this meetings is also knowledge sharing. So we're telling the stories about... Yeah, some interesting stories about our projects... For example, that was the challenge, that's what we need, that's how it was resolved."
(Interviewee 3)

In some teams, especially those focusing on learning and development, the project output was codified knowledge that could then flow into the organizational knowledge base and inform the work of other teams. In this way, the cocreated knowledge directly contributed to the organizational capital.

4.4 Summary of findings

After an in-depth analysis of each of the three phases, this section summarizes the determined enabling factors, described processes, and connects the phases through the achieved outcomes. Table 3 depicts this overview of the findings.

Table 3: Summary of findings

	Enabling factors	**Processes**	**Outcomes**
Phase 1	Knowledge diversity fitted to project needs Clarity of project and role Open approach to MDC	Project formulation Team formation	(Initial) project scope & goal Team composition and structure

Phase 2	Developing shared understanding - Relations of trust - Storytelling - Goal as compass	Knowledge processes: Sharing, generation, and integration Learning processes	***Co-created knowledge*** Integrated project outputs
Phase 3	(Organizational) focus on learning (Individual) interest in learning	Finalizing output(s) / stage(s) Knowledge retention	Completion of project (goals) Enrichment of knowledge bases

The **first phase** revolves around the set-up of the project and team with the knowledge domains of the individuals (human capital) as the core focus. This phase includes the processes of formulating the project, setting goals and scope, and forming the team according to the needs of the project and the availability and interest of employees. The processes are enabled by the fit of the knowledge diversity to the project needs, the clarity of project and role, and an open approach to multidisciplinary collaboration. The open approach to MDC heavily revolved around the individual's background and beliefs. At the end of phase 1 the initial set-up of the project is done, and a team has been formed. In the **second phase** the knowledge of the individuals flows into the interactions in the team (social capital), where knowledge is shared, generated, and integrated. The phase encompasses these processes along with the learning processes of the team. Relations of trust, communicating stories of thinking, and using the goal as a guide for decisions and discussions enable successful knowledge co-creation. These factors can be grouped under the theme of developing a shared understanding, where the team benefits from being on the same page and learning to understand the differing languages within the team. The outcome of this phase is co-created knowledge and the related project outputs, e.g., a report or a presentation made for stakeholders that integrates the co-created knowledge and perspectives of different disciplines. The **third phase** describes the processes of the finalization of the project or a distinct project stage and the retention of the co-created knowledge and lessons learned regarding multidisciplinary teamwork. Here, knowledge is retained on the levels of the individual, team, and organization. To successfully retain knowledge teams deemed a willingness to learn and the organizational focus on learning from experiences as crucial enabling factors. The outcome of this phase is both the completion of the project or achievement of project stage related goals, as well as the enrichment of knowledge bases through the retention of co-created knowledge. All in all, the findings show a model of knowledge co-creation enabled by individual's openness, the development of a shared understanding, and a willingness to learn from the process and developed knowledge.

5. Discussion

The findings provide relevant insights for theory and practice regarding MDC for knowledge co-creation. This section begins with the implications for theory, mainly the contributions to intellectual capital theory. Next, 5.2 discusses the implications the findings have for practice and 5.3 presents the limitations of this study and related future research directions.

5.1 Implications to theory

Intellectual capital theory (ICT) has been used in a variety of research contexts to understand the way knowledge is processed, created, and applied. This study shows that the theory can also provide a suitable lens for the phenomenon of knowledge cocreation through collaboration in MDTs. The findings of this study and the three developed phases allow an extension of the knowledge co-creation model in MDTs through the addition of key collaborative factors and the

lens of intellectual capital theory. The implications of this are presented in this section structured according to the three phases.

5.1.1 Phase 1: Individual knowledge domains

In the **first phase**, one can see the influences of the individual's knowledge and background, i.e. human capital, that flow into the team. Intellectual capital theory here talks about a distinction between specialists and generalists (Kang & Snell, 2009). While one could postulate that through multidisciplinary collaboration specialists might become generalists due to e.g. boundary-spanning interactions (Kelly et al., 2011), this has been found to not always be the case. Instead it seems many choose to stay in their own specialisation. Rather than branching out and gaining knowledge from other disciplines, many members enrich their own domain knowledge through adapting knowledge from other disciplines that is relevant for them into their own discipline. However, there is a clear need for a generalist in the team as interviewees reported the value of having someone with an overview of the project, interdependencies between the disciplines, and general understanding of everyone's discipline. In many teams this role was fulfilled by the manager, however in some teams one or two team members took on the task. These "integrators" need to indeed move from a specialist function to a generalist one, which can be challenging. Kelly et al. (2011) previously criticized the generalist versus specialist distinction as being "too rigid" (p.620) and in their research found that individuals often make the choice and may develop to be able to "move between specialist and generalist roles" (p.607). Indeed this might be the case in MDTs. Generally, research on intellectual capital theory has not sufficiently mapped out the road people take to move from specialist to generalist, especially in a multidisciplinary context, which appears to be highly facilitating for this process. Future research could investigate this process, the motivation for initiating it and the influence the individual's background (e.g. past experiences across disciplines) has on it. In general, the human capital included in MDTs holds great importance as it has to correctly reply to the project needs, while also accounting for the more interrelation aspects of teamwork (i.e. a fit of personalities).

Knowledge co-creation does not occur in a vacuum but instead relates to multiple contexts on the levels of the individual, team, organization, industry, and even country (i.e., culture). Many of these factors relate to the individuals' background and domains (i.e., human capital) and initial set-up of the team. On an individual basis, personality, culture, and past experiences all influenced members' beliefs and approach towards multidisciplinary collaboration. A finding mostly supported by literature as the effect of individual beliefs on the teamwork in MDTs has been examined by literature (e.g., Supper et al., 2014). However, literature most commonly highlights the individual's history of collaboration as determinant for their beliefs and view (Bronstein, 2003), while the aspects of personality, professional background, and culture have not been given the same attention. The findings show though that a curious personality can lead to members choosing a more open approach to collaboration and one could argue that someone having worked in more than one domain or discipline can provide them with an advantage in understanding how to translate knowledge across disciplines. Additionally, the impact of different cultures on teamwork and performance has been found by literature (Dunkel & Meierwert, 2004), but has only limitedly been investigated in the context of multidisciplinary teams. Future research should aim to uncover the concrete effects of such context factors to contribute to a clearer understanding of the complexity of knowledge cocreation and teamwork in MDTs.

5.1.2 Phase 2: Knowledge embedded in social interactions

The **second phase** builds on the mobilization of human capital into social capital (i.e. knowledge embedded in interactions and relations). Interesting in regard to SC is the process of knowledge generation. A vast majority of the teams reported drawing from their own and their team

members social networks to access (missing) information. In traditional teams the social networks of the individuals within the organization (internal SC) likely often overlap as members e.g. belong to the same department, which may lead them to more often branch out to external networks (external SC) to acquire information. In contrast, MDTs have access to widely spread out internal social capital through their social networks across multiple disciplines and therefore often various branches of the organization. This could be another benefit of MDTs not yet explored in depth. Further research should be conducted into the processes by which the decision to draw on external social capital versus internal social capital is made. Furthermore, the differences between ISC and ESC in terms of e.g. benefits and risks should be explored in the multidisciplinary setting.

The findings of this study agree with literature on the importance of developing a shared understanding in teams (e.g., Bittner & Leimeister, 2014). Interestingly a critical aspect for this reported across all teams was that members of MDTs adjusted their way of communication towards **telling stories of their thinking process**. Members reasoned that this helped them better understand each other's point of view as it familiarized them with the unfamiliar background knowledge influencing someone's opinion. In traditional teams with one common discipline, members likely speak a similar language, follow a similar thinking process, as taught by their education, and often do not need the additional insights to understand. In contrast, in MDTs disciplines do not share the same language but, as the findings show, over the course of working together nevertheless learn to understand each other. Storytelling could be an essential means to achieve this. Storytelling can be defined as "sharing of knowledge and experiences through narrative and anecdotes in order to communicate lessons, complex ides, concepts, and causal connections" (Sole & Wilson, 2002, p.6). Literature has looked into storytelling as a form of communication describing it as one of the most ancient modes of communication (Housley, 2003; Tesler et al., 2018). It has been argued that the rise of attention on storytelling comes from the shift from analytic communicative forms to those allowing organizations and teams to synthesize (Katuščáková & Katuščák, 2013; Sole & Wilson, 2002). Due to the diversity in expertise and information needed and present in MDTs, it might be that they more strongly need to synthesize. In other words, individual members and disciplines might analyze on their own and then synthesize in team interactions causing them to more strongly rely on a synthesizing communicative form in their collaboration, such as storytelling. Future research should investigate this. Moving away from reactive storytelling (i.e., unplanned stories told in e.g. social interaction), Tesler et al. (2018) tested the effect of planned storytelling interventions and found a positive effect on teams' shared mental models and thereby indirectly team performance. Team mental models sharedness has repeatedly been noticed as an important element of multidisciplinary collaboration (Bierhals et al., 2007). Such planned interventions could therefore be a beneficial strategy for MDTs. Here, storytelling is viewed not as an occurrence but as a skill that can be trained and developed. Organizations could invest into storytelling through such interventions, as well as through developing codified knowledge built on this communicate form. Sole & Wilson (2002) here for example name the practice of creating online databases with employees' stories. Future research could look into the design and benefit of such planned interventions for multidisciplinary collaboration.

While there has been research into storytelling as a form of communication and learning, it has only limitedly been investigated how this plays out, specifically in MDTs. However, what is known proves the benefit of storytelling for MDC. Sole & Wilson (2002) list five core purposes of storytelling: 1. Share norms and values, 2. Develop trust and commitment, 3. Share tacit knowledge, 4. Facilitate unlearning, and 5. Generate emotional connection. These purposes directly correlate to the enabling factors and aspects of MDC found by this study. To illustrate, trust and emotional connection (i.e., personal relations) were consistently highlighted by

interviewees as necessary requisites for successful collaboration. Storytelling can work to develop these (Sole & Wilson, 2002). MDTs face the struggle of expressing core opinions without too heavily relying on disciplinary terminology and language, which storytelling can respond to (Tesler et al., 2018). Research has found that stories offer a great way to convey complicated, 'deep level' meaning through "a more accessible surface-level structure" to translate the meaning across disciplines and thereby can aid communication in multidisciplinary settings (Bartel & Garud, 2009; Tesler et al., 2018). Nevertheless, the application of storytelling is not yet sufficiently explored. Questions regarding how these processes play out and how members create such disciplinary-spanning stories are left unanswered. Future research should therefore look into how teams use stories to communicate and what factors influence this process. Future research could examine the differences between disciplines in how they approach communication, which tools they use, and how storytelling aids their learning from the MDC. Furthermore, it would be interesting to know what knowledge is shared and combined through storytelling and what information is simply stated. All in all, it can be concluded that storytelling was collectively deemed an important strategy in multidisciplinary collaboration and therefore deserves further attention by research.

Intellectual capital theory has stressed the **importance of the dynamics and relations** between members for social capital within a team. This study supports this statement emphasizing the relevance of trustful relationships and honest communication. Literature on multidisciplinary collaboration has repeatedly highlighted the aspect of trust (Fong, 2006) and the characteristic is also a part of Fong's knowledge cocreation model. Evidently, it deserves strong attention by research and practice. Much of the literature on MDTs has been conducted in the field of healthcare, where many highlight the power imbalances in such collaboration (Saint-Pierre et al., 2018; Supper et al., 2014). However, this research into MDC in the business sector show a lack of such power imbalances and instead found interviewees stressing the importance of respecting each other's expertise. Instead of a perceived hierarchy, often with a surgeon on top and nurses at the bottom (Supper et al., 2014), members believed in the necessity of respecting each other's professional opinion and trusting each other's expertise. One could argue that this difference between the sectors influences the processes and presence of trust within the team. Future research could look into this contrast with the lens of power structures as mediators for trust's positive effect on knowledge cocreation or the development of social capital. In intellectual capital theory, trust has been researched as a dimension of social capital (García-Sánchez et al., 2017). Future research could follow this dimension when researching its importance in MDTs.

Regarding the impact of context on teamwork, interviewees furthermore talked about the effects their company undergoing changes, the diversity in national culture throughout the team, and the values of the organizational culture had on their teamwork. For example, one organization strongly valued challenging each other in collaboration, which was reflected in the team processes. The teams would more openly challenge each other's views and engage in critical discussions, which helped them integrate knowledge. Such aspects of organizational structure and culture influence MDC but have not been examined much by literature. On a team or project level, the project methodology used, and the resulting structures and strategies also influence the teamwork. A few of the teams followed agile methodology, where many frameworks include daily meetings to update each other and set the direction for the day (i.e., standups). This structure provided the teams with an opportunity to update each other on work, an important process of knowledge sharing. Few studies have investigated the usage of agile methodology for multidisciplinary collaboration; however it is argued to have potential with Hermsen et al. (2020) naming "knowledge transfer, stakeholder inclusion, and removal of barriers to interactions" (p.211) as core potential benefits. Further research could compare different project

methodologies in multidisciplinary settings, or specifically the usage of agile methodology for MDC.

5.1.3 Phase 3: Retention of co-created knowledge

The output of the second phase, cocreated knowledge, is used to reach the project goals in the third phase. The results show that members often learn a lot through MDC. Literature supports this benefit of MDTs for expanding one's own understanding through the interactions with other disciplines (Kauppi et al., 2020). However, while knowledge is commonly retained by the individual and in connections, Dahiyat et al. (2020) argue that organizations overlook the need to transform human and social capital into organizational capital. This study as well found a **lack of processes codifying the knowledge about MDC**. While some projects (will) end with outputs that can be shared within the organization, especially in the teams developing learning solutions, this was still rather uncommon. Furthermore, there was almost no codification regarding the very important knowledge gained about how to collaborate. One could hypothesize that this is due to the more tacit nature of such knowledge making it difficult to develop, for example, a guide to MDC. Nevertheless, such organizational capital could be incredibly useful resources and a means for the organization to better support their multidisciplinary teams. Further research should therefore investigate possible ways to codify such knowledge and examine the (potential) effects of it.

Another interesting aspect closely related to the knowledge retained in the bases, especially for teams continuing to work together after the project, is the **growth of teams over time**. Most literature has concentrated on young teams to be able to research the conflicts arising from the multidisciplinary setting. For example, Fong's (2006) knowledge cocreation model is based on their research into young MDTs. While this focus makes sense and has provided crucial insights, more mature teams offer a compelling perspective. As demonstrated by the findings, such teams often have overcome some of the challenges younger teams face (e.g., have learned to understand each other's language) and can contribute to the discussion with lessons they have learned, strategies that have helped them, and a reflective understanding of what caused issues in the first place. Likewise, it is interesting to see what challenges prevail despite their growth over time. For example, some teams have worked for a long time together and might have developed trustful relationships, but still struggle to align on one common direction. Future research should further investigate both directions to draw a comparison between young and mature teams and document their progress. This study offers a first step into this direction having researched both younger teams and more mature teams. However, empirical research, for example a long-term case study following one team, could allow literature to better map the progress a team undertakes to reach the level of maturity. In general, this research contributes to theory on MDTs by providing the perspective of more mature teams on knowledge creation through multidisciplinary collaboration.

5.2 Implications for practice

Various recommendations to practice can be made based on the findings of this study. For one, multidisciplinary teams can use the identified challenges, enabling factors, and processes to inform their practice and focus. Teams should anticipate challenges such as a lack of shared language at the beginning and the need for clear goal(s) and role definitions. Additionally, many reported dealing with an information overload, which hindered the collaboration and active feedback and integration processes. Teams and organizations should therefore aim to develop work sessions that include time for discussion with every discipline relevant to the topic instead of each discipline presenting their own part without team interactions. In some cases creating smaller sub-teams for knowledge integration might be a beneficial strategy. As the findings show the need for someone (or a small group) to take over the role of an "integrator", i.e., someone

overlooking the knowledge integration with the project direction and goal in mind, teams could work to clearly define someone to take over this role. In many cases the manager primarily held this role. Organizations could better support them in this responsibility by providing related training or aiding their development towards a more generalist function and focus (e.g., through general training in various disciplines). Another strategy might be to choose the manager based on their ability to fulfill such a responsibility.

Furthermore, the question of what knowledge should be shared and communicated should be clearly answered. The limited time often available in MDT projects means not everything can be shared, however the decision of what is shared often relies on highly subjective assessments and can lead to important information being missed. This is especially true where information seems obvious to one discipline but is not obvious to another. Related to this, is the importance of regularly aligning and updating each other illustrated by the findings and literature. Teams should have structures set in place to facilitate this process and where possible work in a fixed, shared space. This allows for more informal interactions and communications, where interviewees reported a lot of crucial connections are made and knowledge shared. Additionally, such informal interactions were found to carry a lower information overload with them, which is essential as interviewees mentioned meetings and emails fatigue.

The findings show that the team composition is mainly done based on the needs of the project. However, aspects such as personality or individual beliefs can impact successful knowledge cocreation. Of course, in practice it is nearly impossible to compose a team based both on project needs and personality profiles. However, the individual's approach to multidisciplinary collaboration can be influenced. As the findings show that an open approach with respect for each others expertise and perspective has a highly positive influence, interventions could help develop this. Such interventions should aim to convince members of the value of the multidisciplinary setting and introduce them to the expertise of the involved disciplines. This could foster respect for each other and cause members to challenge their own assumptions of each other's disciplines. One of the teams for example held introductory sessions, where one discipline presented a general overview of their knowledge regarding the project. This strategy helped the team set the ground for the process of developing a shared understanding and could be adopted by other multidisciplinary teams.

To better support MDTs in their knowledge co-creation, organizations should invest in set structures (e.g. team meetings), training opportunities (e.g. storytelling intervention or on leadership of an MDT), and codified knowledge revolving around how to collaborate. Combining the effectiveness of storytelling and codified knowledge, organizations could for example set up a database or report of employees' stories of their experiences working in MDTs. This could then be shared within the organization and help employees approach such multidisciplinary projects with realistic expectations and a database of tools to overcome challenges inherent to teamwork in such diverse teams.

All in all, this study provides rich insights into the reality of knowledge co-creation in MDTs, which combined with the developed model can be utilized by practitioners to improve their practices and reach a better understanding of how knowledge cocreation plays out and can be supported.

5.3 Limitations and future research

There are a few limitations to be considered. For one, due to the scope of this study only one method of data collection, interviews, has been used. Many have recommended drawing from multiple data sources for case studies, i.e., data triangulation (Yin, 2013), to increase the validity and reliability of the findings. Combining interviews with, for example, observations can create a

more in-depth understanding and paint a more cohesive picture. This could also be helpful as interviews provide a limited time to investigate a very complex topic. While the interviews still provided a good understanding of how teams approach collaboration for knowledge co-creation, future research could replicate the set up of this study adding more data sources and comparing and adding onto the findings of this study. This could allow them to address further contextual factors that might influence the team. Specifically, quantitative research into specific relationships postulated and effects of specific contexts could further ground the findings of this study.

Furthermore, from four of the teams only one member was interviewed, which means the view on those teams depends on the subjective perspective of one person. While the majority of the teams still provided two or more interviews, this limitation has to be kept in mind. Relatedly, the study aggregates from the individual to the team level by conducting interviews with individual team members and drawing conclusions about the processes and strategies of the team. By combining perspectives of various team members this is addressed as it creates a more accurate picture of the team and team interactions. However, it still leads to a limitation due to the subjectivity of the individual. Future research could approach this problem of aggregating from the individual to the team level by incorporating more team-level data collection methods such as observations or focus groups.

6. Conclusion

This research aimed to explore how MDTs collaborate to successfully co-create knowledge. To answer this question interviews were conducted with members and managers of MDTs revolving around their experiences collaborating to cocreate knowledge. The findings show interconnected processes surrounding the individual knowledge flowing into the teams, the processes by which this knowledge is mobilized and integrated into project outputs, and the retention of the thereby cocreated knowledge into the knowledge bases of the individual, team, and organization. The developed model viewing the findings through the lens of intellectual capital theory contribute to literature on knowledge cocreation in MDTs by adding the perspective of mature teams, the factors enabling the related knowledge processes, and the strategies by which these are approached. Storytelling, the importance of common ground and context, as well as the growth of teams over time are presented as key conclusions for both research and practice.

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Appendix A

Interview guide[1]

Background information

1. *Please introduce yourself and your role in the team.*
    a. Are you a member of the team or a manager?
2. *What is your professional background (e.g. education)?*
3. *Have you had any prior experience with multidisciplinary teamwork?*
4. How long have you been working with this team?
    a. Could you (very) briefly walk us through a typical work process in your team?
5. *How is your team structured?*
    a. Is there someone with a managerial position?

Benefits & Challenges

6. In your opinion, what is the benefit of working together with multiple disciplines?
    a. What is the benefit of having a non-hierarchical structure vs. a manager in this setting?
7. What are challenges you face in collaborating together?
8. *How do you experience the differences between the different disciplines in your team?*
    a. Could you give some examples of conflicts arising from the differences?

Collaboration

1. In your experience, what are the differences between the disciplines in your team?
2. How would you describe the goal of your team?
    a. How did you decide on the goal of the team?
3. *How closely do the disciplines work together with each other?*
4. How strong are the boundaries between the disciplines?
    a. How did this change over the time of working together?
5. How do you deal with the different knowledge / expertise of the disciplines in the team?
    a. How would you describe your discipline's contribution to the team?

Knowledge processes

6. *How do you share knowledge across the disciplines?*
    a. What are some strategies used to help this?
7. *How do you combine everyone's knowledge and contributions?*
    a. What are examples of resources you use in this process?
8. *How do you fill possible gaps in knowledge?*
    a. What resources do you draw upon to fill gaps in knowledge?
    b. Who is responsible for this process?
9. *How do you integrate this knowledge into the final output?*
    a. How do you ensure the information of each discipline is correctly integrated?
10. *How do you learn from each other in the process?*
11. How is this learned knowledge retained in the team and organization?

Relations in the team

12. *How do you ensure that everyone is on the same page throughout the process?*
13. How do you make decisions in the team?
14. How would you describe your relationship with the other team members?

[1] Core questions asked are highlighted in light grey and written in italic. Other questions show examples of follow-up questions asked.

    a. Do you feel like you can rely on your team members?
15. What is the process if someone makes a mistake?
16. What is important for the team to work together well?
17. How could the organization better support you in your teamwork?
18. What kind of support do you expect from your team members?
19. What could you improve to make the teamwork more effective?

Role of manager

20. How would you describe the role of the manager within your team?
21. What are the responsibilities of your manager in the team?
    a. Is the manager having an active role in managing the context or more people management?
22. How does your manager assess performance and quality when dealing with outcomes from diverse disciplines?
23. In what way does your manager facilitate knowledge sharing across disciplines within the team?
    a. How could they improve this?
24. How does the manager support the professional development among team members with different expertise and backgrounds?
    a. Is the manager taking different approaches in professional development considering the different disciplines?
25. Can you provide examples of how the line manager supports collaboration and coordination across different disciplines within the team?
26. Can you share positive aspects or strengths you've observed in how the manager handles the various disciplines in the team?
27. How should disagreements arising from diverse disciplines within the team be handled by the manager? Challenges what do you expect from the manager?
28. From your perspective, how does the manager balance the diverse needs and priorities of team members from different disciplines?
29. (What are competencies needed for working in a multidisciplinary team?)
30. How does the manager support the performance of individual team members?
31. How does the manager encourage contribution from all team members, regardless of their discipline?
32. Can you provide examples of how the line manager supports collaboration and coordination across different disciplines within the team?
    a. What do you expect him to do regarding this (coordinating various disciplines and achieving collaboration)?
33. What specific expectations (regarding the role) do you have from your manager in managing the multidisciplinary team?
34. What aspects could the manager improve or do differently in managing the multidisciplinary team?
35. Based on your experience, in what ways do you see the manager's responsibilities differing in the multidisciplinary team compared to a general team?
36. What are the essential skills and qualities for a manager leading multidisciplinary teams?
37. What do you think about the way the manager manages your team?

Closing questions

38. *What aspect we talked about stood out to you the most?*
39. *Is there anything else you would like to add or emphasize?*