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PATHWAYS TO DIGITAL TRANSFORMATION: THE ADOPTION OF EMERGING TECHNOLOGIES

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Abstract

The primary purpose of this thesis is to understand the impact of new digital technologies on individuals, teams, communities, or organizations. This thesis uses interpretive research to contribute to the literature on digital transformation, frames, top management teams, and online communities. In total, 116 interviews were conducted for this thesis over five years; every single interview was recorded, transcribed, and coded in my research process. This yielded over 3'000 pages of transcribed data and three studies.

The first study of this thesis, *Digital or Durable? The Impact of TMT Frames on Digital Transformation in Manufacturing Firms* employs a multiple-case approach to study the impact of cognitive frames held by decision-makers on their company's digital transformation. To develop insights into frames and digital transformation, the study investigates manufacturers that belong to the high-tech industry sector of the canton of Zurich that are employing new digital technologies. We reveal three standard frames, *traditionalist, opportunist,* and *futurist,* and three common values, *business, technology,* and *enablement,* and their impact on the organization's digital transformation.

The second study*, Taking Advantage of NFTs to Enhance Your Online Community,* results from a broad search in the blockchain space for projects that use NFTs to foster engagement in their online communities. The study presents three cases, *Avado, ENS,* and *HOPR,* that deploy NFTs to *turn their customers into support, create social belonging,* and *bridge intrinsic and extrinsic motivation*.

The third study, *Please Join Our Closed Community!*, investigates a potential online community centered around a highly complex medical device with a niche and highly educated userbase. The study presents a framework consisting of three layers required to create and sustain a confidential and closed online community in the MedTech industry: *infrastructure, roles,* and *technical features*.

Zusammenfassung

Das Hauptziel dieser Arbeit ist es, die Auswirkungen neuer digitaler Technologien auf Einzelpersonen, Teams, Gemeinschaften oder Organisationen zu verstehen. Diese Arbeit nutzt interpretative Forschung, um einen Beitrag zur Literatur über digitale Transformation (DT), Top-Management-Teams und Online-Communities (OC) zu leisten. Insgesamt wurden für diese Arbeit 116 Interviews über einen Zeitraum von fünf Jahren geführt; jedes einzelne Interview wurde aufgezeichnet, transkribiert und kodiert. Das Ergebnis waren über 3'000 Seiten transkribierter Daten und drei Studien: *Digital or Durable? The Impact of TMT Frames on Digital Transformation in Manufacturing Firms*, untersucht anhand mehrerer Fälle die Auswirkungen der kognitiven Frames von Entscheidungsträgern auf die digitale Transformation ihres Unternehmens. Um Erkenntnisse über Frames und DT zu gewinnen, untersucht die Studie Hersteller, die zum Hightech-Industriesektor des Kantons Zürich gehören und neue digitale Technologien einsetzen. Wir decken drei gemeinsame Frames auf: Traditionalist, Opportunist und Futurist sowie drei gemeinsame Werte: Business, Technologie und Enablement und deren Einfluss auf die digitale Transformation des Unternehmens. *Taking Advantage of NFTs to Enhance Your Online Community*, ist das Ergebnis einer umfassenden Suche im Blockchain-Bereich nach Projekten, die NFTs nutzen, um das Engagement in ihren OC zu fördern. Die Studie stellt drei Fälle vor, Avado, ENS und HOPR, die NFTs einsetzen, um ihre Kunden zu Unterstützern zu machen, soziale Zugehörigkeit zu schaffen und intrinsische und extrinsische Motivation zu verbinden. *Please Join Our Closed Community!*, untersucht eine potenzielle OC rund um ein hochkomplexes medizinisches Gerät mit einer Nische und einer hochqualifizierten Nutzerbasis. Die Studie stellt einen Rahmen vor, der aus drei Ebenen besteht: Infrastruktur, Rollen und technische Merkmale, die erforderlich sind, um eine vertrauliche und geschlossene OC in der Medizintechnikbranche aufzubauen und aufrechtzuerhalten.

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1 Introduction

Technology is evolving and spreading at an incredible pace, entering every aspect of individuals' lives and every part of today's organizations. The onset of artificial intelligence (AI) alone and its adoption through organizations and governments is estimated to add $13 trillion of economic activity by 2030 (Bughin, Seong, Manyika, Chui, & Joshi, 2018). Other technologies, such as blockchain and non-fungible tokens (NFTs), reached new all-time-high user numbers and valuations in November 2021, exceeding $3 trillion in total market capitalization. With the onset of blockchains and distributed ledger technologies, a new form of organization appeared, decentralized autonomous organizations (DAO) that has the potential to start a new era of organizational economics (Bellavitis, Fisch, & Momtaz, 2022). Further driving the technological change are digital platforms that have become omnipresent, paired with social media that has the power to spread information across the globe within hours, no matter if the news is fake or not (Olan, Jayawickrama, Arakpogun, Suklan, & Liu, 2022). Paired with data analytics and the ability to process vast amounts of data, such technologies have allowed companies to create new interdependencies within their organizational boundaries and with novel actors that were previously out of their boundaries (Bailey, Faraj, Hinds, Leonardi, & von Krogh, 2022).

Following Bailey et al. (2022), we treat these technologies as "emerging" since the technologies are constantly changing and designed to change and adapt in the first place and have not yet shown a recognizable and stable pattern. For example, information and communication technology had explicit purposes within organizations, such as aligning and supporting existing processes in specific parts of the organization (Coltman, Tallon, Sharma, & Queiroz, 2015). However, emerging digital technologies are cutting across organizational functions and divisions and demanding changes while enabling new, deployable processes, products, and services (Björkdahl, 2020). These technologies are moving away from a

monolithic application focus, where they serve one purpose; they have the capability to fundamentally transform organizations (von Krogh, 2018). The transformation enabled by emerging digital technologies has the purpose of leveraging them to redefine an organization's value proposition, in contrast to traditional technologies, which were used to support the existing value proposition (Wessel, Baiyere, Ologeanu-Taddei, Cha, & Blegind-Jensen, 2021).

This transformational power comes with a significant competitive advantage, where certain companies are already generating 20% of their revenue because of AI, while others struggle to capitalize on the technology (Balakrishnan, Chui, & Henke, 2020). The ability to adopt digital technologies to transform a company's products, production, operation, and even entire business models through digital transformation will be critical to prevail in future competitive environments (Fichman, Dos Santos, & Zheng, 2014; Yoo, Boland, Lyytinen, & Majchrzak, 2012).

This dissertation studies how emerging technologies are adopted across different domains. We investigate manufacturing companies and their digital transformation over three years, the adoption of NFTs in the blockchain domain, and the potential of an online community centered around a new MedTech device.

Study I of this dissertation investigates digital transformation in six manufacturing firms based in Switzerland. We employ a multiple case study approach to compare the phenomenon of digital transformation between individual cases and gain insights from observed differences (Eisenhardt, 1989a; Yin, 2013). This study is motivated by the lack of explanation in the current literature on why some companies are seemingly better than others at adopting and implementing new digital technologies. As previous researchers have shown, digital transformation has to be driven by the CEO or the TMT and requires constant support and championing (Alos-Simo, Verdu-Jover, & Gomez-Gras, 2017; Matt, Hess, & Benlian,

2015; Sebastian et al., 2017). To understand the role of the TMT and senior managers in digital transformation, we conducted 96 interviews for this study. To compare companies, we develop a metric based on implemented technologies to estimate the level of digital transformation across cases. We found that existing cognitive frames within TMT members impact their view on digital technologies. We identified three common mental frames that TMTs exhibited in our cases and showed how they impact the set of digital technologies that they consider for their organization.

Additionally, we identify three possible sets of common values used to define worthwhile projects' criteria and evaluate them. Lastly, we describe three organizational practices encountered during our study that companies used to decide what digital technologies they will adopt. Study I contributes to the digital transformation literature, the literature on cognitive frames, and finally, the TMT literature.

Study II leaves the manufacturing spaces and enters the realm of distributed ledger technology, more commonly known as blockchain technology. We are not interested in the cryptocurrency or financial aspect of tokens; instead, we wanted to find out if blockchain technology, with its smart contracts, peer-to-peer connectivity, and transparency, can solve some existing problems of online communities. We suspected that the unique ability of blockchains to provide transparency while simultaneously providing pseudonymity might overcome the existing struggles of online communities (Iansiti & Lakhani, 2017). We identified NFTs as a potential blockchain technology to solve existing problems in online communities, such as declining engagement over time, large membership fluctuations, fading motivation over time, and reliance on a small user base to provide most contributions (Faraj, Jarvenpaa, & Majchrzak, 2011; Felin & Lakhani, 2018; Lakhani & Hippel, 2004; Von Krogh, Spaeth, & Lakhani, 2003; Wasko & Faraj, 2005). We highlight three successful projects and present three possible strategies to engage online communities in specific ways to foster

engagement, create sustainability, and explain how NFTs can be leveraged to execute them. Additionally, we highlight three main challenges companies need to consider when they want to engage their community with NFTs. This study contributes to the blockchain and online community literature.

Study III of this dissertation lies at the intersection of Study I and Study II, as it explores the potential of an online community around the product of a medical device manufacturer. For this single case study, we conducted 13 interviews with users and three developers of the medical device to explore the possibility of creating an online community. While traditional online communities are bringing together many individuals, offering complete anonymity and fluid boundaries (Faraj, von Krogh, Monteiro, & Lakhani, 2016), we explore a setting with a small but highly educated userbase that requires privacy and security above everything else. We explore if this user community has similar intrinsic and extrinsic motivations to share knowledge and participate as found in traditional online communities (von Krogh, Haefliger, Spaeth, & Wallin, 2012) and what the role of the medical device manufacturer would need to be in this community. Through our exploratory research, we contribute to the online community literature by exploring a hard-to-access and rare case.

2 Theoretical and Empirical Background

This thesis studies the adoption of emerging technologies in three empirical settings. The first study examined the impact of TMT frames on digital transformation in manufacturing companies in Switzerland. In the second study, the adoption of blockchain technology, specifically NFTs, is investigated in three companies using NFTs to engage with their online communities. The third study collaborates with a Swiss manufacturer of high-end medical devices to examine the potential of creating an online community for users of a specific

medical device. This section will provide additional information on the empirical contexts of manufacturing, blockchain, and online communities.

2.1 Manufacturing

Manufacturing companies and the secondary sector play an essential role in the Swiss economy. According to data from the Federal Statistical Office, they make up approximately 15% of existing businesses and employ an equal part of the working population. While the secondary sector is often considered to be slowly vanishing, it has registered a growth of 2.3% from 2010 to 2019. It is important to note that this growth was achieved when the Swiss National Bank abolished the peg to the Euro in 2016, increasing prices for goods manufactured in Switzerland for non-Swiss buyers by approximately 20%.

For our study, we focus on the manufacturing industry in the canton of Zurich, where manufacturing accounts for 61% of the secondary sector[1]. The manufacturing industry can be classified into two broad categories: high-tech, which is characterized by high spending on research and development compared to revenue, and low-tech. The low-tech part comprises manufacturers of food, repairs, metal, textiles, plastic, and wood. The high-tech part of the industry contains vehicles, mechanical engineering, pharmaceuticals, electrical equipment, electronic products, and chemicals. We specifically focused on the high-tech aspect of manufacturing as these companies spend more on research and development and are more likely to engage and integrate new and emerging technologies.

2.1.1 Digital transformation in manufacturing

Manufacturing firms often go together with a perception of old and slow, i.e., a sense of routine and consistency (McMenamin, 2015). They seem to come from an age we left in the

[1] Source: Feder Statistical Office, Structural business statistics (STATENT), published on 25.11.2021

past, a pre-digital age with pre-digital organizations (Chanias, Myers, & Hess, 2019a). We can also see considerable criticism towards manufacturers in high-cost countries, calling government efforts to support manufacturing "manufacturing fetishism" (Kay, 2020). Indeed, the growth of "born-digital" companies such as Google, Facebook, or Amazon has made manufacturers look slow, dusty, and old. They are seen as late movers and seem to lag behind other industries such as banking, retail, or entertainment (Kohli & Johnson, 2011). Still, the reality is that most manufacturers have just recently started their digital transformation (Sebastian et al., 2017). For them, digital transformation is a complex challenge without a singular solution or outcome. It is a process that occurs across a dimension of maturity. As emerging technologies are constantly changing (Bailey et al., 2022), manufacturers will and always have to be in the process of increasing their digital maturity (Kane, 2019).

It might seem that manufacturers can adopt digital technologies by putting robots next to assembly lines and connecting existing machines to the cloud, but a more fundamental change is required. Digital technologies transform products, production, operations, services, and entire business models (Yoo et al., 2012). For manufacturers, digital transformation is a holistic business transformation, enabled through emerging technologies and followed by changes across the industry, forcing organizational change (Besson & Rowe, 2012; Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). It is, therefore, essential to have a vision and a plan that guides the organization towards the desired state of being digitally transformed (Matt et al., 2015). But who is responsible for this vision and plan?

In the near term, the CEO and his TMT are responsible for focusing on emerging technologies and how they can create value for the organization (Björkdahl, 2020). CEOs will be required to lead and challenge the status quo and commit to learning to avoid becoming paralyzed (Govindarajan & Immelt, 2019a). Seeing digital transformation as a threat might lead to inertia in routines and prevent the successful adoption of new

technologies in manufacturing (Gilbert, 2005). According to Sebastian et al. (2017), the old-school approach of divide-and-conquer that narrowly focuses on efficiencies and optimizations, the historical bread and butter of manufacturers, will not be enough to tackle digital transformation. A new mindset is needed that embraces digital transformation. In general, digital transformation is not an optional discussion for manufacturers anymore; it is already deemed the only way to survive (Govindarajan & Immelt, 2019a).

While manufacturing might face many operational and technical challenges that represent barriers to a digital transformation, no factor is more detrimental or empowering than the unseen dynamics of a pervasive mindset (Jones, Hutcheson, & Camba, 2021).

2.1.2 Frames and Technology

Cognitive frames are mental maps or a mindset that individuals use to navigate and give sense to environments that are too complex and large to comprehend otherwise (Barr, Stimpert, & Huff, 1992). Using the frame to navigate the environment might be a conscious decision (Barr et al., 1992). Still, it might also happen on a constant unconscious basis that uses frames to make sense of the changing environment (Jackson & Dutton, 1988).

Digital transformation is not the first environmental change that challenges companies; technical changes have always posed a potential difficulty (Henderson & Clark, 1990). Long ago, scholars noted that these changes bring uncertainty that challenges a company's strategy, and it is the responsibility of the TMT to respond and formulate an adequate strategic answer (Mintzberg, 1978).

Formulating such an answer might be a more significant challenge than the changing environment itself; decision-makers need to create a strategic response based on the current knowledge and uncertainty about the environment (Bower, 1970). Research in strategic management has shown that decision-makers will resort to frames in times of environmental uncertainty to help them deal with the presented uncertainty (Dutton & Dukerich, 1991).

Decision-makers use frames to sort and make sense of ambiguities in their environment (Walsh, 1995) and translate these into strategic choices that they deem appropriate according to their frame (Daft & Weick, 1984). Therefore, the response of organizations to environmental uncertainty, such as technological change, is influenced by frames that decision-makers possess (Dutton & Jackson, 1987). The consequences of coming to the wrong conclusion or response to the technological change outside might prove deadly for a company (Christensen, 2013). For instance, the well-known misjudgment of the digital imaging market and the subsequent fall of the Polaroid company Kodak have shown the importance of managerial cognition and its impact on a company's trajectory (Tripsas & Gavetti, 2000).

While decision-makers use frames for sense-making, they also use their frames through a political process to convince other decision-makers of their justification for a particular decision and to gain support for it (Kaplan, 2008). Especially in the case of emerging technologies, companies will first need to make sense of them, what they do, what they are, and how they might perform before they can act (Daft & Weick, 1984). Through this sense-making, collective frames around the meaning of new technologies will form and decide what companies will make of them and how they might adapt to this change (Kaplan & Tripsas, 2008).

2.2 Blockchain

Blockchains, or, more specifically, distributed ledger technologies, have made a significant entry into mainstream discussions with Bitcoin's first price rally to nearly $20'000 at the end of 2017. During this time, management scholars have become aware of the potential that blockchains might offer, such as lower transaction costs, transparency of ownership, and seamless and automated contracts (Felin & Lakhani, 2018). Blockchains eliminate the need for a centralized entity that verifies performed transactions or interactions; this decentralized property is ensured through network participants that function as validators, earning rewards for their validations. The proposal for such a network was made over ten years ago, but it would take smart contracts to truly start the era of blockchains (Cong & Klotz, 2018).

Smart contracts were first developed on the Ethereum chain, enabling the creation of decentralized applications that can be used in various domains such as supply chain management, automated market making, intellectual property management, or the issuance of digital identities (Queiroz, Telles, & Bonilla, 2020). Smart contracts may be the most critical and transformative property of blockchain technology (Iansiti & Lakhani, 2017) as they can be constantly expanded, changed, and upgraded, potentially changing traditional company structures (Tapscott & Tapscott, 2017).

Blockchains and especially smart contracts can therefore be considered emerging technologies, as they are constantly changing, evolving, and being integrated into more and more organizational processes (Bailey et al., 2022). Consequently, a new form of organizing has emerged in the past two years through decentralized autonomous organizations. These organizations are collectively owned and coordinated by their members, all through the opportunities and capabilities that smart contracts offer (Bellavitis et al., 2022).

2.3 Online Communities

Online communities are a form of organization that is happening in a virtual form, connected over the internet (Faraj et al., 2011). The development of online communities closely followed the development of the internet when the internet shifted from read-only Web 1.0 to the participative Web 2.0, when the first online communities started to appear (Rheingold, 2000; Tapscott & Williams, 2008). Online communities can emerge around various topics and platforms, such as content creation on YouTube, social and career networking on LinkedIn, or games such as Call of Duty (Wiertz & de Ruyter, 2007).

At the same time, online communities consist of more than the technological platform on which they are built (Howison & Crowston, 2014), as each community comes with its own sociality and set of values that members define for themselves (Faraj et al., 2016; Ransbotham & Kane, 2011). Online communities can be sustainable when members feel they can share valuable knowledge with others and the community while simultaneously being able to profit personally (Von Hippel & Von Krogh, 2003; von Krogh et al., 2012). Some online communities can even be a source of innovation in, for example, open source software development (Von Krogh & Von Hippel, 2006), making them an increasingly relevant organization and stakeholder for companies (Fisher, 2019).

Previous research has identified further benefits that companies could reap through collaboration with online communities: troubleshooting for other members (Füller, Matzler, & Hoppe, 2008), increasing demand for company products (Miller, Fabian, & Lin, 2009), and creating stronger brand commitment (Kim, Choi, Qualls, & Han, 2008). Companies using the right tactics to engage their online community can generate such benefits and ultimately increase firm performance and competitive advantage (Fisher, 2019).

2.4 Overview of Cases

2.4.1 Cases in Study I

The most significant amount of data was collected for Study I through semi-structured interviews. Over three years (2018-2021), 96 interviews were conducted in seven companies manufacturing in the canton of Zurich. Our data collection yielded approximately 115 hours of voice recordings and over 3’000 pages of transcripts. The names of the companies have been changed for reasons of confidentiality and anonymity. All the companies are export-oriented and usually sell over 90% of their products outside Switzerland.

BirdCo

BirdCo is a traditional manufacturer of springs that operates on a global scale with customers and production sites on every continent, which is unusual for a spring manufacturer. *BirdCo* produces specialized springs, offers spring development for their customers, and, in some cases, develops and builds machines to manufacture springs. *BirdCo* is the second oldest company represented in this thesis, with a legacy that goes back over 125 years, when it was founded to manufacture springs. *BirdCo* is run by its founding family, with 450 employees in Switzerland and 1’500 worldwide.

PlatypusCo

PlatypusCo is a manufacturer of high-end conductor plates sold to customers for medical and aerospace applications integration. *PlatypusCo* is relatively young, with 30 years of history, and is one of only two conductor manufacturers in Switzerland. *PlatypusCo* belongs to a conglomerate that specializes in medical technology and medical devices. It only develops custom-tailored solutions, with 200 employees in Zurich.

AntCo

AntCo represents the oldest company in our study, with over 200 years of existence and experience in building and developing complex machinery. Initially founded as a machine builder for the textile industry, it reinvented itself over time through water wheels, turbines, compressors, and engines. *AntCo* has approximately 750 employees in Zurich and now specializes in assembling gas turbines and compressors. *AntCo* is part of a vast conglomerate that focuses on heavy machinery and engines.

WrasseCo

WrasseCo is a family-owned firm specializing in cleaning technology and assembles machines and robots that can perform various cleaning tasks. Founded over 70 years ago as a manufacturer of vacuum cleaners, *WrasseCo* now sells autonomous cleaning robots powered by AI that can learn about the room that needs to be cleaned through demonstration. *WrasseCo* has 250 employees worldwide and approximately 150 in Zurich.

PyrosomeCo

PyrosomeCo is a family-owned company that builds machines used in the packaging industry. Founded over 40 years ago, *PyrosomeCo* has grown from a small machine manufacturer that supplied local customers into a global market leader in the packaging industry. *PyrosomeCo has approximately* 150 employees that build machines in Zurich and 550 employees worldwide.

MosquitoCo

MosquitoCo was founded 40 years ago as a medical device manufacturer. Today it is a publicly traded world leader in laboratory automation equipment. *AntCo* has 550 employees in Zurich and 1400 worldwide, representing the fastest growing company in our manufacturer sample.

BatCo

BatCo is a publicly traded manufacturer of medical devices and hearing aids. *BatCo* was founded over 70 years ago and would have been the largest company in Study I, with 1'100 employees in Zurich and 14'000 worldwide. *BatCo* had to be dropped from our study as it was impossible to interview its TMT members regarding digital transformation. While it was initially agreed upon, we were not allowed to interview TMT members such as the CEO, CFO, and CTO. Because Study I investigates the frames within TMT members, *BatCo* had to be dropped, as we could not collect the required data.

2.4.2 Cases in Study II

For Study II, we investigated three companies and their use of NFTs to engage their online communities. We conducted four interviews at four companies but had to drop one as it did not yield any additional insights due to similarities with another company.

Avado

Avado is a blockchain-computer manufacturer offering all-in-one solutions for users to delegate computing power, storage capacity, and internet bandwidth to validate blockchains. In 2018, during DevCon4 (an Ethereum Foundation developer conference), participants showed more interest in the device that founder Bernd Lapp's team built to support blockchains than the software they developed. From there, he founded *Avado* and started commercializing the devices.

HOPR

Dr. Sebastian Brügel founded the *HOPR* Association to provide data privacy and control to users. They developed an open-source protocol routing data via a decentralized network of computer nodes (so-called relay hops, hence *HOPR*) to protect the identity of participants. It is a decentralized protocol run by its participants (the nodes) and governed via a decentralized autonomous organization comprising all HOPR holders.

Ethereum Naming Service (ENS)

ENS was initially founded through the Ethereum Foundation by Nick Johnson in 2017. *ENS* represents an integral part of the Ethereum ecosystem, as it is the equivalent of the Domain Name System (DNS) of Web 2.0. It allows users to change their complicated addresses to human readable names by deploying NFTs.

2.4.3 Case in Study III

For Study III, we conduct a single case study with the medical device manufacturer Medima (fictional name). Sixteen interviews were conducted in this study, yielding over 120 pages of transcripts. Twelve interviews were done with researcher customers of Medima and four with developers of DeviceX

Medima

Medima is a leading manufacturer of medical analytical devices. It is over 50 years old and a publicly listed company headquartered in Switzerland. *Medima* has more than 5,000 workers worldwide with over 50 locations across continents. As one of the authors has worked at *Medima*, accessing otherwise confidential customers using a particular device was possible. These users were interviewed to understand the potential of an online community in this context.

3 Overview of Individual Studies

This thesis contains three co-authored studies that deal with emerging technologies and their adoption across different domains.

Study I employs a multiple case study approach to investigate the impact of TMT frames on digital transformation in six manufacturing firms over three years. We seek to understand how certain manufacturers are better than others at implementing emerging technologies into their organizations. For this, we draw on data from interviews conducted with TMT and senior management members of our case companies.

Study II investigates blockchain as an emerging technology and NFTs. We analyze blockchain projects and how NFTs can be used to foster engagement in online communities. We present three successful cases and how they deploy NFTs in different configurations to engage their communities to participate, share, contribute or support more.

Study III investigates a potential online community centered around a new medical device that, due to its technological capabilities in reading and creating data and code, makes the creation of an online forum interesting. We use a single case study approach to understand this highly educated and specialized userbase's expectations and motivations for joining and participating in an online community.

3.1 Study I

Digital or Durable? The Impact of TMT Frames on Digital Transformation in Manufacturing Firms

Julian Mueller, Nina Geilinger, Georg von Krogh

3.1.1 Summary of Study I

The first study investigates the phenomenon of digital transformation in manufacturing firms. The ability of firms to adopt emerging technologies, such as AI, can be crucial for their competitive and financial performance (Balakrishnan et al., 2020). In the long run, companies that fail to adopt such technologies might fail to survive (Govindarajan & Immelt, 2019b). We are interested in why some companies are seemingly better at adopting emerging technologies such as AI, robotics, 3D printing, IoT, or virtual reality, and others struggle to do so. Strategy scholars have consistently called for research on TMTs and their decision-making, as it is most relevant to a firm's trajectory (Mintzberg, 1978). While previous research has shown that the TMT is most appropriate for a firm's ability to respond to a rapidly changing environment (Beckman, 2006), and their response is crucial to a firm's performance (Day & Schoemaker, 2016; Eisenhardt, 1989b). While the research on digital transformation is growing fast, for a comprehensive review, see Hanelt, Bohnsack, Marz, & Antunes Marante (2021).

We lack an understanding of the decision-making that underpins digital transformation. It remains poorly understood how TMTs differ in the way they assess new emerging technologies and the possibilities for their own company that ultimately lead to implementation. To study these differences, we will use the concept of social frames, which dates back to Erving Goffman and his frame analysis (1974). Frames have been observed during decision-making as a means to convince other decision-makers to mobilize desired action (Kaplan, 2008) and are directly connected to strategic decisions about technology

implementations (Kaplan & Tripsas, 2008), as they can provide the impetus for change (Feront & Bertels, 2021).

In this study, we use a qualitative research approach, as it is suitable to gain a detailed account of a particular phenomenon of interest (Eisenhardt, 1989a). We take an interpretive perspective to understand how TMT members see the world and emerging technologies around them (Gioia, Corley, & Hamilton, 2013). To find differences in these views, we opted for a multiple case study that allows us to analyze individual cases and later compare across cases (Eisenhardt & Graebner, 2007; Yin, 2013). For this study, we conducted 96 semi-structured interviews at six manufacturing firms, spread across three years, with three waves of interviews. All informants were either part of the TMT or senior management that reported to the TMT. All seven manufacturers are considered part of the high-end manufacturing sector (Swiss Industry Classification) and are in the canton of Zurich, facing similar costs for capital, labor, and technology. We supplemented our interview data whenever possible through internal documents such as project documents and roadmaps and external data such as LinkedIn posts and company news announcements.

We relied on a grounded theory approach to analyze our data (Corbin & Strauss, 2014). As the within-case analysis concluded, we proceeded with the cross-case analysis (Glaser & Strauss, 1967). Using existing guidelines and industry research, we created a metric to measure the digital transformation across cases, named Digital Transformation Performance (DTP). We created three pairings within our sample, *producers, assemblers,* and *system integrators,* to objectively compare DTP based on production and product characteristics. Within our interview data, we were able to identify three *common mental frames* among the different TMTs: *traditionalist frame, opportunist frame, and futurist frame.* These were identified by coding the different ways informants explained ‘how the world is’ and how they see emerging technologies in relation to their own company.

Further, we identified *common values or* 'how things should be' that TMT members used to evaluate emerging technologies based on different criteria for choice and evaluation. These *common values* were: *business case logic, technology logic, and enablement logic*. We also identified three *organizational practices* used to make decisions or 'how things are typically done' and how they relate to the common mental frames and *values.* With our proposed model, we link the emerging technologies outside the organization to decision-making within the TMT and show the impact of different mental frames on digital transformation.

Through our pairwise comparison of *producers*, *assemblers,* and *system integrators* and their respective DTP, we can show the impact of frames on the digital transformation of these manufacturers. We show that specific frames and values are more desirable than others, as they lead to a higher DTP. With this, we contribute to the literature on frames and technology adoption and the literature on digital transformation. More specifically, we contribute to the literature on digital transformation in manufacturing and explain differences between individual companies regarding their adoption of emerging technologies.

3.1.2 Contribution of the author

I did the sampling and onboarding of the companies for this study. I collected all the data (most often accompanied by one of the co-authors), wrote the individual case descriptions, and performed all the data analysis, including creating the performance metric and constructs. I also developed the theoretical perspective and framework of this study and was involved in every stage of the writing process.

3.2 Study II

Taking Advantage of NFTs to Enhance Your Online Community

Julian Mueller, Estevan Vilar, Georg von Krogh

3.2.1 Summary of Study II

The second study investigates how engagement in online communities can be fostered using NFTs. Blockchain and NFTs can be considered emerging technologies as they are constantly being developed and changed (Bailey et al., 2022).

The early internet was characterized by its read-only nature, consisting of static pages without the possibility for interaction. It is now retrospectively named Web 1.0 by the CERN physicist Tim Berners-Lee, who wrote its first proposal in 1989. Web 2.0 would later be characterized by the interaction of users on platforms such as Youtube, Facebook, and Twitter. During this time, online communities emerged as a familiar form for actors to communicate, interact, and transact with one another (Fisher, 2019). While online communities have been shown to be a novel way of organizing, they have proven to be volatile due to large membership fluctuations and their dependence on a few core contributors (Arazy, Daxenberger, Lifshitz-Assaf, Nov, & Gurevych, 2016; Ray, Kim, & Morris, 2014). Thus, the ability to promote engagement and motivation of community members becomes an essential aspect of ensuring the sustainability and vibrance of an online community (Afuah, 2013). Web 3.0, with the current hallmarks of decentralization, openness, ownership, and immutability, might provide new opportunities to enhance and engage online communities.

Blockchain has been identified as an emerging technology to motivate cooperation and coordination within online communities or potentially change how actors collaborate (Lumineau, Wang, & Schilke, 2021). Through the novel technical architecture of blockchain, it offers new and unique ways of distributing ownership, designing governance mechanisms,

and incentivizing interactions (Schmeiss, Hoelzle, & Tech, 2019). We chose NFTs as a potential mechanism and novel technology on the blockchain to study how interactions and engagement can be incentivized to create a more vibrant online community.

To explore the application of NFTs, we drew on the general category of NFT-related projects on a popular blockchain site called Coingecko. At the time of our inquiry, the category contained approximately 200 projects using NFTs in one way or another. We screened the projects through the publicly available information on the project's website on medium.com and on Twitter. We also joined Discord servers to see if and how NFTs were deployed. We searched for projects where NFTs are an essential tool for the project's operation or strategy, as opposed to a collectible or piece of art. After identifying potentially exciting projects, we reached out to team members through Twitter and Discord to understand the project's motivation for using NFTs. We selected four distinct cases that we thought would yield the most insights into our research and conducted a 60–90-minute semi-structured interview with a senior project team member. We present three distinct cases in this study. One case was omitted due to its high degree of similarity to another one, causing it not to yield any further insights.

Our first case is *Avado*, where we interviewed the founder and CEO. This company sells physical blockchain-ready computers with custom software that simplifies the process of becoming a validator for a blockchain such as Ethereum.

Our second case is the *Ethereum Naming Service (ENS),* where we interviewed an early team member who is now a senior developer. *ENS* is the Domain Name System (DNS) of Web 3.0 and allows users to create a social identity by minting an NFT.

Our third case is *HOPR*, where we interviewed the co-founder and current CEO. *HOPR* offers metadata privacy through a system of routed peer-to-peer 'hops.'

Through these three cases, we elaborate our framework that allows for the categorization of NFT use cases based on the NFT's creation process, namely *bottom-up, hybrid,* and *top-down,* and the orientation towards the community, namely *operational, social,* and *strategic.* Our cases represent the configurations of *top-down/operational, hybrid/social,* and *bottom-up/strategic.* We identified these three configurations as the most potent and valuable to the organization in creating and fostering engagement within their online communities among all screened projects. They are represented by the three strategies our case companies follow: *turning customers into contributors* in the case of Avado, *creating social belonging* in the case of ENS, and *bridging intrinsic and extrinsic motivation* in the case of HOPR.

Our research also outlines three potential challenges we identified while investigating NFTs that organizations considering using NFTs should keep in mind: First, there is a chance of community rejection (adverse reaction and possible rejection) when the identity and values of the existing community do not line up with values shared in the blockchain or NFT space. Second, as NFTs exist on the blockchain, any interaction costs money in the form of gas to interact with it. These costs can be considerable, especially on chains like Ethereum when transaction demand is high. Third, a general lack of community awareness of blockchain or NFTs might prove a problematic entry barrier. Users must familiarize themselves with wallets, gas, chains, and security measures required to interact with NFTs and the blockchain.

3.2.2 Contribution of the author

I collected and analyzed all the data together with one of the co-authors. Together an early draft was crafted and revised by the third co-author. The strategic framework was developed with the second co-author following the recommendation of the third co-author. The final manuscript was edited and prepared for publication by me.

3.3 Study III

Please Join Our Closed Community! A Case Study on Creating and Implementing an Online Community Within the MedTech Industry

Julian Mueller, Celina Bernasconi

3.3.1 Summary of Study III

The purpose of Study III is to shed light on a particular online community that requires confidentiality and security. We interview users of a specific medical device, DeviceX, developed and manufactured by Medima, on the conditions they require to join an online community around DeviceX.

We believe online communities centered around medical devices will become very important for companies and researchers. As emerging technologies integrate these devices, they enable new possibilities for collaboration and innovation (Bailey et al., 2022). While traditional laboratory tasks have been done manually, they are now done by programmable machines that require code to run and create data. This data and code become sharable, and users could work together to share code and outputs and help each other fix 'bugs' like in online communities such as StackOverflow.

While online communities traditionally have fluid boundaries and offer anonymity to their users (Faraj et al., 2016), the users in the MedTech industry require boundaries and verification of individuals joining the community. Previous studies have shown that IS security relating to healthcare data is problematic, even when confined to a single community in the form of a hospital (Vaast, 2007). A purely online community would be considerably more challenging to protect and guarantee content security like patient data and samples. Companies will also be interested in such communities centered around their medical devices. As we know from existing research based on traditional open communities, they can

be seen as an external source of innovation and provide solutions to current problems (Dahlander, Frederiksen, & Rullani, 2008).

To understand how such a confidential and closed online community could be created, we employ a qualitative single case study (Yin, 2013), investigating the motivations and expectations of potential community members. We take an interpretive approach for our research and analysis as we are interested in our informants' perspectives on such an online community (Gehman et al., 2017). With this focus in mind, we focus on the articulations of our informants regarding their motivations and conditions to join such an online community and stay as close to their language as possible (Charmaz, 2004; Nag & Gioia, 2012). We employ a grounded and exploratory approach (Glaser & Strauss, 1967) and avoid using existing concepts or constructs to interpret our informants' expressions too early on (Gioia, Thomas, Clark, & Chittipeddi, 1994).

For this study, we conducted 16 interviews. Thirteen interviews were with DeviceX users around the world, and three interviews were with Medima employees. This access to the customers of DeviceX was only possible as one of the authors was employed by Medima to investigate the potential of an online community. DeviceX users that were interviewed, 16 in total, were all highly educated, ranging from PhD students to professors and clinical research leaders. We were still allowed to record and transcribe the interviews for our data analysis and coding, under the condition of not revealing any medical information and providing complete anonymity. (Gioia et al., 2013).

Our data analysis yielded three layers with corresponding aggregate dimensions. We identified Layer 0, which can be considered the infrastructure they expect to be provided by Medima. They see no viability in the online community if this layer is not provided. This layer includes three roles they expect Medima to take: *Administrator, Moderator,* and *Peer.* Through these roles, the users expect Medima to safeguard the community to ensure only

DeviceX users can enter, take responsibility for the shared content, and guarantee the forum's security in terms of data and confidentiality. Our second layer, Layer 1, consisted of the different motivations users described that would make them join and contribute to the online community. We could distinguish *intrinsic* and *extrinsic motivations* and how they relate to parts and activities within the online community. Finally, we identify *Technical Features* in our Layer 2 that can be implemented in an online forum to target specific motivations and foster engagement within the community.

With the case of Medima and DeviceX, we add a very rare and hard-to-access case to the literature on online communities. It has a very specialized and highly educated user base, consisting of scientists and researchers, that will constitute the online community members. Previous studies have focused on either open online communities that do not have a centralized gatekeeper or brand communities that are closed but not due to confidentiality or security reasons, with mostly anonymous members who can share knowledge freely.

Our framework on how such an online community could look can help medical or life-science companies with similar devices plan and implement their online community as they can anticipate the needs and expectations of their customers to turn them into members.

3.3.2 Contribution of the author

I was present for part of the data collection and was involved in crafting the interview guide and the revisions after the initial interviews. I helped develop the initial theoretical perspective and sampling and offered guidance during the data analysis, advising on possible second-order themes and aggregate dimensions of the data structure. I created the current version of this study using the data analysis performed by the co-author during her master thesis development.

4 Contributions

This thesis contributes to the management literature and offers practical implications based on the three individual studies.

4.1 Contributions to Management Research

Study I contributes to the literature on TMTs and frames while creating new insights for the literature on digital transformation. In particular, we create new insights into the role of TMT frames and their impact on digital transformation in manufacturing firms. We identify three common mental frames within TMTs and how they affect the perception of digital technologies. While previous research has focused on positive attitudes toward digital transformation and its characteristics (Dery, Sebastian, & van der Meulen, 2017) or on the uncertainty around digital transformation (Govindarajan & Immelt, 2019b), we provide three clearly defined frames that allow us to understand why TMT members will disregard certain technologies. Previous research has been in agreement about the importance of the TMT in devising a vision and strategy for digital transformation (Chanias, Myers, & Hess, 2019b; Hess, Matt, Benlian, & Wiesböck, 2016) and the support and championing of such a strategy later on (Ross, Sebastian, & Beath, 2017; Ross et al., 2016).

While there has been much emphasis on the fact that this is what TMT members need to do (Singh & Hess, 2017), little is known about the criteria that TMT members use to decide if they will support and champion such digital technologies. We identify a set of three common values that TMT members use to evaluate digital technologies and determine if they will support the pursuit of the technology or if it should be ignored. Previous research argued that there is a constant battle of frames to convince other TMT members of a particular frame about highly political decisions (Kaplan, 2008). We found a surprising amount and stability of "truce" (Nelson & Winter, 1982) in the common mental frames and common values that our TMT used to make decisions.

While decisions on digital technologies can significantly impact the future trajectory of a firm (Warner & Wäger, 2019), they might not be considered highly political decisions and therefore exhibit less frame competition. Our multiple case study approach could also compare the impact of common frames and common values on digital transformation. We can predict which combination of frames and values will lead to a more successful digital transformation. For this comparison, we created a metric to measure Digital Transformation Performance (DTP) that can be used by future research to assess the status of a digital transformation in a manufacturing company and compare it to another. We believe that our approach of comparing only companies that are very similar in terms of their product and production characteristics should be adopted in any future research that compares manufacturing companies concerning their digital transformation.

Second, we contribute the literature on online communities through Study II and Study III. Study II, in particular, contributes new strategies for firms to engage with their online communities to increase engagement and participation (Fisher, 2019). We identify how specific properties of blockchain technology, such as transparent pseudonymity and decentralization (Iansiti & Lakhani, 2017), can alleviate problems that traditional online communities have suffered from. We show that NFTs can create more participation in online communities and increase intrinsic and extrinsic motivation to contribute to the online community, which have been constant issues in online communities (Lakhani & Hippel, 2004; von Krogh et al., 2012).

While blockchain's transparency might solve traditional online communities' problems, Study III explores an online community that prefers privacy and confidentiality. Studies on online medical communities exist, but they focus on patients who search for help or medical personnel such as nurses that share knowledge and practices online (Ford, Korjonen, Keswani, & Hughes, 2015; Marabelli, Newell, & Vaast, 2017; Yan, Wang, Chen, & Zhang,

2016). With Study III, we explore the customers and users of a medical device manufacturer that seeks to understand the potential of a firm-hosted online community. While there are online communities that exist independent of a firm but still provide value to it, sometimes without ever interacting (Fisher, 2019), we found the expectations of the potential online community members, in this case, to be very different. We provide a three-layer model of what the users would expect in such a forum and the critical properties a company would need to provide to make them join and participate. With this model, we provide a blueprint of the roles that a hosting company of such a medical firm would need to fulfill and what features it would need to provide. In particular, we show what features and characteristics of the forum are linked to the intrinsic and extrinsic motivations of the community members to share knowledge (von Krogh et al., 2012).

Additionally, we significantly expand the role of the administrator, which has been characterized in previous literature as a point of contact for technical problems (Gruner, Homburg, & Lukas, 2014). We argue that this role must play the guardian and gatekeeper for an online community that depends on security and confidentiality to share content and data within it. Our three-layer framework can be considered a complement to previous work done on the process of engaging online communities through activities (Porter, Donthu, MacElroy, & Wydra, 2011) as we offer a framework that characterizes specific roles, motivations, and features that need to be created to enable participation in a closed community forum. In addition to our findings and framework, we add a very rare and hard-to-access case to the literature on online communities in general. Medical device manufacturers are careful to reveal who their customers are and are often even less inclined to grant access to them. Thus, this study could inform future researchers who want to study similar medical device-centered online communities.

4.2 Practical Implications

This thesis holds several implications regarding TMTs and digital transformation, blockchain, and NFTs, and finally, the potential of closed online communities.

4.2.1 Practical implications of Study I

Identifying frames present within a company would allow TMTs to assess if those frames are desirable for their goals and could potentially allow them to start changing the frames. Furthermore, it could enable them to identify TMT members who are a hindrance to the company and its digital transformation effort through their individual frames or values. If such members are identified, it should be possible to assess if their frames can be altered or changed towards a more desirable one; if not, having an organizational change in the TMT would need to be considered. Our findings also have research relevant to the board of directors as it is responsible for the appointment and evaluation of the work that the TMT is doing. While the board of directors can give directives to the TMT on where the company should be heading in the future, they might need to consider if the common mental frames and common values of their appointed TMT align with that direction.

Furthermore, our study has shown that organizational practices play an essential role as they determine how common values are applied to decisions on digital technologies in our case. Companies should be aware of their resource allocation process, where decisions are made, by which individuals, and ideally, what common frames and values these individuals hold. In general, we would advise TMT members and senior management members to critically challenge their views on “how the world is” and “how things should be done” in their company, as we have experienced during our interviews that participants were sometimes unable to answer why things were decided on and for what reason precisely.

4.2.2 Practical implications of Study II

Study two provides a 3x3 configuration matrix to support the identification of the most suitable NFT strategy that an organization can use to engage with its online community. We offer three potential strategies: (1) *turning customers into contributors,* (2) *creating social belonging*, and (3) *bridging intrinsic and extrinsic motivations*. Additionally, we outline three potential pitfalls for organizations that consider NFTs as an option to engage their community. First, the chance of the community rejecting NFTs altogether, organizations not native to the blockchain space, and communities not used to gas and chains should be cautious about this pitfall. Second, users will need to pay transaction fees to interact with their NFTs on the blockchain but might not be willing to do so. Therefore, it is critical to consider which blockchain will benefit the NFT strategy most. Chains like Ethereum are considered the most secure but with high transaction costs, while chains like the Binance smart chain are fast and cheap but sacrifice decentralization to achieve that. Third, the unfamiliarity of a community with blockchain opens potential risks. One wrong click might mean that all funds and NFTs are lost to hackers who infiltrate a user's wallet. Therefore, organizations wanting to deploy NFTs in their communities that are not "crypto-natives" must properly instruct and educate them on securing their digital assets. Such steps could include advising them on using hardware wallets and never sharing the seed phrase of a wallet with anyone else that might pose as customer support.

4.2.3 Practical implications of Study III

Study III holds three important implications for practitioners considering creating an online community that hosts their expert customer userbase.

First, while there are cases in which companies have been shown to benefit from online communities without interacting with them or investing resources, it is far from reality for a community like in Study III. Brand identification and intrinsic motivation were not enough

for participants to join the online community. We found that the highly skilled users identified more with their research work and not the company providing the device they use for their work. Therefore, companies need to design their online community around letting users feel that their work would be enhanced by joining the community.

Second, users expected a high investment and commitment to the online community from the company in terms of providing security, confidentiality, guarantees, and content. This suggests that companies will need to hire and train dedicated staff to fulfill the roles that the community expects from them. A laissez-faire community approach will most likely lead to a slowly fading community, or it might never even really start being a community.

Third, our interviews have shown that managers might expect their current employees to check the forum and maybe answer posted questions occasionally. But as we have found, the expectations of a highly skilled userbase are much higher than that. They expect constant monitoring of content regarding scientific correctness as incorrect information shared by other users might have negative consequences on their work. Therefore, companies will need to carefully consider whom they will task with monitoring such a community; it might even need a trained scientist to provide the community with the trust they view as critical.

5 Limitations and Future Research

This thesis' contributions should be carefully considered with their respective limitations and boundary conditions. As we employ a qualitative research approach in all three studies, relying on interview data from a particular set of companies, our findings should always be viewed with the limitations of our method and sample in mind. Additionally, the natural limitations of inductive case study research should be kept in mind. We rely on specific observations and accounts of informants and draw general conclusions from them.

Study I relies on six manufacturing firms investigated during our research. While we identify three common mental frames, common values, and organizational practices and believe these to be true, it might be possible that due to the limited sample size, we might have missed potential existing frames or values. Future research should examine if further frames or values can be found in other companies and to what extent our findings can be applied. Our findings are also limited to the empirical context: all companies are manufacturers and share the trait of producing durable goods. Our goal was not to find universal frames that can be identified in any company; instead, we were interested in frames that impact digital transformation in manufacturing firms. While we have six companies in our sample, our final comparison regarding digital transformation performance relies on even smaller subsamples of two companies per category. Future research could investigate a single type of company, e.g., producers, more closely to understand further what factors impact digital transformation performance when frames are equal. Our geographically constrained sample was helpful for the comparison of digital transformation between cases, as all companies face similar costs for labor, capital, and real estate. At the same time, these factors might distort existing frames, as digital technologies are often used to increase automation to make processes more efficient and less reliant on human intervention. These potential benefits are possibly seen as much more important and profitable in a high-cost environment

where the average salary of a manufacturing worker is approximately CHF 60'000[2]. A direct comparison of frames within TMT members in manufacturing firms worldwide might be an important future avenue of research, as they might have different priorities or perceptions regarding digital technologies. Finally, as we interviewed TMT members in manufacturing firms, only two out of 90 interviews were with a female informant. While this is most likely a generalizable ratio for manufacturing companies worldwide, future researchers might find industries where TMTs with a female majority can be encountered to explore gender differences in frames.

Study II relies on a very small sample of three companies that successfully used NFTs to engage their online communities. For this study, we only searched for successful NFT deployment. At the same time, we encountered some failures that contributed to our identified challenges. We, therefore, have survivor bias in our limited sample. Additionally, our search was based on projects with a token, i.e., already integrated into the blockchain space to some degree. Avado does not have a token but can also be considered "crypto-native." Future research would be needed to gain a broader view of how the engagement of online communities with NFTs has worked out on average, as it might be possible that we have just identified very motivated communities. Another limitation is the timing of our study. We observed community interaction when blockchain and cryptocurrencies were in a "hype" cycle, and it might be possible that general market euphoria might have carried all the generated engagement through NFTs. Future studies might assess the true sustainability of these strategies when the market is on a downwards trajectory.

[2] [2] Source: Feder Statistical Office, Structural business statistics (STATENT), published on 25.11.2021

Study III has specific limitations as it is a single case study and draws on interviews of a single user base. The most important question is whether the findings are generalizable, and we believe that the medical device users in our study can be representative of other user groups in the same domain. Their expectations of what the community would entail and what the company would need to provide seem independent from the device itself but related to the medical context. We do not believe that our findings can be transferred outside of this medical context as there are no other communities that would possibly have patient data or code relating to procedures to share. But we believe that communities around specific medical devices will become more frequent in the future and are essential to study, as they benefit companies and researchers alike in advancing medical care and science. A significant limitation that needs to be kept in mind when viewing our findings is that we were not allowed to choose customers of the medical device ourselves but instead were given a list of customers we were allowed to contact. The problem therein is that we do not know why these customers were selected; it might be likely that the company chose customers that were very favorable towards them or that might not offer any critical views on the idea of sharing data within an online community. We would encourage future research to search for other medical communities behind closed doors to gain further insights into the motivations and designs of such cases.

6 Conclusion

To conclude, this thesis offers three individual studies, giving insights into how emerging technologies are being adopted and shedding light on different digital transformation paths. But since these technologies are still emerging and constantly changing without any predictable pattern (Bailey et al., 2022), the pathways only serve as directional help without any defined final destination. The problem of adopting such emerging technologies can be considered a "wicked problem;" it has no defined solution and can only be managed (Rittel & Webber, 1973). Organizations will most likely never achieve a state that can be considered entirely digitally transformed, as technologies will keep on changing and emerging, and organizations will keep on working to keep up with them.

As Study I has shown, there are organizations that will be more successful at making sense of emerging technologies and, in turn, exhibit more success in their digital transformation efforts. It has also shown that digital transformation is not only about emerging technologies but also about how individuals understand and make sense of them. Study II has shown that emerging technologies can overcome shortcomings and limitations in existing forms of organizing, such as bridging the gap between intrinsic and extrinsic motivations of individuals participating in online communities. Finally, Study III shows that because of emerging technologies, new organizations will be created in domains that were not feasible before, such as the online community centered around a digital medical device and how its users could be engaged to join it.

While this thesis outlines emerging technologies and their impact in three specific settings, their scale and reach will only increase over time. Consequently, future research on emerging technologies could be done potentially anywhere to find different paths towards digital transformation.

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8 Appendices

8.1 Appendix A – Study I: Digital or Durable? The Impact of TMT Frames on Digital Transformation in Manufacturing Firms

(continued on next page)

A.1. Abstract

The phenomenon of digital transformation has emerged as an important topic for researchers and managers alike. We embarked on a multi-year inductive field study with seven case companies to increase our understanding of digital transformation, specifically within manufacturing companies. We interviewed top management team members and senior management members. Whereas prior research has offered little guidance on how and what companies can be compared in terms of digital transformation, we provide a *digital transformation performance* metric based on product and production. Additionally, we suggest categorizing companies based on their position within their respective value chains, *producers*, *assemblers,* and *system integrators*, which allows for a more meaningful comparison of cases. Our findings based on the comparison of paired cases show that the top management teams' perception of digital transformation impacts their company's *digital transformation performance.*

A.2. Introduction

Digital transformation is commonly understood as the fundamental transformation of an organization enabled using emerging digital technologies (Bailey, Faraj, Hinds, Leonardi, & von Krogh, 2022), such as artificial intelligence (AI), process automation, cloud computing, and the internet of things (IoT) (Hanelt, Bohnsack, Marz, & Antunes Marante, 2021; Hess, Matt, Benlian, & Wiesböck, 2016). While information and communication technology was historically adopted to align, integrate, and support existing processes in organizations (Coltman, Tallon, Sharma, and Queiroz, 2015), emerging digital technologies give rise to novel, efficient and effective processes and products, which may demand wide-ranging changes across multiple functions and areas within a firm (Björkdahl, 2020; Wessel, Baiyere, Ologeanu-Taddei, Cha, & Blegind-Jensen, 2021). Some even expecting AI to significantly support managers in their decision-making process (Kolbjørnsrud, Amico, & Thomas, 2016). As such digital technology is not just a single monolithic application centrally placed to support a specific task in an organization but may be pervasive across hierarchical levels, fundamentally transforming an organization (von Krogh, 2018).

Prior research has demonstrated that close links exist between the organization and digital technology, so the digital transformation is required to adopt and leverage new digital technologies (Wessel et al., 2021). When such change is successfully conducted, digital technologies may foster a firm's competitive advantage and - performance (Govindarajan & Immelt, 2019b).

While the research agenda on digital transformation is rapidly evolving, there is still a dearth of work on the strategic decisions of top management teams (TMTs) underlying the successful identification and seizing of opportunities offered by emerging digital technologies. Prior studies have investigated the individual roles of top managers for digital transformation, such as the CEO (Govindarajan & Immelt, 2019b) or the chief digital

officer (CDO) (Singh & Hess, 2017). Still, they have not extended their work to the strategic decisions of the compound TMT.

Strategy scholars have long underscored the importance of researching the TMT in making decisions relevant to the organization's adaptation to a changing environment. (Beckman, 2006; Hess et al., 2016; Mintzberg, 1978). In environments of rapid technological change, the ability of TMTs, - rather than single heroic executives - to make fast and informed strategic decisions is crucial to firm performance (Eisenhardt, 1989b; Miller, 1987, Besson & Rowe 2012, Day & Schoemaker 2016) Yet, it remains poorly understood how TMTs assess the rapid change in digital technologies differently and why they differ in their type of strategic response to changes in technology.

One opportune theoretical inroad to understanding TMT's decision-making underpinning digital transformation is the *social framing of technology*. Early studies in managerial and organizational cognition found that a TMT's ability to make adaptive decisions to changes in the firm's environment is shaped by its recognition that such change is relevant to the firm's strategy (Barr, Stimpert, & Huff, 1992, Tripsas & Gavetti, 2000). More precisely, a TMT creates and applies social frames of technology-shared beliefs, knowledge, and implications of technology or technological change – that either succeed or fail in fostering recognition and eliciting strategic decisions (Kaplan & Tripsas, 2008). According to Kaplan (2008), TMTs use frames of technology to justify their strategic decisions around technology, thus undergirding transformation. While social frames can become deeply rooted within a TMT (Henderson & Clark, 1990) and embody "the way things should be done" (Kaplan & Henderson, 2005, p. 509), they often remain partial, fragmented, and "competitive," representing various world-views and diverse vested interests of TMT members (Kaplan & Henderson, 2005). The failure of a firm to adapt to imminent or ongoing technological change may result from a prevailing dominant TMT frame that

justifies the status quo or the inability to integrate many different frames, constraining a TMTs' strategic decision-making. While TMT's technological frames have been thoroughly investigated in prior work (Kaplan & Henderson, 2005; Kaplan & Tripsas, 2008; Tripsas & Gavetti, 2000), no study has investigated TMT frames related to digital transformation and how TMTs make sense of and decide on new digital technologies in the manufacturing industry. Since technology frames shape the TMT's attitude towards technological change, the frames construed and adopted by a TMT are essential to a firm's strategic decision-making related to digital transformation. An effective TMT is expected to recognize the need to embrace emerging digital technology and drive digital transformation – so they need to "see around corners" Field (McGrath, 2019) – add a page number for a quote. In manufacturing firms with strong legacies in technology and hardware, finding appropriate frames may be a cumbersome and laborious process for TMTs.

Given the status of research on digital transformation in strategic management, we pose the following research question: **How do TMT frames impact digital transformation in manufacturing firms?**

To explore this question, we conducted a longitudinal field study of six manufacturing firms (Eisenhardt & Graebner, 2007). Data gathering was conducted between 2018 and 2021, split into three waves of interviews with TMT members and senior managers of the firm, as well as archival data collection and field visits. We identified and compared TMT frames and strategic decisions centering on adopting new digital technologies in the six firms' (Kopalle, Kumar, & Subramaniam, 2020). We measured the "digital transformation performance" (DTP) of a firm by elaborating on prior measures of digital maturity in manufacturing firms (Forum Industrie 4.0, 2015; Schuh, Anderl, Gausemeier, Ten Hompel, & Wahlster, 2020) and inductively created a theoretical framework that explains the relationship between TMT frames, strategic decisions on digital transformation, and DTP.

Our findings show that DTP differences between manufacturing firms in similar value chain positions can be explained by their TMTs' technological frames related to the interpretation and assessment of digital technologies. Elaborating on prior research on cognitive frames and biases in strategic decision-making processes (J. L. Bower, 1970; Kaplan, 2008; Kaplan & Henderson, 2005; Tripsas, 2009), we explain why some sample firms are more advanced in implementing new digital technologies and how their TMTs made decisions that ultimately led to a higher DTP.

A.3. Literature Review

A.3.1. Digital transformation and the role of TMT

Digital transformation is a topic of growing interest in the information systems and management literature (Hanelt et al., 2021; Majchrzak, Markus, & Wareham, 2016; Vial, 2019) and a critical, continuous (Benner & Waldfogel, 2020), and pervasive challenge for managers in firms. Such transformation is complex and confounding, affecting many or all roles, units, and positions within an organization (Hess et al., 2016, p.4), (Hanelt et al., 2021).

The capacity of new digital technologies to transform existing processes and structures sets digital transformation apart from traditional IT transformation that aims to support existing processes and products (Wessel et al., 2021). The emergence of new business models enabled by new digital technologies, e.g., data-related services in manufacturing, also lies outside the research on traditional IT that tends to focus less on disruptive change within organizations' (Orlikowski, 2000). The technologies now relevant for digital transformation are also highly different from traditional IT systems that focus on storing and retrieving information and communication and networking (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013a). The focus on technology has also shifted from storing data

to data availability, which is essential to applications using machine learning or data analytics (Weichert, 2017).

From early research on digital technologies, we know that organizational conditions within a firm shape where a firm's digital transformation starts and where and how it evolves (Henfridsson & Bygstad, 2013). Novel digital technologies are complex, flexible, and might reach beyond the boundaries of a single firm (Tilson, Lyytinen, & Sørensen, 2010). For example, one case company developed an operating software for their device that was later opened to be directly integrated into ERP systems used by their customers, interacting with more than just their device. Adopting digital technologies such as AI, big data analytics, cloud computing, and IoT are often critical strategic decisions in the digital transformation (Sebastian et al., 2017) and may endanger competitive advantage for firms' (Singh, Klarner, & Hess, 2020). Digital technologies are becoming increasingly crucial for the performance and survival of firms in many industries, raising the question of how top managers respond to these developments and when and how they decide a firm needs to digitally transform (Chanias, Myers, & Hess, 2019a).

The rapid rise of digital technologies and the corresponding opportunities and threats for digitally transforming a firm represent uncertain, turbulent, and ambiguous conditions for TMTs. Strategy scholars have long pointed out that decisions made by the TMT shape such strategic responses to the technology (Mintzberg, 1978). In such decision-making, TMTs interpret, assess, select and champion the digital technologies that drive their firms' digital transformation efforts (Bailey, Leonardi, & Chong, 2010; Furr, Cavarretta, & Garg, 2012). While a TMT can influence a firm's performance in various ways, strategic decisions making has the most substantial and direct impact on financial performance (Finkelstein, S. and Hambrick, 1996). Moreover, strategic decisions about digital technology cover investments

in technology types (e.g., collaborative technologies, cloud, software) (Furr et al., 2012), IT infrastructure, and capability development (Yeow, Soh, & Hansen, 2018).

Previous research has examined organizational and managerial characteristics and their influence on technology adoption. Devadoss & Pan (2007) highlight the historically shaped context of organizations that influences their technology adoption, while other researchers focused on processes and values (Dewan, Jing, & Seidmann, 2003). Research on the digital transformation of the workplace has shown that managerial characteristics, such as the digital transformation awareness of the CIO, are essential to initiating digital initiatives (Dery, Sebastian, & van der Meulen, 2017). Moreover, prior studies show that awareness of TMT members becomes vital as a digital transformation initiative needs to be formulated in a strategy (Chanias et al., 2019a) that includes a business and a technological trajectory for the firm (Bharadwaj et al., 2013a).

Scholars have thus concluded that the TMT is responsible for creating a digital transformation strategy (Matt, Hess, & Benlian, 2015) and developing adequate capabilities for its implementation (Karimi & Walter, 2015). Creating a digital strategy is critical for TMTs to mobilize and accelerate the digital transformation (A. M. Hansen, Kraemmergaard, & Mathiassen, 2011). In creating such a strategy, a shared mindset among TMT members plays an essential role for the firm adapting technology in highly dynamic environments (Hansen et al., 2011).

Moreover, it is well understood that a successful digital transformation requires not only agreement on the importance of the topic within a TMT but also their continuous championing of the digital transformation initiatives (Andriole, 2017) and alignment of divisions within the company (Haffke, Kalgovas, & Benlian, 2017). While scholars have proposed various mechanisms whereby the TMT engages in pursuing digital transformations (Hanelt et al., 2021), there is limited understanding of factors that shape TMT members'

decisions to realize digital transformation projects, particularly in the context of pre-digital manufacturing firms. We turn to this issue next.

A.3.2. Digital Transformation in Pre-Digital Manufacturing Firms

Only a few studies have examined digital transformation in pre-digital manufacturing firms[1]. Pre-digital firms' adoption of digital technologies constitutes an actual example of a "late mover strategy," where such firms often lag behind other firms in industries such as retail, banking, or entertainment (Kohli & Johnson, 2011). Prior studies highlight that even after recognizing the importance of digital transformation to maintain a competitive advantage, pre-digital firms often struggle to identify new opportunities in digital transformation (Govindarajan & Immelt, 2019b) and instead shift their focus to digital technologies as means to achieve productivity gains (Björkdahl, 2020; Chatterjee, Grewal, & Sambamurthy, 2002).

Research on pre-digital firms, including Björkdahl (2020) and Govindarajan & Immelt (2019b) or (Kohli & Johnson, 2011), was mainly focused on *why* digital transformation is essential for manufacturing firms and *how* a digital transformation strategy should be formulated and planned. The studies examined the roles of select members of top management in these activities, such as the CEO (Alos-Simo, Verdu-Jover, & Gomez-Gras, 2017; Govindarajan & Immelt, 2019b) or a CDO (Singh & Hess, 2017). However, prior research on managerial decision-making has underscored that structural, processual, and

[1] Recent empirical research has focused on industries such as the telecommunication industry (Muehlburger et al., 2019), financial services (Chanias et al., 2019b; Gomber, Kauffman, Parker, & Weber, 2018; Huang et al., 2017; Singh & Hess, 2017), healthcare (Agarwal, Gao, DesRoches, & Jha, 2010; Gray, El Sawy, Asper, & Thordarson, 2013; Srivastava & Shainesh, 2015) and the retail industry (R. Hansen & Sia, 2015).

political process around strategic decisions is directly connected to the technologies they will implement (Kaplan, 2008; Kaplan & Tripsas, 2008).

As prior studies found, successfully selecting and implementing new digital technologies could fundamentally change how manufacturing firms create value and increase existing captured value (Björkdahl, 2009). Suppose firms fail to transform and harness these additional opportunities digitally. In that case, they will likely be 'out-transformed' and out-competed by firms that identified growth opportunities earlier and seized them (Björkdahl, 2020).

Seeking to explore the phenomenon of digital transformation within manufacturing firms and why certain firms may be more successful compared to others (Govindarajan & Immelt, 2019a) shall focus on fundamental mechanisms that shape TMT's strategic decision-making undergirding such transformation. Thus, a perspective on social frames adopted by TMT members in such decision-making is expedient to the understanding digital transformation of the pre-digital manufacturing firm (Mintzberg, 1978).

Digital technologies and -transformation engender strategic decision-making on many aspects of a business, including products, production, processes, infrastructure, and organizational design (Lanzolla, Pesce, & Tucci, n.d.). TMTs strategic decisions may thus impact secure a firm's long-term performance, as failing to implement important technologies leads to a loss of competitiveness (Benner, 2007). Digital transformation-related strategic decisions are likely path-dependent since they need to be compatible with existing capabilities and technologies (Svahn, Mathiassen, & Lindgren, 2017). and alter organizational structures, roles, and processes (Henfridsson, Mathiassen, & Svahn, 2014; Henfridsson & Yoo, 2014). Path dependencies ensue when the firm has costly legacy systems to substitute and combine with new digital technology (Warner & Wäger, 2019). At the same time, the decisions need to address the threats and opportunities created by the diffusion of

new digital technologies, not only within but also outside of their own industries (Govindarajan & Immelt, 2019b; Warner & Wäger, 2019). Under such uncertainty regarding the value of new technologies, TMT may be more prone to select technologies compatible with existing systems and exhibit a higher willingness to pay for those (Bonaccorsi, Giannangeli, & Rossi, 2006).

Internally strategic decisions undergirding digital transformation may affect many of the firm's stakeholders, such as employees, suppliers, customers, and owners (Chanias, Myers, & Hess, 2019b, Chen, Mocker, Preston, & Teubner, 2010). Thus, transformation decisions reflect high uncertainty and ambiguity, as it remains challenging to stipulate which technologies will be most relevant and what benefits they will deliver when implemented (Cyert & March, 1963).

A.3.3. TMT frames and strategic decision Making

The concept of social frames dates back to the work of Erving Goffman and his frame analysis (1974), Gregory Bateson (1972), and others. Through interactions among individuals, shared frames emerge as a temporally bound and interwoven set of messages about a specific phenomenon under observation (Bateson, 1972). Thus, frames are fundamental to decision makers' sense-making in situations of uncertainty and selecting alternatives that are consistent with the specific frame (Nelson & Winter, 1982). As shown by studies in sociology, such social frames, when embedding conditions and decisions, can give a powerful impetus to change (Feront & Bertels, 2021; Snow, 2001).

Studies in strategic management have demonstrated that decision-makers often cope with environmental uncertainty through frames (Dutton & Dukerich, 1991). Such framing of strategic issues and uncertainty by decision-makers impacts their organizations' response to those issues (Dutton & Jackson, 1987). Such frames serve as maps that enable individuals to

navigate various situations and environments that are too large or complex to otherwise fully grasp (Barr et al., 1992). Frames have also been examined as "dominant logic" or "lenses" used to filter and interpret data; as a specific map shows essential information to the reader, decision-makers then become active selectors and interpreters of data (Fahey & Narayanan, 1989).

While frames help TMT to deal with uncertainty, keeping a social frame might also lead to harmful decisions or failure to respond to environmental changes accordingly, leading to a downward spiral of organizational decline (Hambrick & D'Aveni, 1992). While the concept of the social frame suggests a conscious choice of using or not using the map, research shows that people constantly identify their environment and consciously or subconsciously compare it to frames and patterns stored in their memory to make sense of it (Barr et al., 1992; Jackson & Dutton, 1988).

Such a mechanism can be nicely observed in an isolated game of chess; Magnus Carlsen, the Norwegian Chess Grand Master, described his way of approaching the next move: "I get an idea (for a move), and then I follow it. naturally… I am not going to focus on moves that I think are bad…would hang my Queen, for example…and even in complicated situations, I am contemplating at most three positions…at some point, I will stop the variation when it is hard to continue… because there are too many possibilities" (Interview Performers, 2018).

Similar to the chess players, previous research in strategic management suggests that TMTs use social frames that help them to interpret and make sense of ambiguous and complex decisions (Dutton & Jackson, 1987; Huff, 1990; Walsh, 1995). Such frames allow managers to categorize information faster and apply preexisting templates to interpret different aspects of decisions (Walsh, 1995). TMTs then pursue the option the template

deems most promising and stop evaluating possibilities when the cost of further evaluation or situations become too complex - like the Chess Grandmaster.

Bounded rationality restricts possible moves and decisions (Simon, 1972), and managers tend to pragmatically draw on cognitive frames to make sense of their environment to justify decisions and initiatives (Nadkarni & Barr, 2008). A manager will selectively choose aspects and information according to his cognitive frame to reduce the complexity he needs to deal with and will only use this selection to form a conclusion (Bettis & Prahalad, 1995; Dutton & Jackson, 1987; Prahalad & Bettis, 1986).

Prior research has shown that managers often hold a "confirmation bias" that will focus on cognitive frames that have previously worked, steer them towards decisions that fit or satisfy these frames, and possibly reject opportunities that would invalidate their framing (Palich & Bagby, 1995). A confirmation bias might hinder exploring new opportunities if a manager had bad experiences with exploration before or was very successful by sticking to what he was doing.

Frames allow management to reach conclusions and make decisions under uncertainty and complexity. At the same time, frames enable decision-making per se, (Barr et al., 1992; Simon, 1972). Frames narrow decision makers' understanding of decision-making situations as information is filtered out.

Prior work has shown that managers may engage in highly political framing contests using their frames to convince others and mobilize action (Kaplan, 2008). Frames are not only used to interpret external and internal information but also to convince a group or a TMT board of a decision. Thus, research on cognitive frames managers apply to interpret and instigate strategic decision-making around new digital technologies is needed. Moreover, research is required on the essential features of frames that successfully lead to actions and decisions that drive digital transformation. Thus far, no research is available covering TMT

collective frames regarding digital transformation. We know from research in other research areas, such as sustainability or technological discontinuity, that a spectrum of frames can be used to explain how TMT members evaluate projects or make decisions on ambiguous issues (Hahn, Preuss, Pinkse, & Figge, 2014; Raffaelli, Glynn, & Tushman, 2019).

Similarly, we need to understand TMT members' frames regarding digital technologies that translate into digital transformation within their firms. Suppose we know the role of TMT frames in strategic decision-making. In that case, we may be able to explain why certain firms perform better than others, even if their opportunities to adopt new digital technologies are similar (Hess et al., 2016).

A.4. Empirical Setting and Methodology

A.4.1. Approach

To understand the current levels of digital transformation in manufacturing firms that we measure with the DTP, we explore six firms and their digital transformation. We investigate how the TMT and senior management decide on digital transformation and related projects. To investigate our research question, we use a qualitative research approach as it lends itself to providing a detailed account of a phenomenon of interest (Eisenhardt, 1989a; Eisenhardt & Graebner, 2007) and allows the reader to dive into our informant's experiences through our research (Bansal & Corley, 2011). Among the plethora of paths that can be taken to build theory with qualitative research, we take an interpretive perspective that assumes our interview partners are knowledgeable agents, given that they are highly educated and experienced individuals within their field (Gioia, Corley, & Hamilton, 2013). The interpretive perspective is adequate, as we are interested in how TMT members perceive digital technologies and how their perceptions might differ internally and between companies.

To avoid the lingering trap of getting convinced by our knowledgeable informants with their mostly practically dominated views and beliefs (Gioia et al., 2013), one researcher was the primary interface for contact with the firms and informants. He was responsible for the interview database (Gibbert, Ruigrok, & Wicki, 2008), including the first round of coding that sought to represent descriptively what the informants were dominantly talking about and how they viewed new digital technologies. This thought of inducing rigor by assigning different levels of involvement within the cases (Gioia, Thomas, Clark, & Chittipeddi, 1994) was implemented further with the second researcher being present for the interviews but not involved in the first coding round. A third researcher kept his distance until enough interpretations and propositions were developed. The third researcher, in this case, was able to question and challenge the findings from a completely unbiased point of view, again to ensure that our closeness to informants did not impede our judgment in interpreting the accounts given (Corbin & Strauss, 1990).

With this setup, we believe in creating a solid balance between immersion within the cases, informed theorizing, and a robust abstract perspective that allows for solid theory-building grounded in the data our informants provided us with (Glaser & Strauss, 1967).

A.4.2. Sampling

We employ a purposeful sampling approach instead of randomly investigating different firms. We selected six firms with digital transformation projects from six industries to achieve a high variability Field (Patton, 1980). We aim to understand why different views might exist and how they impact TMT decision-making. Firms from various industries will most likely allow for contrasting cases that we can learn the most from (Guba & Lincoln, 1994). We rely on accounts of single informants and their perceptions but ultimately want to understand the standard reasoning applied by executives that decide matters relating to digital

technologies. For each firm, we tried to interview TMT and senior managers with different roles that are involved in any capacity when it comes to the topic of new digital technologies, such as the CEO, CFO, CTO, CIO, Head of R&D, and other top managers to obtain an understanding of what perspectives they hold. (Hoppmann, Naegele, & Girod, 2018).

As a starting point for our sampling process, we accessed a public ledger of all registered firms within Switzerland and a general classification of economic activities (admin.ch) like the Standard Industry Classification (SIC) in the US. We focused on firms with the industry type "C," the manufacturing industry. We excluded the firms with less than 99 employees, as they rarely have a traditional TMT that would fit our research purpose. We contacted the remaining 100 firms via email, stating our research interest and our intent to interview executive members. Some firms expressed interest in the topic and acknowledged its relevance but declined because of time or resource constraints. Other firms did not want to participate since they would need to reveal too much sensitive information during the interviews. Finally, some firms expressed interest in the research but admitted that they were currently not implementing any digital technologies. We eliminated interested firms that only had headquarters in Switzerland for administrative purposes but no manufacturing operations in Switzerland.

We ultimately selected six manufacturing firms with digital transformation initiatives or projects implementing new technologies. An overview of established companies and their industry can be seen in Table 1.

Table 1: Overview of sample firms

Category	Name	Founded	Industry	Employees	Revenue in million CHF	Interviews	Recording Minutes
Producer	BirdCo	1886	Springs & Machines	450	220	18	1295
Producer	PlatypusCo	1991	Conductors	170	40	14	1055
Assembler	AntCo	1785	Energy & Gas	750	550	15	991
Assembler	WrasseCo	1950	Cleantech & Chemicals	140	80	14	820
Integrator	PyrosomeCo	1970	Packaging & Machines	140	100	11	844
Integrator	MosquitoCo	1980	Medical Devices	550	500	13	784
Integrator	BatCo*	1947	Electrical Engineering	1100	2600	11	672

*BatCo was eventually dropped from the sample as we were not allowed to interview the TMT members that would have been important to our research (CEO, CTO, CFO) and is therefore greyed out

A.4.3. Interviews

Over three years, we conducted 96 interviews carried out in three waves, where every wave had a similar number of interviews. We conducted 28 interviews (four at each firm) before starting the constant comparison of data and theory to gain a general understanding of our sample (Gioia et al., 1994). We called this first set of interviews a "wave" and continued to schedule the following interviews in two more waves. Each wave lasted approximately two months, in which we conducted four to five interviews within each firm for about two weeks. Considering how hard it is to articulate one's detailed experiences from the past, we tried to use recent events and decisions instead of old ones, as these would be more prone to retrospective bias, which our multiple waves approach helped to mitigate (Kaplan & Tripsas, 2008).

In the second wave, we used semi-structured interviews identical to the first wave of interviews, usually asking about the informant's role, the industry, what technological challenges they currently face, and how they make sense of it. To increase the credibility and richness of our data, we always asked for recent projects or initiatives to allow the informants

to describe how they experienced the projects and what about them they perceived as challenging or why they might not be going as expected or desired (Nag & Gioia, 2012).

In the third wave, we adapted our interview protocol where needed and gathered information on the resource allocation process in a step-by-step manner that companies used.

During our sampling process, we had phone calls with all firms; the participants knew our general research interest and were asked to suggest four TMT or senior management members for the first wave of interviews. While some informants closely fit our request regarding responsibilities or tasks, others pointed us toward other TMT members or senior executives that would be more relevant to our inquiry. With this snowball sampling strategy to identify people of particular interest to us (Patton, 1980), we adapted our set of informants between waves and increased relevant information gained during the interviews. If certain informants proved right for our cause, we interviewed them again in the next wave.

We conducted 96 interviews; 53 were TMT member interviews, 38 were senior manager interviews, and 5 were managers. Table 2 provides an overview of all 96 interviews and their respective firm, ranks and in which waves they were interviewed, and how the interview was conducted (in person, on the phone, or Microsoft Teams). We valued, especially at the start, personal interviews at the firm sites to build a relationship and trust but switched towards virtual interviews during the pandemic that started in 2020.

To gain further insights into the manufacturing industry and its challenges, we interviewed two independent industry veterans that had chaired various large manufacturing firms as CEOs and chairpersons during their careers and are currently still CEOs.

Table 2: Overview of conducted interviews at each case company

Interview Number	Wave	Formal Role	Functional Level	Educational Background	Mode
BirdCo					
1	W0	CTO	TMT	Engineering	Phone
2	W1	Head Engineering	Sen. Mgmt.	Engineering	In Person
4	W1	Business Division Head	TMT	Business	In Person
5	W1	Head Production	Sen. Mgmt.	Business	In Person
6	W1	CIO	TMT	Business	In Person
7	W1	Head Business Unit	Sen. Mgmt.	Business	In Person
8	W2	CTO	TMT	Engineering	In Person
9	W2	CEO/Chairman	TMT	Business	In Person
10	W2	Head Strategy & Communicati	TMT	Business	In Person
11	W2	Head Technology	TMT	Engineering	In Person
13	W3	Head Strategy & Communicati	TMT	Business	MS Teams
14	W3	Head Technology	TMT	Engineering	MS Teams
15	W3	CEO/Chairman	TMT	Business	MS Teams
16	W3	CFO	TMT	Business	MS Teams
17	W3	Head of Communication	Sen. Mgmt.	Marketing	MS Teams
18	W3	Product Engineer	Manager	Engineering	MS Teams
AntCo					
1	W0	CEO	TMT	Engineering	Phone
2	W1	Business Division Head	TMT	Engineering	In Person
4	W1	CIO	TMT	Business	In Person
5	W1	Head Engineering	TMT	Engineering	In Person
6	W1	Head Product Management	Sen. Mgmt.	Engineering	In Person
7	W1	Head Production	TMT	Engineering	In Person
8	W1	Head Quality Management	TMT	Engineering	In Person
9	W2	Head Production	TMT	Engineering	In Person
10	W2	CEO	TMT	Engineering	In Person
11	W2	Head Engineering	TMT	Engineering	In Person
12	W2	Business Division Head	Sen. Mgmt.	Engineering	In Person
13	W2	Business Division Head	TMT	Engineering	In Person
14	W3	Head of Communication	Sen. Mgmt.	Marketing	MS Teams
15	W3	Head Digital Product	Sen. Mgmt.	Engineering	MS Teams
WrasseCo					
1	W0	Head Engineering	Sen. Mgmt.	Engineering	Phone
2	W0	CEO	TMT	Business	Phone
4	W1	Head Business Unit	Sen. Mgmt.	Chemistry	In Person
5	W1	Head Engineering	Sen. Mgmt.	Engineering	In Person
6	W1	Head R&D	Sen. Mgmt.	Engineering	In Person
7	W1	CEO	TMT	Business	In Person
8	W1	Head Supply Chain Manageme	TMT	Business	In Person
9	W2	Head Engineering	Sen. Mgmt.	Engineering	In Person
10	W2	Head Supply Chain Manageme	TMT	Business	In Person
11	W2	CFO	TMT	Business	In Person
12	W2	CEO	TMT	Business	In Person
13	W3	Head of Communication	Sen. Mgmt.	Marketing	MS Teams
14	W3	Engineer	Engineer	Engineering	MS Teams
External					
1	W2	CEO	TMT	Business	In Person
2	W2	CEO	TMT	Engineering	In Person

Interview Number	Wave	Formal Role	Functional Level	Educational Background	Mode
PlatypusCo					
1	W0	Head Quality Management	TMT	Physics	Phone
2	W1	Head Quality Management	TMT	Physics	In Person
4	W1	Head Process Engineer	Sen. Mgmt.	Engineering	In Person
5	W1	Head R&D	Sen. Mgmt.	Physics	In Person
6	W1	CEO	TMT	Physics	In Person
7	W2	CFO	TMT	Engineering	In Person
8	W2	Head Operations	TMT	Engineering	In Person
9	W3	Head Quality Management	TMT	Physics	MS Teams
10	W3	CEO	TMT	Physics	In Person
11	W3	Head Quality Management	TMT	Physics	MS Teams
12	W3	Manager Quality	Manager	Engineering	MS Teams
13	W3	Manager Compliance & Engin	Manager	Engineering	MS Teams
14	W3	Manager Product Engineering	Manager	Engineering	MS Teams
PyrosomeCo					
1	W0	Head R&D	TMT	Engineering	Phone
2	W1	Head Sales & Project Manage	Sen. Mgmt.	Engineering	In Person
4	W1	Head R&D	TMT	Engineering	In Person
5	W1	CIO	TMT	Business	In Person
6	W2	CEO	TMT	Physics	In Person
7	W2	CFO	TMT	Business	In Person
8	W2	Business Division Head	TMT	Engineering	In Person
9	W2	COO	TMT	Engineering	In Person
10	W3	CEO	TMT	Engineering	In Person
11	W3	Head Division	Sen. Mgmt.	Marketing	MS Teams
MosquitoCo					
1	W0	Head Operations	TMT	Business	Phone
2	W1	Head Production	Sen. Mgmt.	Business	In Person
4	W1	Head Software Development	Sen. Mgmt.	Comp. Science	In Person
5	W1	CIO	TMT	Business	In Person
6	W1	Business Division Head	TMT	Biology	In Person
7	W1	Head Division	TMT	Business	In Person
8	W2	Head Software Development	Sen. Mgmt.	Comp. Science	In Person
9	W2	Head Production	Sen. Mgmt.	Business	In Person
10	W2	Head Operations	TMT	Business	In Person
11	W3	Head Research Division	Sen. Mgmt.	Engineering	In Person
12	W3	CTO	TMT	Biology	MS Teams
13	W3	Head R&D	Sen. Mgmt.	Engineering	MS Teams
BatCo*					
1	W0	Head Operations	TMT	Business	Phone
2	W1	Head Process Development	Sen. Mgmt.	Engineering	In Person
4	W1	CIO	Sen. Mgmt.	Comp. Science	In Person
5	W1	Head Operations	TMT	Business	In Person
6	W1	Head R&D	Sen. Mgmt.	Engineering	In Person
7	W1	Business Division Head	Sen. Mgmt.	Engineering	In Person
8	W2	Head Process Development	Sen. Mgmt.	Engineering	In Person
9	W2	Head Software Development	Sen. Mgmt.	Engineering	In Person
10	W2	Head R&D	Sen. Mgmt.	Engineering	In Person
11	W2	Business Division Head	Sen. Mgmt.	Engineering	In Person

* BatCo is greyed out because it was impossible to conduct further interviews with TMT members; therefore, we excluded them from our analysis and case comparison due to a lack of comparability as only 1 TMT member could be interviewed.

A.4.4. Data Analysis

Using a multiple case study theory-building approach (Eisenhardt & Graebner, 2007; Eisenhardt, Graebner, & Sonenshein, 2016), we started data analysis after the first wave of interviews was conducted. For each firm, a detailed case description was created (approximately 70 pages), including accounts of the firms' activities, production, informants, and general impressions of the company.

Each case was analyzed independently and coded with the general topic of digital transformation in mind, allowing us to understand what was happening within that case. Merging our initial coding of interviews with acquired firm documents and impressions from two researchers visiting the firms, we created comprehensive case histories for each firm in our sample (McDonald & Eisenhardt, 2014). We were looking for information on digital transformation and news about new products and technologies while also paying increased attention to themes mentioned by multiple informants (Jick, 1979). After completing our within-case analysis, we started the cross-case analysis to compare similarities and differences between our initial coding and case files (Eisenhardt & Graebner, 2007).

As we compared our coding across cases, we realized that digital transformation was described differently between cases and that decision-makers held different opinions on why and when it should be approached and executed. Therefore, we started to pay more attention to the description of how TMT talk about digital transformation and what attributes they use to describe their rationale on when and why they consider digital transformation beneficial or not. At the same time, we started to pay attention to descriptions of how they come to conclusions with the evaluation of digital technologies.

Simultaneously, we compared what kind of digital technologies the firms already had implemented or planned to implement and what they did not intend to implement. Observations and insights from our visits to the production facilities were later used to create

our DTP comparison between firms. During this cross-case analysis, we compared the technologies implemented within a case. We searched for similarities and differences from other cases, searching for patterns or constructs along the way (Eisenhardt & Graebner, 2007). Iteration across cases led us to conclude that we need to establish a metric that will allow us to compare the use of technologies within our sample in a quantifiable way (Klag & Langley, 2013).

We used existing guidelines of the German Machine and Tool Builders' Association and the RWTH Aachen University that help firms to identify potential areas to drive digital transformation as a basis for our digital transformation performance assessment. We combined the guidelines with current literature from management research and data from our interviews to triangulate as much data as possible. Triangulating between these different data sources allowed us to create a metric that is generalizable and supports the accuracy of our theoretical arguments (Eisenhardt & Graebner, 2007).

While searching for a metric that would allow us to compare the digital transformation performance of the firms in our sample and discussing the digital transformation efforts with our informants, we observed that firms seemed to be unique regarding their problems and respective solutions to digital transformation. For example, specific use cases of AI were not comparable between cases (e.g., AI in a hearing aid versus AI in a cleaning robot). Still, adopting AI as a tool for productivity or within the product was. Finding an objective metric that can be used consistently and representatively across a range of firms was challenging.

In the beginning, we argued that it is unfair to judge the digital transformation regarding the product since the two case firms produced mechanical parts, e.g., a spring, that is not comparable to a machine with its software and programs. But during these comparisons and evaluations, we realized that the DTP already gave an accurate estimation of the digital

transformation firms; comparing the lowest to the highest-ranked one did not make sense per se.

What made sense instead was to compare firms that had a similar place within the value chain, e.g., a supplier of mechanical parts or a manufacturer of machines. Specifically, two firms (BirdCo and PlatypusCo) manufacture simple components that are further built into other products by their customers. The middle ground is held by a pair of machine assemblers with simple functions (AntCo and WrasseCo), such as creating pressure or cleaning the floor. Two firms (PyrosomeCo and MosquitoCo) are manufacturers of complex machines that require sophisticated software and programming to run. To categorize our pairs, we use the following terms: Producers (BirdCo and PlatypusCo), Assemblers (AntCo and WrasseCo), and Integrators (PyrosomeCo and MosquitoCo). Producers manufacture parts they sell to their customers using them in their products. Assemblers build components or simple machines, and Integrators create sophisticated devices, including the software. We use these categories to compare frames and decision-making among TMT members. Since these pairs face the most similar challenges regarding digital transformation and within pairs, we always have a relatively low and high performers regarding our DTP. This allows us to examine the differences within the pairs to understand better the impact of TMT decision-making on the DTP and what underlying frames benefit or slow down a firm's digital transformation.

A.4.5. Evaluating Digital Transformation Performance

Digital transformation (DT) can yield a plethora of outcomes (Henfridsson and Yoo, 2013) that can improve efficiency or completely change current business models (Hinings et al., 2018). A traditional machine manufacturer, for example, may transform into a digital service provider, transcending the barrier between steel and data (Brynjolfsson et al., 2013). We assess two main areas of digital transformation, within the production and for the product

itself (Forum Industrie 4.0, 2015; Govindarajan & Immelt, 2019b; Muehlburger, Rueckel, & Koch, 2019).

To measure a firm's digital transformation level, we created a Digital Transformation Performance (DTP) measure, derived and adapted from industry-proven digital maturity measures designed for manufacturing firms (Forum Industrie 4.0, 2015; Schuh et al., 2020). These measures are not evaluated by a survey but by our data gathered in numerous interviews and firm visits. The DTP consists of two categories that are considered separately. The first is focused on the *production* and the digital tools that a firm employs to enhance or redesign current manufacturing processes (Dery et al., 2017). The second assesses the development of the *product* and its digital capabilities, such as smart features and connectedness (Porter and Heppelman, 2015). We adapted and defined nine distinct categories: four are production-related, and six are product related. Each category is split into five planes representing the stage at which a firm currently is, as seen in Table 3. We distinguish from “none” to “very high” for each category representing the level of maturity within that category. The overall rating of all these categories made up the final DTP representing the application level of digital transformation across the firm that was used to compare the paired cases.

Product Categories

We evaluate six product properties to measure the performance of the firm’s digital transformation efforts about their product. Namely, we assess the (1) *use of sensors* built into or onto products that allow the products to become an interface from the real world into the virtual world, a requirement for an efficient digital transformation (Zimmermann et al., 2016). (2) The *connectivity* of the product that allows it to share or receive data as the adoption of modern digital technologies has manifested in “digital ecosystems” and related services that require the product to be integrated (Kopalle et al., 2020). Not only connectivity

matters: Data access's availability and (3) functionality reshape how firms generate and share data (Porter & Heppelmann, 2015). Furthermore, (Huang, Henfridsson, Liu, & Newell, 2017) note the importance of fine-grained (4) *monitoring and diagnosis* in various domains such as usage data, growth rates, and use patterns that require a product.

Whereas the categories mentioned above represent the digital capabilities of the product per se, they become the enablers for new (5) *digital services* that are offered to leverage the digital capabilities of the product (Yoo, Boland, Lyytinen, & Majchrzak, 2012). Finally, we will assess the degree to which these digital capabilities within the product and the (5) *digital services)* have contributed to new (6) *digital business strategies and business models* (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013b).

Production Categories

The second part of our DTP measure evaluates different aspects related to the use of digital technologies within the production domain of a firm. The connection of physical and digital systems within production enables new ways of how a firm can produce and optimize its processes. Using new technologies within production will allow firms to avoid trading off flexibility for efficiency or quality for speed and *"change the way that work is done"* (Olsen & Tomlin, 2020, p.1). We evaluate four aspects of the production that emphasize the connection between physical machines and digital elements represented by data and the ability to communicate and leverage this data within the firm.

Like the product, the use of digital technologies within the production starts with the (7) *data processing ability.* The ability to generate and analyze significant amounts of data was a critical mechanism for firms to drive their operation and seize growth opportunities (Huang et al., 2017). We will categorize interfaces used to access and utilize generated data as (8) *production connectivity,* as standards within communication are drivers for technological advancements (Kim, Lee, & Kwak, 2017). To assess data integration, we will look at the

availability and sharing of data from production to other parts of the firm, such as business units and management, to make decisions based on the gathered data (Kohli & Johnson, 2011). As (9) *communication and information sharing* within firms is also driven by the digital transformation (Tilson et al., 2010), the Information and Telecommunication (ICT) infrastructure of firms is evaluated based on their ability to exchange data effectively and integrate processes to share data with partners such as customers or other firms. (10) *Digitized machine interfaces* that allow users to easily interact with machines for users are an integral part of digital transformation as they allow for deeper interaction with the machine (Gregory, Kaganer, Henfridsson, & Ruch, 2018).

Evaluating these critical aspects of digital transformation allowed us to compare our case firms' digital transformation performance. The information for this fine-grained evaluation was gathered during our interviews and visits to each firm's production site and can be seen in Table 3 and Table 4 respectively:

Table 3: Digital transformation performance evaluation

Application Category		None	Low	Medium	High	Very High
Product	Use of Sensors	No use of sensors	Sensors are built into the product	Sensors are used by the product	Product is processing sensor data	Product can evaluate sensor data and respond to it
	Product Connectivity	No connectivity	Product can communicate simple signals	Product has industrial connection possibilites for a distributed control systems	Product has possibility to be connected via Ethernet or similar	Product has its own access ot the internet via Wireless or LAN
	Functionality of Data Access	No functionalities	Possibility of unique identification via barcodes or QR	Product can store data for access	Product can exchange information automatically	Data exchange becomes a key aspect for further applications of the product
	Monitoring and Diagnosis	No monitoring	Failure can be traced	Continuous recording and sharing of data for evaluation	Product can diagnose itself	Product can use diagnosis to adapt own status
Services related to Product	Digital Services	No services	Services are offered via a online access for customers	Product can be accessed and evaluated for service remotely	Product can suggest services autonomously	Product is integrated into whole service systems such as a webshop
	Digital Business Models	No change	Selling data with the product	Selling digital services as an add-on	Selling integrated digital solutions	Selling the function of the product as a solution provider
Production	Data Processing Ability	No processing	Storage of data	Analysis of stored data	Automatic processing of data	Automatic process planning and evaluation
	Production Connectivity	No connectivity	Industrial connectivity options	Advanced connectivity options	Machines have access to the internet	Machines communicate via the internet
	Communication and Information Sharing	Traditional systems like Email and phones	Centralized data for organization	Web based data portals	Automatic information delivery systems	Fully integrated information systems across company
	Digitized Machine Interfaces	No interface	Local user interface	Remote user interfaces	Modern interfaces via phones or tablets	Virtual or augmented reality interfaces with remote possibilities

A.4.6. Digital Transformation Performance Across Paired Cases

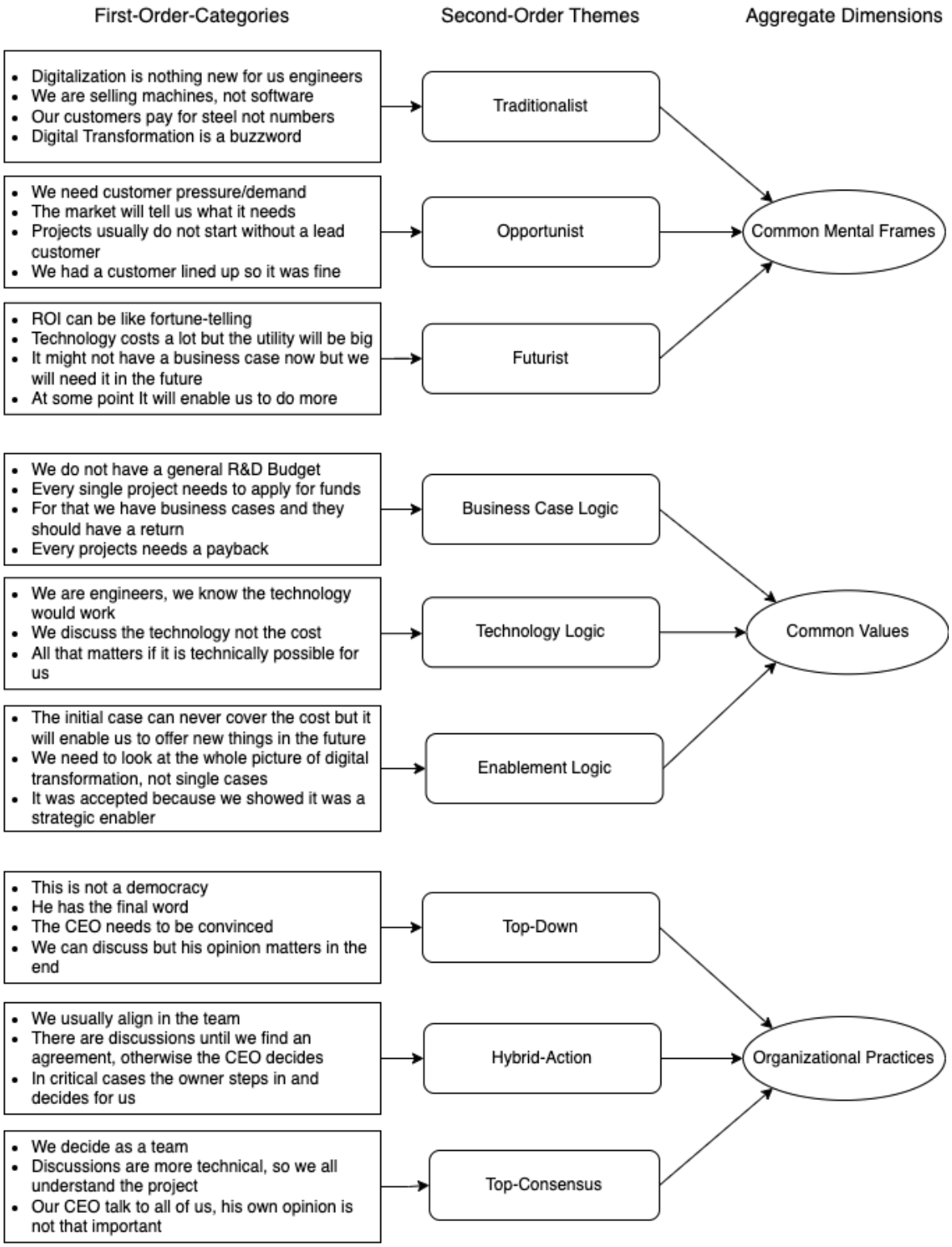
We assessed the DTP with our established *application categories* and their respective *implementation stage* within each case individually. We used the description of technologies that our informants provided, which were being used at the time to determine their current implementation location and our visits to the firms' production sites. Our assessment showed the following DTP across our cases:

Table 4: Digital transformation performance comparison

		Producers		Assemblers		System Integrators	
Application Category		BirdCo	PlatypusCo	AntCo	WrasseCo	PyrsosomeCo	MosquitoCo
Product	Use of Sensors	None	None	Low	High	Medium	High
	Product Connectivity	None	None	Medium	High	Very High	Very High
	Functionality of Data Access	None	None	Medium	Medium	High	Very High
	Monitoring and Diagnosis	None	None	Medium	Medium	High	Very High
Services related to Product	Digital Services	None	Medium	Low	Medium	Medium	High
	Digital Business Models	Low	Medium	High	High	Medium	High
Production	Data Processing Ability	Low	Hihg	None	Low	Medium	High
	Production Connectivity	Low	High	None	Low	Medium	High
	Communication and Information Sharing	Medium	Medium	Medium	Medium	Medium	High
	Digitized Machine Interfaces	Low	Medium	Low	Low	Very High	Very High
Relative Pair Comparison		Lower	**Higher**	Lower	**Higher**	Lower	**Higher**

For our findings and analysis, we will not compare specific technologies that have been implemented in one company or in another. We will use the relative pair comparison between *producers, assemblers,* and *system integrators* where we always have one higher performing case and one lower performing case with regards to digital transformation.

Figure 1: Data structure



A.5. Findings

To study frames that influence digital transformation in our case companies, it is first necessary to identify the frame that is present and describes "how the world is" through a *common mental frame* for the company. Second, understanding the *common values and assumptions* that define "how things should be" and the *organizational practices* that represent "how things are typically done." For that reason, we first present the content of these structures we were able to observe in our cases. Figure 1 shows our derived data structure, including first-order categories that remain close to our informants and second-order themes created by us that finally led to our conclusion in aggregate dimensions.

A.5.1. Common Mental Frames

We found clear patterns of *common mental frames* among TMTs and their senior managers that showed variation across cases when discussing new technologies and digital transformation. These mental models describe shared *ways* of thinking among TMT members. They have three main configurations: (1) a *traditionalist* frame that induces legacy and history in discussion on how digital technologies should be seen, (2) an *opportunistic* frame that focuses on present opportunities with new technologies, and (3) a *futuristic* frame that focuses on the possibilities that might exist in the future. We discuss every configuration of these patterns and demonstrate their presence in each case through first-order data.

Traditionalist. This mental frame configuration is focused on existing structures or technologies that have been integrated into the company in the past and are often linked to the history and legacy of the company. They use events in the past of the company to answer questions regarding current technological possibilities and why they are not possible to implement or would not make sense. Two case companies have exhibited the *traditionalist* frame as the most common; BirdCo and AntCo, the two companies with the longest legacy,

are both over 100 years old. In both cases, when we asked how TMT members and senior managers understood digital transformation and digital technologies, we generally received deflective answers and justifications. In the case of BirdCo's executives, they labeled digital transformation as a 'hype' or 'buzzword' that does not require attention, as there are more important topics:

> *"For me, it is a buzzword where we are not going to spend time on it; we have areas with more important problems" (Head Strategy & Com., BirdCo)*
>
> *"Our TMT thinks digital transformation means funny robots doing accounting, but not that it could be a priority for our traditional business (CIO, BirdCo)*
>
> *"Digital transformation has not been a topic so far in TMT meetings; we are not driven by technology outside… we get out hammer and screwdriver when there is a problem like we always did" (Head BU, BirdCo)*
>
> *"Digitization sure… it would be nice if machines could communicate all, but we think there are more important topics at the moment" (CEO, BirdCo)*

Similarly, we found that TMT and senior executives of AntCo express their opinion on digital transformation by relating their answers to their past or legacy:

> *"Stop calling it something new! We are doing it in the past 25 years; digital transformation and Industry 4.0 are marketing efforts and buzzwords to make some money" (CEO, AntCo)*
>
> *"We are building machines for over 250 years; can you imagine how deep that runs in our DNA? Of course, people do not take digital transformation serious here" (Head of Service, AntCo)*
>
> *"We will probably keep using paper for the next 100 years as we did for the last 100 years" (Head of Production, AntCo)*
>
> *"I did a doctorate on artificial intelligence 25 years ago, and I already said then: There is no artificial intelligence. I am still convinced that there is no artificial intelligence." (CEO, AntCo)*

In general, we have observed that if the *traditionalist* is the *dominant frame* present, the discussions revolve around existing things that might be enhanced by new technologies and why digital transformation does not pose an immediate topic of interest since older issues are more important to solve. The company has been doing fine historically without digital transformation, so it can also do so a bit longer without.

Opportunist. This mental frame configuration relies heavily on the present and what can be determined or evaluated right now or in the very short-term future. We have observed this mental frame in two companies, WrasseCo and PyrosomeCo. Within both cases, we kept a constant focus on what customers currently want and how it can be achieved, and simultaneously a strong skepticism about what might be demanded in the future. In the case of WrasseCo, there were developments in the past that were done without having demand for the product, which seemed to have left a mark on their mental framing:

> *"We had supposedly very innovative products in the past, but they were not accepted in the market, and our customers are relatively conservative, so we try to figure out what they want and bring that to the market" (CEO, WrasseCo)*
>
> *"We know what the market wants; we think we know what the customer wants; we have to make sure to focus on that right now" (Head Supply Chain, WrasseCo)*
>
> *"An idea can be nice and great, and then there might be a product, but it is the customer that ultimately decides if it is good" (CFO, WrasseCo)*

A similar pattern can be found in the case of PyrosomeCo; while being a market leader for most of their past, developing and building the mechanically most advanced machines, they are used to reacting to their customers 'pull' or requests in terms of technology:

> *"We are innovative and integrating digital technologies but always on customer pressure. For me, that's a limitation" (Sen Manager 1, PyrosomeCo)*
>
> *"Why can't we develop something that puts us ahead in one or two years? Not always so dependent on the customer. Not if the customer brings something and then evaluating, I would like to see it the other way around" (Sen. Manager 2, PyrosomeCo)*
> *"No one is willing to spend money here if there is nobody on the other side [customer side] who will pay for it" (Head of IT, PyrosomeCo)*

In both cases where the *opportunist* pattern of thinking was dominant, they showed the same remedy for their worries, finding a 'lead' customer that either participated in the proposed development or would cover some of the cost:

> *"That digital project also started as a request; we were invited by our customer that said we need that. What does PyrosomeCo do? We said we're in, but how much will you pay?" (CEO 2, PyrosomeCo)*
>
> *"If the customer says, 'tomorrow I need this, and if he is willing to put money on the table, then the risk management is already done for us" (CTO, PyrosomeCo)*

"Look, I said, we can develop a digital twin; I just want a customer. I want a customer that is willing to pay for it and makes it profitable" (CTO, AntCo)

And that is the approach that we took there, saying that we deliberately want to have a customer that plays along, and we will not do it without (CEO, AntCo)

Futurist. The *futurist* frame of thinking was mainly observed in two of our cases, PlatypusCo and MosquitoCo, their arguments and trains of thought focused on the future and what their companies might be doing with digital technologies they do not currently have. When asked in retrospect about significant projects that have been started with regards to digital transformation, their reasoning often came from a belief on how it will be beneficial in the future and how it might be uncertain, but it is what they believe will happen. In the case of PlatypusCo, a large and expensive project was started years back to digitize as much data in the production as possible to drive the company's digital transformation; when asked what the TMT was thinking back then, they recounted:

"Either you believe in it [digitization project] or not. You can't do another capital budgeting, and I do not know what; you do not even know what projects from customers will come from it. But the abilities we gain from it for the future, that matters" (CFO, PlatypusCo)

"Of course, you could simply estimate some returns and then calculate, but that would be equal to fortune-telling. We just agreed that this technology will be valuable in the future" (TMT member 1, PlatypusCo)

"…no discussion… I believe already back then, everybody in this building agreed: We need to go into that direction [of implementing a digitized production]" (TMT member 1, PlatypusCo)

We identified very similar patterns in MosquitoCo, where TMT members and Senior Managers explained to us that they specifically allocated funds towards digitization projects that they believe might solve a problem in the future that they do not have yet:

"Yes, this is a multi-year and multi-million project [a new software]; of course, there were many discussions, hardware projects can be calculated to see if they make sense, but such a project requires intellectual discourse to make it future proof, but through our discussions we all agreed, it makes a terrible amount of sense to do it" (COO, MosquitoCo)

"Yes, we have this budget for digital technologies, but it is only possible because the whole chain is on board. Beginning with our board of directors to our CEO and other committees, they allow us to invest in projects that might not immediately become products but maybe in the future (Head of Software Development, MosquitoCo)

Common Values

While *shared mental frames* represent how a company sees the world around them and how it interprets possibilities, our analysis indicated that while some cases had a similar *common mental frame,* they used different reasoning for their choices and actions. We looked specifically at logics that informants used to make decisions relating to digital transformation projects and found three distinct logics in our cases: (1) *Business case logic, (2) technology logic, and (3) enablement logic.*

Business Case Logic. This frame puts business attributes at the highest priority; the most common characteristics in this regard were the return or investment (ROI) and payback-duration (describing the time a project has paid for its initial costs through newly generated revenue). This logic, to some degree, assumes that a project's financial aspects can be estimated with precise accuracy. Therefore, potential projects can be ranked based on their estimated financial performance. Furthermore, as the *business case logic* focuses on quantitative measures that can be calculated, it generally disregards potential future possibilities a project might bring. We identified the use of the *business case logic* most prominently in two cases: BirdCo and PyrosomeCo. In BirdCo, every idea needs to be formulated and presented as a business case that then gets evaluated by TMT members. In that evaluation, the return and the revenue potential revenue generation are most important as the TMT members describe how they choose projects to allocate funds to:

> *"And for that [evaluating projects], we have business cases, and I believe you should be able to calculate a pretty clear return for those, or you have to search for a better case" (CEO, BirdCo)*

> *"In the end, you need to be able to use and live such [digital] applications, so you need to have a payback." (CEO, BirdCo)*

The CTO of BirdCo, the only engineer within the TMT, confirmed our feeling that financial attributes dominate discussions in BirdCo. Two other informants also argued that the focus on financials instead of technology comes from the business background dominance in the

TMT. The CTO also confirms that he started to adapt his strategy in presenting potential technologies with more focus on, for example, how much it could save:

> *"I did not find a recipe yet [to get approval]. But I found highlighting that the technology could save us this much instead of what it does in the production seems to be more successful" (CTO 1, BirdCo)*

> *"Yes, he [CTO 1] is an engineer, but… it is hard next to all these businesspeople. Trying to initiate things while the others look at you while saying "yes, it is important… but not important" their heart just does not beat for that [technology]" (Senior Manager 2, BirdCo)*

> *"Technology [IT infrastructure and digitization] simply has a low significance because our TMT is coming from a marketing background and are not as technology savvy as I would wish they were they focus on business numbers" (CIO, BirdCo)*

A similar approach is used by PyrosomeCo, which focuses mainly on potential technologies that have direct financial benefits. Like BirdCo, PyrosomeCo ranks projects yearly based on potential returns and uses ranking to decide where to allocate funds. Additionally, due to a new organizational structure, the CTO is worried this logic might even become more prevalent:

> *"The first question is always, how do we generate money for the business" (CIO, PyrosomeCo)*

> *"We believe that must be proactive [bringing up ideas], there must be a business case, it must be a product in the end that we can sell to our customers without uncertainty" (CEO, PyrosomeCo)*

> *"Sometimes I was able to fund such projects [digital transformation projects] with my allocated R&D funds, but now the increasing R&D controlling I am worried that exactly that will happen, everything is controlled and approved through business cases" (CTO, PyrosomeCo)*

Technology Logic. The technology logic focuses more on what a specific technology can do and how that could potentially solve a problem for the company or the customer. During our interviews, when we asked why a specific digital project was approved and how people justified it, a standard answer was that "*we just believed in it*" or that the TMT or specific individuals were excited about new digital possibilities that new technologies could bring. In our cases, we observed *technology logic* as, to some degree, described by individuals with a

business case logic as *"happy engineering"* that cares too little about the financial aspects of the project. We found the *technology logic* in three cases: AntCo, WrasseCo, and PlatypusCo. In AntCo, we found our informants describing a lack of a formal process to channel ideas and that most digital transformation projects they have were started by passionate individuals that tried to convince others of the technology; the TMT itself preferred traditional engineering projects but was usually on board if they believed in the digital technology:

> *"Finding new technologies and digital technologies especially is not supported by the process, so the process does not ensure that we find and implement new technologies, so to speak. It depends on the individuals, the process itself is just too weak, it relies heavily on the individuals to pay in and to have the desire to pursue a technology" (Head of Quality, AntCo)*
>
> *"Engineering projects is where they saw real added value compared to digital projects. They [TMT] have always waved them through and have shown an interest in them [non-digital projects]" (Senior Manager 1, AntCo)*
>
> *"There are initiatives by younger employees, and there are discussions around digitization, but the biggest discrepancy is usually if our board believes in these technologies, they prefer topics like oil and gas" (Head BU, AntCo)*

WrasseCo also shared the trait of *technology logic.* Still, it is worth noting that compared to AntCo's TMT, dominated by engineers that believed in more traditional technologies, WrasseCo's TMT expressed more belief in new technologies and digital transformation that they thought was coming now, if they want or not. Therefore, they often started projects that were missing financial fundamentals but built their confidence through belief in the technology:

> *"We knew this technology was going to be expensive, but it just required much faith in it, and we believed that the market would want it now, even though we could not estimate revenues" (Head BU, WrasseCo)*
>
> *"Our CFO told me he does not see a product on the shelf, so I told him he needs the ability to imagine the product and then believe in it" (CEO, WrasseCo)*
>
> *"I am sure there is some textbook framework that has clear prerequisites, but in our case, it is often about faith in the project, and if we all agree, we usually go for it" (Head Supply Chain, WrasseCo)*
>
> *"I believe that this networking and connectedness and the use of all this information will be important for us, so we will certainly be very active in this digital area" (CEO, WrasseCo)*

The third case with a *technology logic* is PlatypusCo, the only case where every single informant had a technical background in either engineering or physics. PlatypusCo relies on its extensive technical knowledge with more TMT and senior management PhDs than any other case. Their decisions on new digital projects revolved around the agreement of involved individuals that the technology makes sense to them. The CEO even insultingly praises his CFO (also an engineer by training) for not being an obstacle:

> *"I mean, it is his job to count the beans [referring to finances] and to make sure the beans are there, but I think we have a good CFO in this regard; he is not an obstacle that would say he does not see the value in there [referring to digital projects]. We did hire him as a CFO because he knows his finances, but the engineering background helps… it does help" (CEO PlatypusCo)*

> *"I am not the classical 'penny pincher.' I read that there are 'No-CFOs'and 'Go-CFOs'and I am for sure the latter. I am here to support and not to stop business." (CFO, PlatypusCo)*

> *"…of course, financial accountability is important but… thank God we [the TMT] are so technical [referring to backgrounds and understanding] that everybody understood the use case [of the most significant digital project]" (Head of Quality, PlatypusCo)*

> *"And of course, there were discussions [about a digitization project] but rarely financial, more like: 'do we need the laser data per second or per microsecond'*laughs*" (Head R&D, PlatypusCo)*

Enablement Logic. We could only observe the *enablement logic* in one case: MosquitoCo. We identified the *enablement logic* as a conscious effort to mix *business logic* and *technology logic*. Informants usually were able to distinct digital projects that were created through *business logic*, i.e., it was reasonably possible to predict the return or payback, but they were also able to apply a *technology logic* when they discussed projects that currently do not offer payback but might enable more possibilities in the future. For example, they clearly state that, especially for digital projects, a singular business case approach would not work, but it enables them to pursue their strategy:

> *"If you take our example of project X, it alone never generates value, but we believe it will enable various other products or business cases later. The problem with a staggered approach, especially with digitization, is that a single business case can never absorb the initial cost. But if you say it is strategically important for us and we believe we can offer a whole range of digital services with X, then the case makes sense." (Head of Software Dev., MosquitoCo)*

> *"You need to see digital transformation as a holistic case, so we are trying to digitize every component, every subsystem, every motor, and encoder. Some things might be pure digitization, such as AR, VR, and 3D simulations, and some activities intimately tie hardware and software together. We call all this digitization, and even if they are five different activities, they all work towards the same case for us" (Head of R&D, MosquitoCo)*

This holistic view does not come by chance; the COO of MosquitoCo actively shapes it that got the task of developing a digital strategy for MosquitoCo:

> *"You need a perspective when you digitize; you must have a vision of how you want to do it; you must be clear. You need this holistic picture to be able to create a holistic strategy out of it. Because isolated solutions might look good in the short run, but they will not be able to enable further our business model, which is too complex for isolated initiatives" (COO, MosquitoCo)*

Between our first two waves of interviews, we noticed news published by MosquitoCo that the COO will now take over the responsibility for IT matters from the current CFO. We know from previous interviews that often, the CFO is described 'obstacle' or a 'brake' for digital projects, and after probing for a while, the COO told us the 'real' reason from the top (board of directors) for the change (as opposed to the CFO had too much work):

> *"Well, you know, as CFOs like to keep costs as low as possible, and if he's responsible for IT, of course, he will say: 'this all stays as standard as possible and as cheap as possible, and if you are someone who only considers rudimentary IT to be useful, it is hard to look at digital transformation positively. I try to bring more of a value-added point of view that allows us to do more with more" (COO, MosquitoCo)*

This was also welcomed by other members of MosquitoCo, such as the head of production, that also admitted the benefits of not having the CFO as responsible for IT, and the Head of IT himself:

> *"You know who was responsible before, right? The CFO, so you can add one and one together… A finance person tries everything to maximize profit and minimize cost, we all do to some degree, but it is now easier with a person that understands the value better and does not only see costs" (Head of Production, MosquitoCo)*

> *"I mean, I report to a CFO, he would prefer fixed, and lowest price for everything, and all is good" (Head of IT, MosquitoCo)*

In sum, we have three dominant logic types to justify and make decisions in our cases. While it is possible that single individuals might not have shared this logic or even complained about the logic of their colleagues, we were interested in the logic used to justify and start digital projects that have been consistent within cases.

A.5.2. Organizational Practices

Our interview data suggests that an important topic for our informants was: where decisions were taken and how they were taken. In our cases, we considered these accounts of 'how things are done' as organizational practices used to start things, such as digital projects. We found three distinct described patterns of how things are done: (1) *top-down* by a powerful individual such as a CEO or the owner of a company, (2) *hybrid-action* where certain decisions are made top-down and others through consensus, (3) *top-consensus* where the TMT is trying to find consensus on decisions.

Top-down. We were interested in how decisions are made after values and decision premises were discussed and applied for our top-down coding. This allows us to understand and confirm which frame was used to decide. During our interviews, we encountered two cases that exhibited very clear *top-down decision-making*. In BirdCo and AntCo, it became clear early in our interviews who has the most influence on decisions. For BirdCo, every single informant mentioned the CEO, who is also the chairman and owner of the company, to be the final decision-making authority:

> *"We can discuss it all we want, but in the end, it is the CEO that says how it will be" (CTO 2, BirdCo)*
>
> *"It might be discussed in the TMT meeting… but the final word is with the CEO" (Senior Manager 2, BirdCo)*
>
> *"In the end, most of the decisions are made by the CEO that also chairs the administrative board" (CFO, BirdCo)*

This was confirmed very clearly by the CEO himself when asked about who makes the decisions regarding, for example, what new digital technologies to consider:

> *"I mean… we are not a democracy here. At the end of the day, I make the decisions, but everyone can give his opinion, of course" (CEO, BirdCo)*

And we observed a similar pattern in AntCo, where the CEO is considered the only person that needs convincing so a project can "fly" and renders further discussions with the TMT unnecessary:

> *"So, if the CEO says we'll do it, we'll certainly do it. Nobody will oppose it. If the CEO is still a little bit against, it must be discussed" (Senior Manager 1, AntCo)*

> *"At some point, the whole idea reaches a certain maturity, then I discuss it with our CEO. If he says we'll do it, it will get done; if not, we might discuss it in the team again" (TMT Member 3, AntCo)*

While *top-down* more commonly refers to the TMT taking all decisions for the organization without delegation, in our cases, the *top-down* is even representative of how decisions are made within the TMT, namely through the CEO.

Hybrid-action. We identified a mix of decision-making in two firms where we found that, in general, the TMT seeks to align and find consensus to make decisions. Still, we found instances of discussions where the CEO or the owner steps in to take final decisions for the TMT. Two cases exhibit *hybrid-action* for decision-making within the TMT, WrasseCo, and PyrosomeCo. In the case of WrasseCo, the organizational hierarchy is flat, but the TMT strictly makes decisions for nearly all topics:

> *"Nobody tries to control the organization; the flat hierarchy, of course, helps us; we live from that primarily" (CEO, WrasseCo)*

> *"Whether it's a project or an innovation, it's up to the TMT. In such cases, the TMT decides" (Head of Business Unit 1, WrasseCo)*

> *"Only the TMT takes decisions; nobody else influences it" (Senior Manager, Wrasse Co)*

And while the TMT members reported that they take decisions when are they in agreement, some instances showed that when there are controversial ideas and discussions, the CEO will have the final word:

> *"Yes, of course, we had discussions about the project; we have had the most intensive discussions about the timing and whether this is really what is needed or whether we need something completely different to move forward. It took us two or three attempts to get to the point where we said we can agree on it and move forward." (CEO, WrasseCo)*

> *"The paths are very short; if anyone has an idea, he comes to me, and if it is a good idea, it will not take long until I discuss it with our CEO that needs to be convinced" (Head of Engineering, WrasseCo)*

The second case where we identified *hybrid-action* was PyrosomeCo, where the TMT board usually is responsible for making the decisions for most things and describing similar flat characteristics as WrasseCo:

> *"It is always the same five people making the decisions. R&D, sales, controlling, my colleague the CFO and me. We say do we or don't." (CEO 2, PyrosomeCo)*

> *"We are very close as a TMT, and we have short paths and simple decision-making channels; we do not create big processes for such things." (Head R&D, PyrosomeCo)*

> *"We do project clearance, that is one document where we write down what we want, what the market is, what the costs are, where everyone says we believe that it needs this. Then everybody signs that, and we have a decision" (CEO 2, PyrosomeCo)*

And in cases of highly critical projects such as a recent multi-million costing digital project, the owner of the company decides on the TMT:

> *"Yes, in that case, the owner said 'we would do it. No argument, we do it,' and there was no process, and yes, in the case of X and Y, this was the same, owner and no process" (CEO 2, PyrosomeCo)*

Top-consensus. We identified two companies, PlatypusCo and MosquitoCo, that generally only described their interactions within the TMT to find consensus and the most viable option. They highlighted the discussions to understand projects and evaluate as a team. We found no evidence of a single person described as crucial to convince or that would have the final word on decisions discussed within the TMT. In the of PlatypusCo, the CEO himself describes his role as an evaluator and moderator, not a decision-maker for the TMT:

> *"I evaluate decisions mainly based on utility for our customers, and then it is not a decision in that sense. Instead, I discuss with the people; this would be my reasons, are there other reasons… until we find something together" (CEO PlatypusCo)*

> *"I don't [decide], I try to delegate if the decisions allow me to. Only when there are things needed like additional resources then they invite me" (CEO, PlatypusCo)*

It is described similarly by another TMT member of PlatypusCo; he describes the opinion of the CEO not as specifically necessary, but convincing the team in general that the CEO will ask for input is essential to get approval for initiatives:

> *"Influencing him [CEO] directly is not so important; I will first go to the people I know he will ask and talk to them. He wants to hear their opinion, and if they are already on my side, he will agree with them" (Head of Quality 2, PlatypusCo)*

While the CFO of PlatypusCo, a previous member of the TMT in BirdCo, talked about the kind of discussions they have within the TMT at PlatypusCo and compared:

> *"If I compare it with BirdCo, our discussions [at PlatypusCo] are much more technical. Some topics are hard for me to follow… some go down to the level of material used in our products; in BirdCo, it was more about convincing others…." (CFO, PlatypusCo)*

The other case of *top-consensus* is MosquitoCo; we found no instances where informants described a decision that was taken by a single individual or decisions that were not aligned according to a more comprehensive strategy that the TMT had already agreed on. The COO points out that since the board of directors asked the TMT to create a plan and a strategy for digital transformation, there is alignment within the TMT and another TMT confirms that there is little controversy:

> *"If I get the mandate from the board of directors to move digital transformation forward, then it becomes part of our strategy and part of our planning with that, and as a TMT, we need to agree on these things before releasing them" (COO, PlatypusCo)*

> *"We all agree that this topic is coming [digital transformation], and we clearly say that we are tackling it together and we want to do it. The only controversial topic might be how fast it is coming" (Head Division, PlatypusCo)*

While we observed that in very crucial decisions where it is hard to find a solution, some CEOs might take the final judgment or last vote, the CEO of MosquitoCo described how one of the most significant digital investments was discussed:

> *"Yes, we discussed it a lot, as this represented a multi-year, multi-million development project. And as it was in this software area, it was not as easy to evaluate as a hardware project. And it took a lot of intellectual effort, persuasion, and argumentation until we all agreed. We even talked with consultants to sound our views, and at some point, the board felt confident to proceed." (CEO, MosquitoCo)*

In sum, we found three *common mental frames* that informants used to describe the world and technologies around their organization, three sets of *common values* that they applied to evaluate things with a common set of criteria, and three different *organizational practices* used to make decisions within the organization. Table 5 summarizes our findings related to the individual cases.

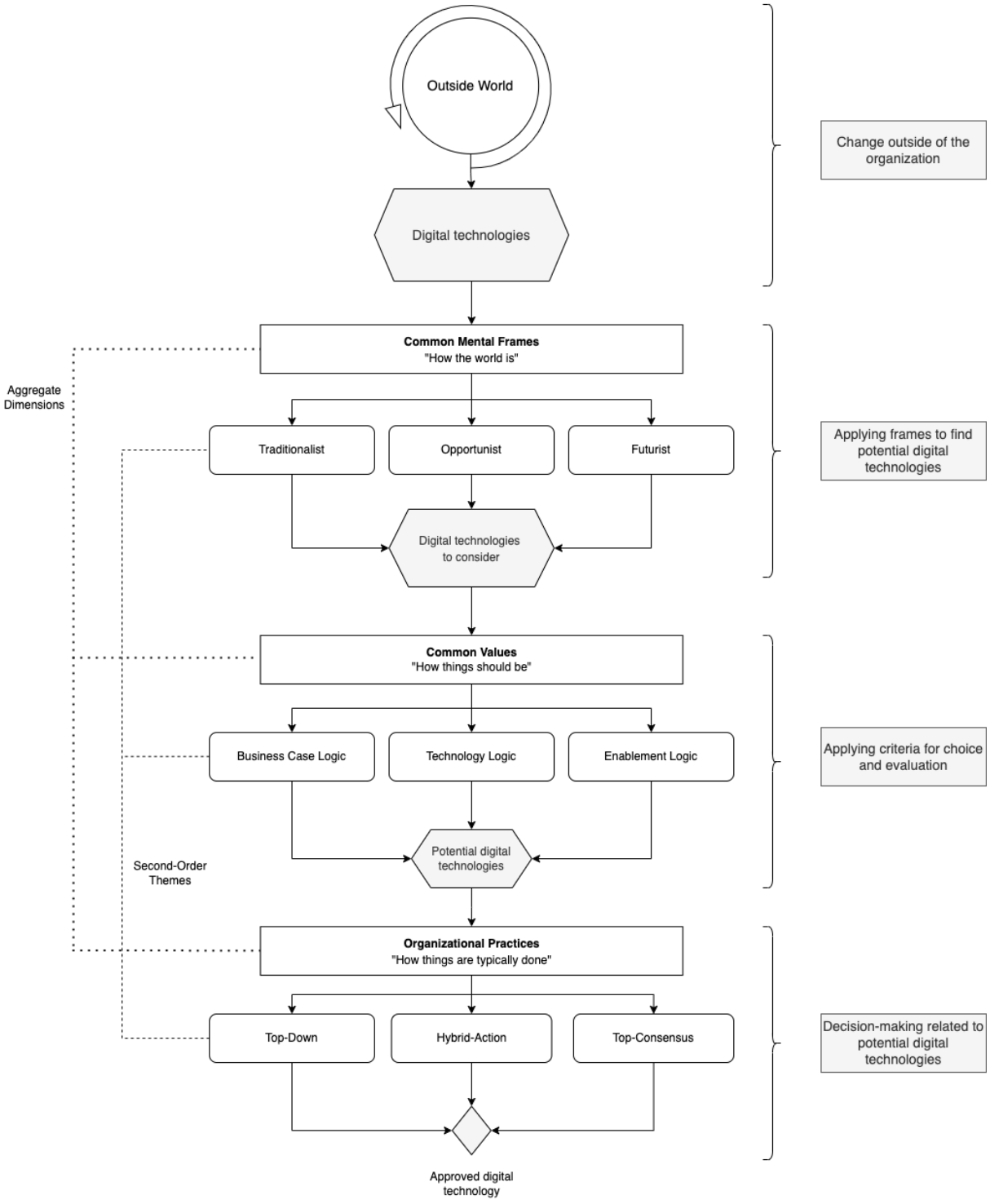
Table 5: Summary of findings per case

Category	Name	Shared Mental Model	Values and Decision Premises	Organizational Practice
Producer	**BirdCo**	Traditionalist	Business Case Logic	Top-Down
Producer	**PlatypusCo**	Futurist	Technology Logic	Top-Consensus
Assembler	**AntCo**	Traditionalist	Technology Logic	Top-Down
Assembler	**WrasseCo**	Opportunist	Business Case Logic	Hybrid-action
Integrator	**PyrosomeCo**	Opportunist	Technology Logic	Hybrid-Action
Integrator	**MosquitoCo**	Futurist	Enablement Logic	Top-Consensus

A.5.3. A Model Linking TMT Frames and Digital Transformation

To develop a grounded theory model, we will explain the relationships between our concepts and how they relate to our phenomenon of interest (Corley & Gioia, 2011). Through the connection of our aggregate dimensions and second-order themes that are visualized in our data structure (Figure 1), in combination with the individual findings in our cases, we create a model that shows the connection between TMT frames and digital transformation. Figure 2 visualizes this model and the relationship between our concepts, which start from an external change or trigger in the form of new digital technologies and end with selecting a specific digital technology. We found four phases around our discovered aggregate dimensions, linking the events between the existence of new digital technologies and the implementation or approval by the TMT.

Figure 2: Linking frames and digital transformation



Applying Frames

Throughout our cases, we observed how different common mental frames affect how our informants made sense of new technologies or digital transformation. It also affected which technologies they would consider looking at or discussing with their colleagues. This limits the possible pool of technologies that could be evaluated in a second step. When talking about the digital transformation at BirdCo, the *traditionalist* frame showed that they heavily start their search for digital technologies around their existing machines and disregard things that are not directly linked to their production. This filtering limits the already scarce discussions about technology, as one senior manager complains:

> *"If we talk about digital technologies here, everybody only talks about getting data from our existing machines with sensors and feeding them back. This is too little if we ever want to do a technology jump, simply looking at possibilities to gather data is too little" (Head of Production, BirdCo)*

Opposed to a very open approach by PlatypusCo that seeks as much input as possible on the topic and is consistent with the *futurist* frame we identified:

> *"Ideally, this [finding potential digital technologies] happens bottom-up; we found that telling people top-down what to look for does only work to a limited extent. Now we only lay the groundwork where we want to go and that we care, so people realize that these things are important and they come up with fascinating suggestions in these areas" (CEO, PlatypusCo)*

What passes through this initial filtering of digital technologies deemed appropriate to consider will then be evaluated.

Evaluation through common values and criteria

The digital technologies pass the initial frame as potentially interesting and will then be evaluated by specific investment boards, resource allocation meetings, or regular board meetings. Our three identified *common values* will be applied in such discussions to determine if the suggested technology is "worth it," and the evaluation will be used as a ground to make an informed decision. Such evaluation can be in a simple form as a business

case that is considered worth it when the ROI is positive, or in a more complex evaluation if the future potential of the technology is considered so high that it can justify the initial costs:

> *"The question is in the end, what is the return on investment and based on that we will decide if we want to do it or not" (CEO, BirdCo)*

> *"We evaluate such projects on a future potential, where we see a need to build that capability without necessarily focusing on, you know, the basic business case and milestone gated product development stages." (Head R&D, MosquitoCo)*

When the evaluation is done, it gets passed on to a decision-making board; in our cases and related to new digital technologies; it was most often the board of executives.

Organizational Practices

In the last stage, before a new digital technology is approved and implemented, a decision must be made based on the previous evaluation. As we mainly interviewed TMT and senior managers, all accounts of decisions made have been in the TMT board meetings. Here it will usually come to a final decision that allocates resources to move the project from a cognitive exercise into the material or digital world. The way that decisions are taken here, i.e., *top-down, hybrid-action, or top-consensus,* is essential to our model, as previous steps might have been done in anticipation of this final step. Especially in the *top-down* settings, other TMT members would anticipate the criteria and mental frame of the *top-down decision-maker* and use it to their advantage. For example, in the case of BirdCo, potential technologies would be presented with as much business and financial focus as possible to convince the CEO. Similarly, TMT members in PlatypusCo tried to make sure early on that they could individually convince fellow TMT members of technologies, as they knew that the consensus would matter in the board meeting.

A.5.4. How Frames relate to Digital Transformation Performance

We can compare the respective pairs of producers, assemblers, and system integrators as we have established our DTP for each company. A comparison across all cases would not make sense. The three pairwise comparisons, where we highlighted the higher-performing case with regards to DTP, can be seen in Table 6:

Table 6: Pairwise comparison: producers, assemblers, system Integrators

	Producers			**Assemblers**			**System Integratos**		
	Common Values			Common Values			Common Values		
Common Mental Frame	*Business Case Logic*	*Technology Logic*	*Enablement Logic*	*Business Case Logic*	*Technology Logic*	*Enablement Logic*	*Business Case Logic*	*Technology Logic*	*Enablement Logic*
Traditionalist		AntCo		BirdCo					
Opportunist		**WrasseCo**					PyrosomeCo		
Futurist					**PlatypusCo**				**MosquitoCo**

The distribution of cases within our 3x3 matrix confirms what we have observed during our company visits and interviews; the observed frames and values impact the DTP of the company. For example, BirdCo has the lowest DTP of all companies with the *traditionalist-business-logic* combination, while MosquitoCo ranks highest among all cases with the *futurist-enablement-logic.* In all three pairs, we can find the higher-performing case either lower or further to the right within our 3x3 matrix. Comparing producers shows that an *opportunist* frame is more desirable than a traditional frame, regarding DTP as an outcome. Since no other paired cases share the same frame regarding common values, we cannot conclusively say if the *futurist* frame would be more desirable to achieve a high DTP. But from the content of our interviews and the general distribution of cases, we believe any movement downwards or to the right in the matrix is generally desirable for a company seeking to increase its DTP.

A.6. Discussion and Implications

Our final framework that connects the *common frames, common values,* and *organizational practices* and our identified contributes to the general literature on digital transformation and specifically to the literature on TMT frames. Our findings suggest that digital transformation is not a well-defined phenomenon for practitioners with a shared meaning across industries or companies. Instead, digital transformation is interpreted by TMT members and senior managers through an existing *common frame* that influences the way they will make sense of the observed digital technologies and what they deem helpful or interesting for their own company.

TMTs perception of Change and Digital Technologies

While previous research has studied the difference in awareness of TMT members of capabilities of technologies in public sector organizations, it focused on disagreements between the business and IT leaders and how they can be aligned to accelerate digital transformation (Hansen et al., 2011), or the alignment through frames of specific company divisions such as the IT and business division to foster transformation (Haffke et al., 2017). We argue that before an alignment process could start, an underlying, more *common frame* determines the amount of awareness TMTs want to devote to digital transformation and digital technologies. Additionally, we identify three specific *common frames,* i.e., *traditionalist, opportunist,* and *futurist,* that offer the ability to determine what type of framing is present in the company. At the same time, previous research has focused on positive attitudes towards digital transformation and its characteristic (Dery et al., 2017). While scholars argue that successful companies are less willing to transform compared to failing companies that are motivated to transform themselves (Andriole, 2017), we found that the two most cases that are transforming and embracing digital transformation the most (PlatypusCo & MosquitoCo), both *futurists*, are highly successful companies and industry

leaders in their respective domains. We can confirm the suggestion of Day & Shoemaker (2016, p. 75) for companies "Ideally, sensing and adaptation systems are less-tailored to the firm's current capabilities and more to future trends and uncertainties" we believe the *traditionalist and opportunist* represent the idea to relate digital transformation to past or existing technologies, while the *futurist* focuses on future of the organization. Similarly, Benner (2007) concluded on the topic of technological change that TMT members must be aware of change within the industry and their environment to be able to detect new potential technologies to stay competitive; we believe this is also captured in our *common frames* that TMT members use to make sense of how the world is changing.

Values in TMTs regarding Digital Transformation

While (Alos-Simo et al., 2017) show that transformational leadership can influence the adoption of digital technologies in manufacturing companies, where leaders prioritize such projects, we show that applying values and criteria to evaluate projects relies on the *common values* held by the leadership. These *common values* decide if digital transformation can be 'sold' to the upper management and if it will receive continuous support from the TMT in order to succeed (Andriole, 2017). We show that the *common values: business case logic, technology logic,* and *enablement logic* that are used to evaluate digital projects will affect the DTP of a company, as these logics determine how they estimate the value or potential of a project. We did not encounter a single decision within the TMT that was supported or taken by AI (Kolbjørnsrud et al., 2016) but have observed that for particularly complicated decisions, consultants were used to provide arguments to support specific decisions. Prior research has found that the investment rationale, which is similar to our *common values*, can be used to predict TMT championing of web technologies, seeing that projects focused on cost reduction and savings gain more support (Chatterjee et al., 2002), we

extend this finding by being able to predict which factors in evaluation they will focus on based on their *common values*.

Similarly Gale & Aarons (2018) found that companies that trained their employees specifically to understand and see the value that digital technologies are more successful at becoming digitally transformed through increased support by organizational members. They confirm that decisions people must make are fundamentally different concerning digital technologies, and without proper training, they fall short of grasping the potential. Through our findings, it is possible to assess the current logic applied to evaluate digital technologies and in what direction this logic might have to be changed, e.g., from business to technology or *technology* to *enablement*. Field (Gerth & Peppard, 2016) identified one possible way of shifting logic, as they found that the CIO can engage in increasing the technology literacy of his TMT colleagues in enhancing their understanding of the potential value of IT technologies.

TMT Frames and Digital Transformation

Research on digital transformation strategy has found that it is cross-functional and cuts across other functional and operational strategies. It notes the difficulty firms have to achieve a shared goal and calls for guidelines to support firms (Matt, Hess, & Benlian, 2015). We believe we offer at least two areas where such alignment should be sought before a strategy is formed; frames and values should be examined so strategy makers can be aligned on 'how things are' and 'how things should be' in the first place, our interviews have shown that some informants wished for a *technology logic* while their fellow TMT members are arguing in a *business logic* setting. Similar to this, we found surprising stability of "truce" (Nelson & Winter, 1982) in observed frames and TMT discussions; from the accounts of our informants, it never seemed like there were motivations to actively make a frame triumph over another (Kaplan, 2008). The only instance was MosquitoCo, where the CFO was

stripped from his responsibilities over the IT department of the community to, in some sense, lessen his frame on the decisions taken regarding IT-related projects. With this stability, we also felt that these frames were deeply embedded in the organizations and expressed through the common frames we observed within the TMTs (Henderson & Clark, 1990).

Digital Transformation and Organizational Practices

While a previous single case study on digital transformation has argued that new forms of governance are required for digital transformation and might require a separate board that reports to the CEO (Chanias et al., 2019a), we did not see any problem regarding the process of decision-making through established *organizational practices.* While the observed *organizational practices: top-down, hybrid-action, and top-consensus,* influence the *common values* that are most likely applied in the end and need to be considered if competing frames would need to be studied (Kaplan, 2008), as in a strictly *top-down* setting, any frame competing against a powerful CEO will most likely 'lose' or 'fail.' Throughout our interviews, we also mainly investigated if TMT members feel the need for a Chief Digital Officer (CDO), but not a single informant thought this was a requirement; they instead pointed toward the *common values* that are applied within the board that is of importance. Previous research on the position of the CDO concluded that CDOs are establishing themselves as a new member within existing TMTs and guide organizations through their digital transformation (Singh & Hess, 2017), but was conducted in more digital industries (e.g., finance and publishing), where such roles could be more important due to higher market pressure in terms of digital transformation. We believe the industry plays a crucial role in researching digital transformation as the requirements and expectations vary strongly across sectors.

Digital Transformation Performance

We believe that measuring digital transformation within a company is very difficult as no well-established measures, especially in qualitative research, can be applied to companies in various industries. Our method of assessing DTP can be applied to any company, but it should only be used to compare companies in a similar category, i.e., *producer, assembler, or system integrator*. Otherwise, the measures based on specific product and production characteristics lose their meaning. While we were able to populate six different quadrants of our 3x3 matrix, leaving three spaces empty, we believe that only seven are "inhabitable." The combination of *traditionalist-enablement logic* and *futurist-business logic* seems counterintuitive as *enablement* requires the incorporation of future possibilities, and the *business logic* does correspond well with a focus on an uncertain future. Our measures are also specific to manufacturing companies as they include production; we believe that any particular industry would need a specific set of measurements to estimate the company's degree or performance regarding digital transformation.

A.6.1. Future Research Directions

This study offers a model and a performance metric to study and measure digital transformation in manufacturing firms that can be applied in future studies. Although we identified existing frames in TMTs, we could not witness how they come into existence and how potentially new TMT members are affected by existing frames. Furthermore, an important question for future research is if there are other types of *common frames* and possibly *common values* and what types are better under what external circumstances. Our case companies have all been studied at the same time when the economy was doing very well; it must be seen if frames like *futurist* would be doing as well or disappear if economic circumstances are less favorable and companies go from growth into a survival mode. Although we have a body of research on the resource allocation process, most notably:

Bower (1970), Burgelman, (1983), and (Bower & Gilbert, 2007), we lack research that can identify frames and how resource allocation decisions can be predicted through them. As our case study consisted of three pairs, we could only compare a higher and a lower performing case per pairing regarding the DTP. Future research could be focused on a deep dive into a specific category, such as the *system integrators,* and create a more fine-grained analysis of DTP and frames with more similar cases that allow for further comparative studies.

A.6.2. Managerial Implications

By identifying common frames, common values, and organizational practices that impact DTP, we offer three managerial implications for TMTs. Firstly, TMTs need to assess critically and truthfully which frames and values they currently hold. For example, knowing that the *common frame* is *traditionalist* allows TMT members to identify backward reasoning relating to their past, e.g., why they cannot pursue a particular technology because we did X in the past, and actively identify which individuals are promoting such frames and the members that maybe hold a different frame. Secondly, TMT members need to consider if such a member can adapt his frame through discussions or more knowledge or is unwilling to adjust his frame; otherwise, switching that member's responsibilities or maybe searching for a replacement might be required. As our external interview with a CEO that consults companies with regards to digital transformation put it with regards to the wrong mindset of TMT members:

> *"At some point, you realize that person is a lost cause and will never change, then you need to get them out of the way, or they will slow you down" (CEO 2, External)*

The board of directors or owners should consider this implication regarding the TMT they oversee. A TMT might be stuck in an undesirable frame and value combination, unable to change or willing to adapt by themselves. At that point, intervention through the board of directors might be needed to enforce change within the TMT and the organization. Thirdly,

organizations need to consider their resource allocation process to identify where frames start to affect possible decision-making and who is making those decisions, as these individuals or groups hold frames that will possibly either identify digital technologies that are to be considered or make the decisions on what should be approved and ultimately funded.

A.7. Limitations

This study naturally comes with limitations in addition to the typical limitations of inductive case study research. We heavily rely on the accounts of our interview partners and their perception of how things happened and how things were decided. We tried to alleviate this limitation through interviews with as many informants as possible that were present for the discussions and decisions to get an as unbiased as possible understanding. We attempted to gain access to transcripts of TMT meetings, but even with NDAs signed with each company, we could not do so. We visited all the companies in person and were taken through production lines and shop floors to see and confirm what technologies are implemented and how the product is manufactured or assembled. When people mentioned documents that were used to evaluate and sign off projects, we always tried to gain access whenever possible to confirm the story of our informants.

Further, all our informants and companies were based in the same geographical region in Switzerland, with a very high cost of labor and real estate, with comparably low cost of capital. As many of our informants noted, some technologies for, e.g., automation, that are being considered here would never even remotely pay off in countries with different cost structures. While this geographical limitation might affect our identified dimensions, more frames might exist elsewhere. We believe that the more homogenous external environment makes the cross-case comparison of our frames more reliable and valid. While we do have six cases that are investigated closely, we only have two companies per category that are not precisely in the same industry, e.g., machines for packaging versus devices for lab

automation; while surprisingly similar in the end, further studies with companies that produce the same might be needed. Finally, out of over 90 interviews with senior managers or TMT members, we only interviewed two female TMT members and one senior manager. While we did not identify any specific differences in their frames or values, it might be possible that female executives hold different frames or values in similar contexts compared to their male counterparts. In generalizability, this limitation does not pose an issue since (unfortunately) most TMT and senior management positions in manufacturing companies are held by men.

We believe our findings are generalizable within the manufacturing industry but should not be applied to other sectors, such as retail or banking, as our research goal was to understand digital transformation in manufacturing specifically. Other industries are less prone to decisions that include the 'digital or durable' decisions we were interested in.

A.8. Conclusion

Research on digital transformation is rapidly expanding and evolving in all fields of strategy, management, and operations. We believe this study has helped to build avenues for further in-depth research on frames relating to digital transformation and offers a metric to measure it in manufacturing. The possibilities of new digital technologies are growing daily and show no sign of slowing down or stopping any time soon. Therefore, research on digital transformation will be in high demand in the foreseeable future. Understanding this phenomenon could provide an edge to companies to make it to the future and save them from being remembered as the traditional manufacturer from back in the day.

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A.10. Appendix

A.10.1. Appendix I

A.10.2. INTERVIEW GUIDE I (90min scheduled)

Getting to know the informant

1. Could you tell us a little about yourself and how you got here?
2. How long have you already worked in the company, and what is your background?
3. What does a typical day of work consist of?
4. Which topics are currently most important? Any technology-related ones?

Position of an informant within the company

5. What is your function, and what are your responsibilities?
6. What does your team look like (size, type of members)?
7. Who are you in contact with the most? About what?
8. What does your contact with TMT and senior management members look like?
9. Who are you in contact with the most externally? About what?

Technology projects

10. What are the most important projects you are currently involved in?
    a. What are the goals of this project, and how did it start?
    b. What were the most important reasons to start it?
    c. What did the discussions look like at to start it? Were there disagreements?
    d. What other roles and functions are involved in the project?
    e. What is the relevance of the project to your company?
    f. Where did you get the know-how for this project?
    g. What were the biggest challenges in the project?
11. Any projects that were concluded recently (ask 10. Questions if necessary)
12. Any project recently that was discussed and was not able to start or was put on hold?
    a. What were the main problems? What were the expectations vs. reality?

New ideas

13. If you have a new idea or plan, what will you do with it?
    a. Who is most important in the company to convince to get it going?

b. What type of ideas is easy to pursue, and which ones are hard? (software vs. hardware, big vs. small, expensive vs. cheap)
c. If there is a formal process, what does it look like?
d. How do you feel about this process? Advantages/Disadvantages

14. Who is a particularly innovative person within the company, in your opinion?
a. Why this person, and can you describe what makes this person innovative?
b. Any external person or company that is important?

Strategy

15. Could you briefly walk us through the general strategy of the company?
16. How would you describe this strategy is formulated?
a. What is your role in that process, and how often does it happen?
b. What person is most important/influential on this strategy?
c. Is there any person that makes final decisions?
d. What do you think about this process?
17. How does the company communicate its strategy?
18. How vital are technological topics and discussions in your meetings?
a. What are the most important topics currently?
b. Could you give us examples where there is agreement and disagreement?
c. How do you resolve these?
19. What do you think about the strategy of your company?

General open questions (if time permits)

20. What are the most significant opportunities for your company?
21. What are the current challenges for your company today/past?
22. What worries you the most?

Ending questions

23. Do you have a suggestion on whom we should talk to next?
24. Did we forget anything important?

A.10.3. INTERVIEW GUIDE II (60min scheduled)

Getting to know the informant (if the informant was new)

Getting up to date

1. What have you been up to since we were last here x months ago?
2. Did we miss anything significant for the company during this time?

Technology projects

3. Are any new technology projects about to start or being discussed?
4. If Yes:
   b. What are the goals of this project, and how did it start?
   c. What were the most important reasons to start it?
   d. What did the discussions look like at to start it? Were there disagreements?
   e. What other roles and functions are involved in the project?
   f. What is the relevance of the project to your company?
   g. Where did you get the know-how for this project?
   h. What were the biggest challenges in the project?

Previous technology projects

Note: Here would be an existing list of projects discussed in the previous interview, and we would ask for information that we felt was missing in our data.

5. Do you remember how you pitched the project?
   a. How did your colleagues initially receive the project?
   b. Are there any specific tricks/techniques you must convince your colleagues of?
   c. What was discussed most about the project? (budget, technology, return, size)
   d. How did you discuss the budget for the project?
   e. What is the biggest obstacle to such a project? (technology, people, admin)
6. What would you change about the way you evaluate new ideas/projects?
7. Who do you first discuss with when you have an idea for a new project?

Questions about missing documentation

8. Could you send us X or give us access to the X you talked about?
9. Did we forget anything important?

A.10.4. INTERVIEW GUIDE III (60min scheduled)

Getting up to date

1. What have you been up to since we were last here x months ago?
2. Did we miss anything significant for the company during this time?
   Resource

Previous technology projects

3. How is the project going?
4. Ask about any last missing information about a specific project

Resource allocation

5. Could you walk us through the process of when a project needs to be funded? (step by step)
   b. Who is involved at what stages?
   c. Who is most important in this process? Why?
   d. What happens if there is disagreement at some stage?
   e. At what budget levels does this apply/when does it not apply?
   f. Is there a person that has more decision power than others?
   g. What do you like or dislike about this process?
6. Could we do this process step by step for a previously discussed project?
7. Was there a specific project where the process was adapted or changed
8. Did we forget something important?

Note: Questions were improved between interviews, especially during the first interviews, as we learned which questions resulted in rich answers and which did not. These are the most common questions we used during the meetings for the respective interview wave.

8.2 Appendix B – Study II: Taking Advantage of NFTs to Enhance Your Online Community

(continued on next page)

B.1. Introduction

Blockchains, cryptocurrencies, tokens, and non-fungible tokens (NFTs) have recently made business headlines. Cryptocurrencies reached a valuation of over 2 trillion USD, and application diversity is increasing by the hour. NFT has become Collin's Dictionary's Word of the Year 2021 and is a candidate for the 2022 MIT Technology Breakthrough. Recently, scholars found that blockchains could be used to motivate cooperation and coordination in online communities[i], leading to a growing interest in the applications of blockchain technologies across settings[ii]. This article posits that beyond artwork, NFTs could prove to be powerful tools to engage online communities in novel ways.

Online communities have emerged as potent forms of organizing discourse in many economic and social areas. In such circles, a vibrant and engaged user base is essential for sustaining community activity[iii]. Thus, measures to promote engagement with and between community members are an important ingredient for success[iv]. However, sustainable community engagement is a challenge given the staggering fluctuations in membership[v,vi] and fading motivations to contribute[vii]. Given the mounting evidence, we believe NFTs could add and serve as powerful incentives to build communities and keep members engaged[viii].

In the following, we first offer the reader a better understanding of NFTs by distinguishing them from blockchains and cryptocurrencies. Then, we present three strategies to leverage NFTs in online communities: (1) *turning* customers into contributors, (2) *creating* social belonging, and (3) *bridging* intrinsic and extrinsic member motivations. Additionally, we present a 3x3 configuration matrix to support the identification of an organization's most suitable NFT strategy. We then exemplify the strategies through three real use cases developed from interviews with industry experts. Finally, we discuss organizational challenges to be considered when adopting NFTs.

B.2. What are NFTs?

The technology behind NFTs can be understood by distinguishing it from other related but different technologies. For one, blockchains are distributed digital ledgers managed via cryptographic algorithms[ix]. They eliminate the need for a centralized verification system by providing a secure, transparent, and immutable trail of the transaction history. These features are safeguarded by the network participants who provide computing power (proof-of-work) or money (proof-of-stake) in exchange for the blockchain's native cryptocurrency (e.g., ETH for Ethereum) to validate new transactions. The development of smart contracts – algorithmically enforced agreements between two parties – allows the proliferation of *(decentralized) applications* in various domains such as supply chain tracking, medical data transfer, digital identity issuance, or intellectual property management.

Next, the fungibility of an asset is its ability to be traded for another of the same type, e.g., exchanging one Bitcoin for another random Bitcoin. Conversely, Non-Fungible Tokens (NFTs) are unique assets that cannot be copied or changed but are tradeable. The blockchain serves as a public record of their provenance.

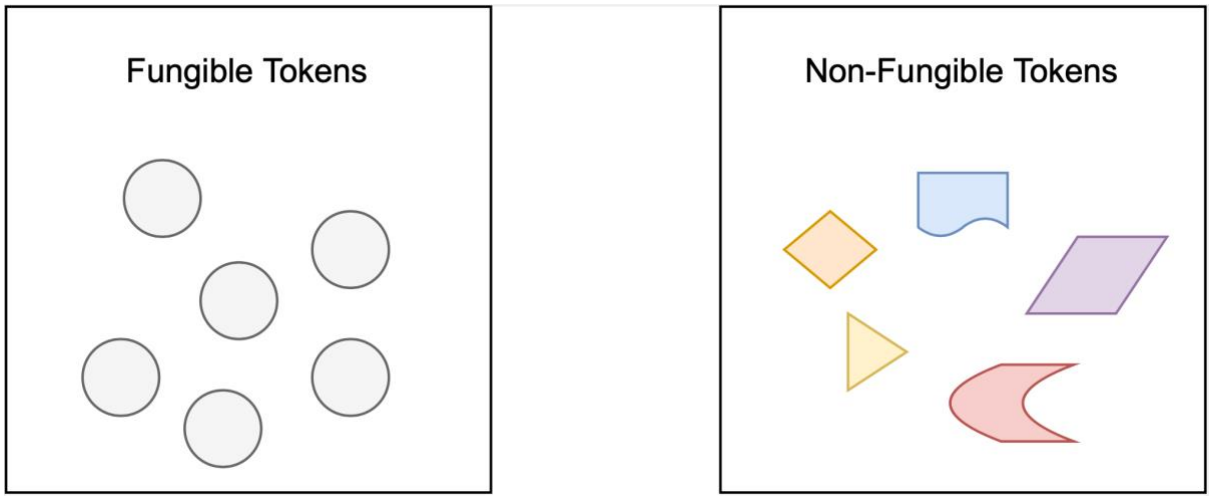

Figure 1: Fungible and Non-Fungible tokens

NFT adoption was boosted by the ERC-721 standard, released on the Ethereum Blockchain in 2021. It facilitated the issuance of non-fungible tokens with smart contracts, encouraging companies, including Adidas, McDonald's, and TIME Magazine, to explore the potential of NFTs in their business. Today, NFTs are most prevalent in the digital art and collectibles spaces.

B.3. Engaging Online Communities with NFTs

We categorized projects along two dimensions by examining more than 200 blockchain applications and NFT projects that draw on online communities initiated and/or managed by the organization. First, organizations and their online communities differ in how they engage in the creation process (bottom-up, hybrid, top-down). Second, organizations differ in their orientation towards their online community (operational, social, strategic)[x].

The categorization allowed us to identify three configurations (blue boxes) that creatively use NFTs as a powerful incentivization tool. This blue diagonal represents configurations in which NFTs have successfully fostered bi- or multi-lateral engagement. We present three cases along this diagonal. The other six cases employ NFTs more passively, e.g., the Graph issues NFTs as a receipt for creating a search query, while Nike sells a digital sneaker as an NFT. While these are successful use cases, they do not represent configurations in which NFTs foster and incentivize community activity or engagement.

Creation Process/Orientation	Operational	Social	Strategic
Bottom-Up	**The Graph**	**POAP**	**HOPR**
Hybrid	**Uniswap**	**Ethereum Naming Service (ENS)**	**The Sandbox**
Top-Down	**AVADO**	**NIKE**	**Meta (Facebook)**

Table 1: Examples of organizations using NFTs in different configurations

The Graph	Users create subgraphs (APIs querying blockchain data) that they own as an NFT.
Proof of Attendance Protocol (POAP)	Users receive an NFT as a badge for attending events.
HOPR	Members participate in activities of the organization and receive NFTs as rewards, which also strengthen voting power in the organization.
Uniswap	Users provide liquidity for the decentralized exchange in the form of an NFT.
Ethereum Naming Service (ENS)	The NFT serves as proof of ownership for a .eth domain name.
The Sandbox	Users can create and trade NFTs that are digital assets in the metaverse.
AVADO	NFT serves as proof of physical ownership and is used for business processes.
Nike	Users can purchase digital versions of their sneakers in the form of an NFT.
Meta (Facebook)	Meta is creating a metaverse in which they will sell NFTs.

Table 2: Exemplar organizations and their respective NFT deployment in online communities

B.3.1 Strategy 1: Turning your customers into community contributors

"The NFT is a trigger for a lot of processes, and these processes can be made very efficient because they are automated. Instead of verifying a user's warranty, or if he has signed something, or to check if he is in a database that I would need to maintain, I simply check his NFT."

Bernd Lapp, CEO of AVADO

AVADO is a blockchain-computer manufacturer offering all-in-one solutions for blockchain computing power, storage capacity, and internet bandwidth delegation. AVADO leverages the non-fungibility of NFTs to accurately and automatically identify customers and pair devices through an entirely anonymous process. The NFTs that customers generate (i.e., "mint") contains information like the time of purchase, warranty, and the device's technical specifications, absent personal information.

The *turning customers into contributors* strategy leverages NFTs to incentivize customers towards more active community member roles. This strategy is well suited for organizations seeking to deploy top-down online community structures for resolving operational tasks, such as answering troubleshooting questions from new customers in the case of AVADO, which presents an attractive value proposition because such delegation can reduce the organization's fixed and variable operational costs[xi].

AVADO took a top-down approach to face the dynamic demand for onboarding support. It set up an incentive structure for its customer base via NFTs to add peer-to-peer assistance or contributions to the common knowledge base. Each device sold releases a budget that users can allocate through "praises." AVADO then rewards helpers with a US-pegged stable coin cryptocurrency (DAI) according to the number of praises received (one praise was worth 11$ in February 2022). According to Lapp, active community members receive up to 500$ a month

through "praises," eliminating AVADO's need to hire a dedicated support team. This strategy incentivizes customers to engage in mundane tasks that often need significant intrinsic motivation in other settings[xii]. The company managed to grow its customer base by over 100% within the last year without hiring a single customer support member.

Bernd Lapp has been part of the blockchain space since 2014 when he first heard about the capabilities of Bitcoin. In 2015, he joined the Ethereum Foundation as an advisory board member. In 2018, he joined the DAppNode team that would later spin out Avado as a node manufacturer, where Bernd is now co-founder and CEO.

B.3.2 Strategy 2: Creating social belonging

"When Vitalik [founder of Ethereum] just put his .eth name on his Twitter, it started to blow up. This changed our thinking; the names are not just for cryptocurrency payments, they're not just websites, people associating this, just like branding, it's like your digital identity."

Jeff Lau, Senior Developer of ENS

Sociality – a tendency for people to build rich and supportive relations – is worth striving for in online communities because it keeps people engaged[xiii,xiv]. This second strategy aims at *creating social belonging* in online communities that emerge in both a top-down and bottom-up fashion. Providing infrastructure for users to create and shape their online identities within the ecosystem has proven paramount for promoting sociality. The Ethereum Naming Service (ENS) represents this infrastructure for the Ethereum ecosystem. Its significance is evident from the average weekly fees users pay to ENS of approximately 300,000 USD[xv].

ENS is a decentralized protocol launched in 2017 before NFTs became standardized. Its role is analogous to the Domain Name System (DNS) that current web applications use insofar as it translates computer identifiers into easily readable names. However, as its name suggests, ENS provides this service on the Ethereum blockchain. For instance, the wallet address of Vitalik Buterin, founder of Ethereum, is *0xAb5801a7D398351b8bE11C439e05C5B3259aeC9B,* now resolved by the ENS address *vb.eth*.

In 2019, ENS migrated its registry into an NFT (ERC-721) format. Consequently, ownership of ENS domain names became transferable via conventional NFT marketplaces. Initially, the goal was to make the Ethereum blockchain more accessible for users. What ENS did not expect, however, was that .eth would turn into a signal of support for Ethereum, a marker of community belonging, and a piece of digital identity for users within the Ethereum blockchain. It allows members to link their identity to their actions transparently and verifiably while protecting their anonymity[xvi].

Jeff conducted a Twitter survey to understand why users would display their .eth identity on the platform. The survey results indicated that being able to display support, develop a sense of belonging, and the increased trust from verifiable community figures are powerful social signals that promote knowledge exchange among users.

Jeff Lau is a trained graphic designer who switched to web development and entered the blockchain space in 2016. In 2017, he pitched a proposal to Nick Johnson (founder of ENS) for a freelance gig and has been with ENS ever since. Jeff is now a senior member of ENS and mentors developers who want to enter the Web3 space.

B.3.3 Strategy 3: Bridging intrinsic and extrinsic motivation

"*NFTs are an interesting concept, like a lot of the things that you do anyway can be captured by NFTs. It's just a different way of thinking about something, like a token of gratitude or the representation of something that a community member did."*

Sebastian Brügel, CEO of HOPR

HOPR uses NFTs to incent community members to engage in key strategic network development decisions. Additionally, to attract new users, HOPR has gamified its onboarding with an educational online treasure hunt that awards valuable NFTs and tokens as prizes. HOPR uses the third strategy, where NFTs are deployed to *bridge intrinsic and extrinsic motivation* to leverage the community strategically.

From past research on online communities, we understand that intrinsically motivated members who find the tasks inherently attractive contribute more than extrinsically motivated individuals who perform tasks in exchange for a tangible reward[xvii]. Yet, rather than rewards crowding out intrinsic motivation, we also know that a mix of extrinsic and intrinsic motivation may offer the best results under many conditions[xviii]. This is particularly true in projects expected to be community-driven, and such members are required to create and discuss strategic initiatives.

The HOPR Association aims to provide data privacy and control to users. The network represents a decentralized, anonymous peer-to-peer network run and owned by its users (nodes) and governed via a Decentralized Autonomous Organization (DAO) comprised of all HOPR holders. The DAO coordinates and makes decisions for the HOPR protocol via democratic votes on the community's proposals (1 token = 1 vote).

HOPR NFTs work as interest rate boosters and allow users to upgrade the benefits they get from depositing their tokens in the HOPR staking smart contract. Instead of redeeming the NFT, community members can also trade it on an independent marketplace for other currencies. NFTs awarded for valid proposals in a DAO vote can be worth up to 250 USD. By incentivizing active participation in the project's strategic direction, HOPR token holders are encouraged to become activists. As a result, HOPR has increased community governance participation in the DAO by 61% in less than a year.

Dr. Sebastian Brügel is the founder and CEO of HOPR. Before joining the blockchain world, he worked as a biomedical engineering postdoctoral researcher. Before HOPR, he co-founded Validity Labs, a company focusing on educating people about blockchain applications and other decentralized technologies.

B.4. Challenges to Consider when Dealing with NFTs and Communities

Considering the recent nature of NFTs, our three proposed strategies also carry certain risks. Below, we outline three: community rejection of NFTs, development ecosystem selection, and potential security risks such as frauds and hacks.

B.4.1 Community rejection

Not all communities display enthusiasm for NFTs. For instance, while most NFTs owners interact via Discord – a VoIP and instant messaging platform popular among gamers – its core user base was not enthusiastic about NFTs making their way onto the platform. On the other hand, Twitter, popular among NFT aficionados, recently released NFT integration for profile pictures and the possibility to tip users with Bitcoin and Ethereum.

Mitigating community rejection requires a good understanding of the community via careful observation of digital traces complemented with surveys or interviews with key members. We know that each online community develops its own identity and values. Ensuring these are compatible with the technology is fundamental to leveraging NFTs.

B.4.2 High transaction costs within the ecosystem

NFTs have been created on various blockchains, including Ethereum (and Layers 2), Solana, Binance Smart Chain, and Avalanche. These blockchains present trade-offs between security, decentralization, and scalability, translating into transaction costs that differ greatly between ecosystems. Yet, leveraging the network effects of a given ecosystem – the theory that users increasingly benefit from a growing user base – might outweigh the costs of interacting with its blockchain. Until now, most successful NFTs projects have been developed on the Ethereum ecosystem, infamous for its high transaction costs during peak usage, such as in May 2021, when one transaction cost up to 500$.

HOPR, on the other hand, deployed its NFTs on the Gnosis Chain, which allows users to incur comparatively negligible costs.

B.4.3 Lack of community awareness

Today, NFTs are a cutting-edge technology known by few, and many community users might be unfamiliar with the security requirements for protecting their digital assets. There have been several cases of phishing attacks and social engineering schemes that successfully stole assets from unaware users. For example, Arthur Cheong, founder of venture capital firm DeFiance Capital, lost $1.7m worth of NFTs because of such an attack.

If an online community is not “crypto-native,” users will require instruction on securing their digital assets properly. Steps include using a hardware wallet such as Ledger, keeping the password in cold storage, and cultivating habits of permanent vigilance, among others.

B.5. OUTLOOK

NFTs began their rise in 2021 and can still be considered a novel asset class and emerging technology with an unpredictable future trajectory. We believe that NFTs will play an important part in how companies, decentralized entities, and individual users within online communities interact. While we describe three distinct strategies to leverage configurations through NFTs in this article, we expect more complex applications of NFTs in the future. These applications will integrate the unique properties of the blockchain as an ecosystem and NFTs as a technology for value creation.

We would like to thank Prof. Patricia Wolf for the careful and insightful review of our article and her helpful comments.

About the research method

- To explore the application of NFTs in the blockchain space, we drew on multiple sources of information to find projects using NFTs. Coingecko.com was used to gain an overview of NFT-related tokens.
- Within 200 NFT-related tokens, we visited project websites and social media channels (such as Twitter, Discord, and Discourse) and screened announcements on medium.com to index the use cases of NFTs related to the token.
- After clustering the use cases, we decided to reach out to individual team members (such as community managers, developers, and owners) to understand their motivations for using NFTs and how it has impacted their community. This also allowed us to find more NFT-related projects (such as AVADO, since it does not have a token issued) that held relevance to our research.
- We then held 60-90-minute interviews with members of the four most insightful cases. We presented three of them in this article (one case was omitted due to similarities with another presented case).

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8.3 Appendix C – Study III: Please Join Our Closed Community! A Case Study on Creating and Implementing an Online Community Within the MedTech Industry

(continued on next page)

C.1. Abstract

Research on online communities has shown that they can create value for members and sponsor or member companies alike. Users often contribute to online communities because of intrinsic motivations, such as participating or helping, and extrinsic motivations, such as social recognition or career benefits. However, little is known about closed and confidential online communities in industries such as life-science or MedTech. We believe that the medical device industry, with its increasing level of digitization, could become a potential host of highly specialized communities. These communities could provide benefits to members and companies alike, reducing cost and representing a source of innovation. Therefore, we need to understand what motivates these potential community members, in order to understand how a company can successfully create an online community around a medical device. Based on a single-case study of Medima, the manufacturer of DeviceX, a device used by a highly skilled, small, and educated userbase, we shed light on motivations and expectations in an online community that could only exist in secrecy and confidentiality. We inductively develop a framework that explains what motivations and requirements users in a medical or health related field have, to consider participation and engagement in an online community. Following this, we reveal very that users have very high expectations towards the host company, in terms of community support, involvement, and how the host can successfully guarantee the security and privacy of the community.

C.2. Introduction

Online communities have been an important topic for industries and researchers alike for over 20 years now. They are a novel form of organizing and can bring together a large number of individuals supporting interests or identities, with fluid boundaries and often anonymity (Faraj, von Krogh, Monteiro, & Lakhani, 2016). Brands use them to foster engagement and interaction with their customers (Fournier & Lee, 2009), while researchers are interested in various aspects ranging from how knowledge is shared (Wasko & Faraj, 2005) to why people are actually sharing knowledge in the first place (von Krogh, Haefliger, Spaeth, & Wallin, 2012). Companies have multiple goals for engaging with or creating an online community: the community might create and reveal valuable knowledge to the company as an external source of innovation or even offer new perspectives to reframe existing problems (Dahlander, Frederiksen, & Rullani, 2008).

Technology has evolved rapidly in the last 20 years, and with it, the means of connecting people and the ability to communicate in various forms, ranging from basic email, virtual calls, and online conferences to meetings in the metaverse (Chodot, 2022). But it is one thing to create the technical capabilities that allow individuals to connect, and an entirely different matter to create a community of connected individuals (Erickson, 1997).

Online communities consist of more than the technological underpinnings on which they rest (Howison & Crowston, 2014). They are also characterized by their own sociality, set of values, and often, high membership turnovers (Ransbotham & Kane, 2011).

A significant amount of scholarly knowledge on online communities has been derived from studying those that exhibit a very open nature in terms of who can join and how quickly they can join. Most of the time, online communities can be accessed by creating an anonymous account and are open to everyone with no restrictions on what is required to be a member. This open nature was abundant in two places: the communities that worked on open

source technologies such as the Apache suites (Lakhani & Hippel, 2004) and places that are used to host and manage open source code from users such as GitHub (He, Puranam, Shrestha, & von Krogh, 2020).

In these open communities, continuous engagement and community "liveliness" are essential to sustain it over time, since without activity, we revert from a community back to pure technologically connected individuals (Erickson, 1997; Ray, Kim, & Morris, 2014). Therefore, the capacity of the forum or online community to foster engagement between members becomes a key aspect of creating and maintaining such a community (Afuah, 2013). However, even with no restrictions on membership and a very low barrier to entry into such communities, continuous engagement has been a key problem in addition to the sometimes-large fluctuations in membership (Arazy, Daxenberger, Lifshitz-Assaf, Nov, & Gurevych, 2016; Von Krogh, Spaeth, & Lakhani, 2003).

These problems get compounded when the two strengths that were previously identified are removed: joining the community now requires users to reveal a substantial amount of information (such as location, identity, affiliations), and the ability to join the community is tied to several criteria (owning a certain product, seniority, signing bylaws). This scenario is not too unlikely in certain industries. Communities that relate to specific equipment, such as laboratory or specialized manufacturing equipment, have these constraints.

The constraints arise mostly due to the need for confidentiality on both sides of the value chain. The firm wants to protect as much knowledge about its product as possible to avoid giving away potential competitive advantages to competitors, while users need devices from the firms to conduct research, sell services, or build products with a similar need for confidentiality. Protecting knowledge and online communities do not seem like an ideal match at first sight. Nevertheless, firms see potential value in hosting or providing the

community with tools that alleviate the tension between the added benefit of sharing knowledge and the danger of sharing knowledge.

We know from previous research that users like to be part of communities that emerge organically (i.e., not artificially created by a specific entity), but they can be proactively motivated towards engagement by appropriate measures through a firm (CMR NFT). The firm, in this case, needs to provide the community with appropriate resources and opportunities to create value for themselves in the first place and for the community of the firm in the second place (Wenger, 2004). Group attachment (such as being part of a group using the same device) can even motivate users to participate with others in the same community (Algesheimer, Dholakia, & Herrmann, 2005) and, therefore, can be more significant in artificially created communities than organic ones (Algesheimer et al., 2005).

The demand for such communities is currently growing, especially in the MedTech industry. Firms are actively searching for ways to reach and connect their customers far beyond what they have done in the past. We can already observe the value of online communities in the health care sector where patients are actively improving their quality of care through participation in online communities (e.g., Zeynep Erden), which is a form of patient empowerment (Johansson, Islind, Lindroth, Angenete, & Gellerstedt, 2021).

These developments in MedTech are triggered by the rapid digital transformation that the industry is currently going through (Fernandes, Huising, & Peduzzi, 2021). The products that firms sell to their customers are getting smarter and create more data every single day (Möller & Moser, 2020). For example, instead of sampling a liquid 400 times manually, a user today can write their own script or module that the lab automation robot will execute instead.

Such changes in how researchers work in a laboratory today make their problems and insights more like a problem that a software developer might face. While the average Python

problem can be solved by visiting websites such as StackOverflow, the runtime error on a custom script for a lab automation robot might not be already answered on a public forum. Additionally, the development of software and frameworks for medical devices and life-science-related devices has happened behind tightly shut doors. In contrast, it has been a core feature of open-source software development (Lakhani & Hippel, 2004).

Due to these special characteristics of customers in the MedTech industry, we need new insights related to closed and restricted online communities and the benefits they present to their members and sponsor firms. On one hand, we need to understand the needs and expectations customers (in our case, users owning a specific MedTech device) have towards an online community, i.e., how 'gated' or restricted does it have to be to safely post problems, experiences, or data, and what do they need to get out of it. On the other hand, we need to understand the role of the firm that will offer the technical space for this online community to emerge and what they need to offer in terms of resources and involvement to sustain an active community over time.

With this research, we want to answer the question, how such an online community would need to look like to ideally cater to the members motivations, and what role the company or host needs to fulfil to implement and sustain the online community.

C.3. Literature Review

Managers and researchers alike have shown great interest in online communities and their ability to rally users around certain topics, engage with a company's product, create something as a collaboration, promote things or search for followers, or simply motivate purchases of products (Algesheimer & Dholakia, 2006; Lee, Vogel, Limayem, Lee, & Vogel, 2003; Meng & Agarwal, 2007). Members of such online communities are able to harness the knowledge of other members without having to put in knowledge themselves or can choose to contribute to a community with their own knowledge (Constant, Sproull, & Kiesler, 1996).

While the possibility for online communities and their powerful network effects seem endless, the vast majority of online communities lack participation or slowly fade out due to a lack of new members joining (Ludford, Cosley, Frankowski, & Terveen, 2004; Von Krogh et al., 2003). The early belief that companies could open a forum where users will exchange help and ideas ideally even to benefit the company itself has been overly optimistic. Simply creating the technological interface for collaboration and providing a space for users does not foster active collaboration by the users. To achieve a sustainable online community, a company needs to actively create a sense of belonging for the user, incentivize users to engage in value-adding interactions, and even actively search for a constant stream of new members (Chen, Harper, Konstan, & Li, 2010).

Previous research has shown that a host or sponsor can help foster engagement by helping members achieve their basic needs within an online community (Porter, Donthu, MacElroy, & Wydra, 2011). The most basic need, in this case, is information; community members want to be able to access information that helps them learn new things, solve current problems, or make better-informed decisions (Porter et al., 2011). Other needs include relationship building, social identity, helping others, enjoyment, belongingness, and status (Porter et al., 2011). Understanding these needs and how to fulfill them to motivate users to participate in an online community that otherwise would not emerge on its own are the most important aspects that a company must get right. While members come from various backgrounds and join the forum for different reasons in traditional open online communities, some communities are more homogenous as they are defined by their specific practice. As we conduct our study within the MedTech industry, we need to understand how communities within specific fields behave and can be engaged to participate in an online community. One such area of research has emerged in communities of practice (CoP) that originally were

thought to be offline-only and later were theorized and observed in electronic or virtual settings as Virtual Communities of Practice (VCoPs).

C.3.1. Online Communities

Online communities are based on a pool of like-minded individuals with the same passions and who exchange ideas, obtain new tricks, and spread knowledge or information among each other (Salleh, Yusof, Mohammed, Zahari, & Hamzah, 2020). Online communities originate from the concept of CoPs as they share many similarities in terms of a common passion and goal. One difference that can be argued would historically separate CoPs from online communities would be that physical communities would meet in person before forming a community, whereas in online communities, it is more often the other way around.(Martínez-López, Anaya-Sánchez, Molinillo, Aguilar-Illescas, & Esteban-Millat, 2017). The advantage of online communities is that they enable new types of sociality compared to traditional organizations, as knowledge can be more effectively collected, integrated, and combined without traditional boundaries (Faraj et al., 2016). These online communities can be seen as virtual organizations and enable knowledge sharing and collaboration on a scale that CoPs could have never achieved without virtual capabilities (Faraj, Jarvenpaa, & Majchrzak, 2011). Online communities emerged in the early days of the internet due to the human desire for knowledge, networking, and information, similar to the emergence of CoPs (Martínez-López et al., 2017).

C.3.1.1. Online Brand Communities

Online brand communities are a particular subset of online communities usually related to a specific product such as the VW Golf or an entire brand such as Apple. Brand community members have a specific interest in the brand or the product and can be a valuable source of information or even innovation for other members or the brand itself (Füller, Matzler, & Hoppe, 2008). These members have extensive experience in using the product,

which provides them with valuable knowledge, and the connection to the brand gives them a shared passion with other users that amplifies their willingness to engage in product-related discussions and troubleshooting for other members (Füller et al., 2008). Members of online brand communities often share the same interest and personal experiences and want to chat, exchange experiences, or acquire product-related news with other members or opinions on products to simplify decision making on new purchases (Romero & Molina, 2011)

Online brand communities can be product or service-based, depending on the nature of the brand they are representing. They can be fan-made, i.e., without a sponsor or brand, or include the brand as a part of the userbase (Martínez-López et al., 2017). For example, there are large online brand communities built around World of Warcraft (an online multiplayer game made by Blizzard Entertainment) that are officially supported by Blizzard and informal forums for older pirated versions of the game that are run by the community and technically illegal. Online brand communities are, therefore, specialized and structured communities without geographical or legal boundaries, which allows for continuous communication within the respective community (Tran et al., 2022). This ability to communicate among members of a brand community enables socializing consumers and positively influencing their attitudes toward the product or brand, further creating a shared culture and identity for members (Liao, Fei, & Liu, 2008). This immersion within a brand-specific online community can go so far as to turn the community-based relationship an individual might have in the first place into a brand-based relationship over time, where the brand becomes more central than the community itself (Kumar & Nayak, 2018).

In most cases, firm-hosted online brand communities are free of charge and come as an additional benefit or service when purchasing a product or a service from the host company. Therefore, the purchase by the consumer allows them to become a user or member of the online brand community where they can access information, content, or support from the

company itself or other community members that have joined as consumers (Wiertz & de Ruyter, 2007). These communities contribute to the development of customer-to-customer (C2C) relationships, deepen the business-to-consumer (B2C) relationship, and allow the collection of customer feedback and sentiment towards products or developments and the rapid diffusion of news and information across the community (Martínez-López et al., 2017). This information network can be used as a powerful marketing tool to identify likes, desires, and values within a community to effectively monetize them and create products that correctly address customer needs and discover potential areas to innovate (Kumar & Nayak, 2018; Tran et al., 2022), in addition to launching completely new but brand-related products (Gruner, Homburg, & Lukas, 2014).

Marketing plays a big part in online brand communities from a firm's perspective, but Brogi (2014) advises firms to have brand managers (marketing), researchers, and developers interact with the community to achieve better results by drawing on community knowledge and feedback to improve or launch new products. Collaborating with the community does not come for free; the cost of interacting and providing the community with the infrastructure and motivation to engage is a continuous expense. Companies might also need to consider creating dedicated positions that manage the community, facilitate community-company knowledge transfer, and distribute this knowledge to their relevant departments (Sawhney, Verona, & Prandelli, 2005).

The most adopted way of creating a community and communicating with it for companies has been by far the online forum. An online forum is simply a website where users can interact with each other and exchange ideas, write opinions, pose questions, and offer answers (Martínez-López et al., 2017). In general, users do not need to be experts in their common field, and experience can be gained while participating in the community.

C.3.1.2. Closed Brand Communities

Online communities can create value for brands even when they are closed or offer restricted access to users or specific groups that either own a product or fulfill some other criteria (Pitta, Franzak, & Fowler, 2006). The successful creation of online communities can lead to increased customer loyalty and, therefore, increase lifetime customer value for the company and brand through measures such as customer pyramids (platinum customers, gold customers, etc.) (Schau, Muñiz Jr, & Arnould, 2009) and other rewards programs. (Pitta et al., 2006). For some online communities, Nambisan (2002) suggests deploying security tools to restrict access to a specific part of the target customer base, ideally consisting of potential innovators and contributors to maximize the value of the online community for the hosting brand (Nambisan & Nambisan, 2008).

This suggestion is similar to a classification based on access of online brand communities done by Gruner et al. (2014), where three types of online brand communities (OBC) are identified: Open OBC, Discerning OBC, and Restricted OBC.

Open OBC is the classic online community where members can freely join and leave without imposed restrictions or requirements. This fluidity has been found to be one of the main advantages for online communities, as it creates a greater inflow of users and members that can contribute with varying backgrounds and expertise (Faraj et al., 2016). These communities generally have less bonding between members or long-lasting relationships, as most members seek out the Open OBC to find answers to product-related questions. Host integration, i.e., the involvement of the company or brand within the forum, is also low and does not show high efforts to engage with the community or to inspire specific activities. Participation is marginal and might include necessary moderation and rarely answering direct questions (Gruner et al., 2014).

In the Discerning OBC, host integration is much higher, and customers are required to register for community access by accepting guidelines, bylaws, and other conditions. The host or the company plays a much more important and active role in Discerning OBCs; they monitor the user community and its activity and frequently interact with them in discussions and tasks to foster engagement (Gruner et al., 2014). This presence has one downside: it can discourage community members from posting personal information or experiences compared to the less-monitored Open OBC. Regarding the C2C relationship, members that participate in Discerning OBCs form stronger bonds and participate more frequently in activities within the community and with the host (Gruner et al., 2014).

Restricted OBCs have strict predefined requirements to join the community, such as possessing a specific product, being a previous owner, or paying a fee to gain community access. Communication is also often restricted and strictly monitored by the host, with low integration of the host in discussions and troubleshooting. In general, Restricted OBCs have less motivated members and less frequent participation, thus forming looser connections (Gruner et al., 2014).

C.3.1.3. How to create an OBC?

According to Martínez-López et al. (2017), there are three key considerations to make when creating a new OBC: (1) The potential customer base or targeted customers must provide enough participants who are willing to join and engage in the online community, (2) the hosting company needs to understand the social relevance of its presence within the OBC. Therefore, it needs to consider the number of interactions that are expected with the community and consider creating brand-related positions to foster and engage in these interactions with the community, and (3) the host company needs to estimate the influence of the to-be-created OBC on their customer base to compare network effects and externalities with the costs of creating the OBC itself.

C.3.1.4. Success Factors of OBCs

The most important success factor for OBCs is the same as for any other product searching for users: the fulfillment of a specific user need that gets satisfied by the OBC (Sicilia & Palazón, 2008). The six most common success factors are similar to the general needs of online communities: member needs, motivation, self-management, low control, convenient technology, user roles, and support (Martínez-López et al., 2017). Another key success factor is early activity on the forum that signals other members that it is worth joining. If the forum and spaces are empty, new users might decide not to join. It might therefore be worth it to actively engage new users to join and motivate them on an individual level to create content and participate in the discussions (Malinen, 2015). While OBCs ideally reduce a company's time spent on things such as answering questions and troubleshooting for community members, it might be worth investing more time in the beginning to signal strong customer service within the OBC (Wiertz & de Ruyter, 2007).

In preparation for interviews with potential community members for the product-based online community within this study, we will focus the rest of the literature review on three previously identified success factors that we believe require the most consideration by a host company when planning online community creation: (1) user roles in online communities, (2) motivation to participate in online communities, and (3) features of online communities.

C.3.1.5. User Roles in Online Communities

Online communities pose different sets of roles taken or assigned to community members by a host, administrator, or the community itself. Because different online communities have different user needs, they create roles that support these needs or roles emerge that fill the needs. Identifying and understanding the different roles members can have and what roles key community members should be assigned becomes critical in

sustaining and growing those communities (Nolker & Zhou, 2005). Different roles are important as they can address different needs exhibited by different user types existing within online communities. Furthermore, these roles can adapt and evolve over time and become an important factor in the contribution behavior of a community member (Akar, Mardikyan, & Dalgic, 2019).

C.3.2. Motivation to Participate in Online Communities

Companies can leverage online communities as a tool to analyze their customers' or potential customers' behavior, but only if they reveal information about themselves in the form of posts or discussions that can be observed (Akar et al., 2019). Users have various reasons and motivations to participate in an online community, and these might differ between specific types of users (Yang & Li, 2019). It is therefore important to understand the motivation that drives the main desired user group to participate in the online community. Companies can use this information to develop strategies to increase the online community's participation rate and active user count to gain more insights in the long run (Akar et al., 2019). We know from previous research that we can separate motivation into two basic categories: intrinsic motivation and extrinsic motivation.

C.3.2.1. Intrinsic Motivation

Intrinsic motivation, as the name suggests, comes from the internal or inherent satisfaction that results from an activity itself and not from a consequence or reward that results from this activity (Deci & Ryan, 1980). In online communities, intrinsic motivation strongly relates to the individual members' identification with the online community and the satisfaction of being helpful within this community (Faraj et al., 2016). Intrinsically motivated users will be more motivated and work harder for that community compared to individuals who only seek extrinsic rewards for their contributions and actions (Coser & Etzioni, 1991). Intrinsic motivation is also, specifically in knowledge-sharing activities, a

much more powerful tool than extrinsic motivation (Osterloh & Frey, 2000). Similarly important for a sustainable online community is the fact that intrinsic motivation lowers transaction costs of knowledge-sharing and leads to increased social capital within the online community (von Krogh et al., 2012).

C.3.2.2. Extrinsic Motivation

Extrinsic motivation is characterized by the motivation to perform a task based on an external or disjunct outcome, such as a gift, reward, or payment not directly related to the task or action itself (Deci & Ryan, 1980), or actions taken to steer possible outcomes towards a certain desired outcome by the individual (von Krogh et al., 2012). In online communities, extrinsic motivation mostly relates to changing user participation behavior through external factors (Faraj et al., 2016). These factors are often in the form of rewards such as feedback, gifts, or unique identifiers that signal social recognition of the user (Tedjamulia, Dean, Olsen, & Albrecht, 2005). Within firm-sponsored online communities, there are more extrinsic motivation options due to the involvement of a sponsor compared to traditional online communities. The firm can offer extrinsic motivation in the form of loyalty programs, functional benefits (such as more support or priority), peer recognition by the sponsor, or simply products (Tran et al., 2022). Users might also participate in online communities without directly benefitting from external rewards, but do so under the belief that visible participation might positively impact their career, reputation, and future opportunities (Faraj et al., 2016; von Krogh et al., 2012).

C.3.2.3. Motivation in Online Brand Communities

Online brand communities offer similar motivations to their users as normal online communities with some differences. In the case of online brand communities, users might join due to an intrinsic motivation that stems from the self-identification with the brand and its image or the enjoyment of helping others in a like-minded community. An additional

extrinsic motivation exists in the form of users joining the community to facilitate transactions between members, such as exchanging work or product-related data to increase their own job performance (Martínez-López et al., 2017). Other extrinsically motivated activities include self-presentation and opinion leadership with the goal of influencing the community through status and gaining visibility and favor in the eyes of the brand or sponsor. To enable as much motivation as possible, companies must focus their activities on creating as much intrinsic motivation as possible for their users through their online brand community's features.

C.4. Empirical Setting And Methodology

We intend to understand how a successful online community can be created within a very niche, highly specialized, and highly confidential space. Wealso investigate all possible stakeholders and explore their views, needs, and expectations of such a community. Given the need to explore a specific phenomenon (Eisenhardt, 1989) and answer questions relating to how events unfold (Pratt, 2009), we employ a qualitative single case study (Yin, 2013).

As we are interested in potential community members' and non-members' motivations and lack thereof towards a new online community, we take an interpretive approach for our research. We rely mainly on the experiences and information shared by our interview partners and their views regarding online communities. In this approach, we are less interested in controlling aspects across cases and time but instead in variability and understanding where it stems from (Gehman et al., 2017).

Even though our interpretive approach gives voices to our interview partners, we will use prior research to make sense of, interpret, and structure this information according to our judgment (Corbin & Strauss, 1990). With our main research question in mind, we focus on understanding the motivation or lack of motivation that our interview partners articulate regarding joining and participating within a specific online community (Nag & Gioia, 2012).

At the same time, we do not use existing concepts or constructs to interpret our informants' expressions, avoiding the trap of too-early abstraction and theorizing (Gioia, Thomas, Clark, & Chittipeddi, 1994). We tried to take as unbiased an approach as possible, even though the literature on online communities offers a plethora of options for theorizing, which could interfere with our grounded and exploratory approach (Glaser & Strauss, 1967).

Gioia, Corley, & Hamilton (2013) discuss the risk of the possibility that researchers are too close to the informants and might lose the ability to be unbiased enough to reach an abstraction level required for informed theorizing. This research setting was only possible since one of the researchers was working for the case company. Without this, it would not have been possible to gain access to interviews with internal informants, and even more impossible to reach customers and research sites around the globe in the field of medical research and MedTech due to the high confidentiality of the work. Additionally, the researcher was hired to research the design and implementation of an online community for the case company and was allowed to do so free of restrictions and imposed goals by the company.

Following the guidance in D. Gioia et al. (1994), the researchers tried to balance this challenge of closeness by separating the roles of the insider, working within the company and managing the stakeholders along the way, and the role of the outsider, only involved with the company when needed. Within this setting, the insider got familiar with the structure and hierarchy of the company, the product that the online community was based on, and the customers and institutions that were using the product. The insider was also responsible for conducting interviews with clients, as she possessed additional domain knowledge in the life science domain that helped to understand the informants' perspectives further. The outsider joined initial meetings with the company where the research scope was discussed and the first interviews within and outside the company to gain an initial understanding of the case.

During the research endeavor, the insider and outsider theorized together through the information collected in the interviews. This duality of perspectives, separated by the design of the research, lends itself to more unbiased and informed theorizing (Ketokivi & Choi, 2014).

C.4.1. Sampling

As our study seeks to understand why an individual or user would become part of and participate in an online community, we will stay as close as possible to the expressions and feelings of these individuals. Our unit of analysis, therefore, is the individual user that owns DeviceX made by Medima, the case company (Eisenhardt, 1989), and thus could join a newly created online community around DeviceX. We were allowed to look through the global list of customers (in this case, institutions and not individuals) that purchased DeviceX and suggested 31 potential customers, with a clearly defined key contact person, to Medima to be interviewed for our research.

The suggested 31 customers were split across continents, with 22 in Europe, four in North America, four in Asia, and one in Australia. It is important to note that DeviceX is region-agnostic and delivers standardized and reproducible results regardless of geographic location. The reason we suggested customers across the globe is the fact that they might hold different perceptions and motivations concerning online communities. Consistent with our interpretive approach, we tried to capture maximum variability in the unit of analysis (Gehman et al., 2017). Medima allowed us to contact 15 customers after reviewing our suggestions, and 12 responded positively to our request and showed interest in talking about online communities.

To further understand the motivations, possibilities, and expectations that Medima has concerning its envisioned online community, four internal interviews were conducted in total. Three of these interviews were Europe-based, where DeviceX was developed, and one

employee was from Asia. Asia is managed separately by Medima from the rest of the world, where we were unable to facilitate an interview with a customer, instead choosing to at least have a senior customer support role as an informant.

C.4.2. Data Collection

The primary data source for this research is 16 semi-structured interviews conducted over six months. One of the researchers was employed at Medima and was allowed access to confidential information on DeviceX and its userbase. The insider also participated in company meetings, joined company presentations on DeviceX, and acquired strategic roadmaps and plans of Medima to further understand the potential an online community could bring and what resources were available to pursue it. This later became important to judge what is technically and financially possible for Medima to provide in terms of infrastructure and support for the online community. During the six months, two significant events took place within Medima. One was the announcement of another product-based online community from a different division, and the other was the announcement of a trading platform. These announcements led to the inclusion of a specific internal employee responsible for the announcement of the online community and the adaptation of our interview questions for existing DeviceX customers to optimize data collection (Leonard-Barton, 1990).

Three types of interviews are important to distinguish: (1) external interviews with customers, (2) internal interviews with employees, and (3) expert interviews with two forum developers to validate our findings.

Within the customer type (1) interviews, we conducted 12 interviews with 16 informants in total because one interview was joined by two informants and one by three. The 16 users of DeviceX are highly skilled and educated employees. Their functional roles within their organizations are: four laboratory specialists, four PhD students, four group or

laboratory leaders (e.g., postdoc), three professors, and one CEO. These informants come from a variety of life-science and medical fields and institutions, summarized in Table 3.

The interviews lasted approximately one hour, and we allowed informants to elaborate as much as possible on research-related topics in a semi-structured way. The customer interview phase started with four interviews, where two were conducted with both researchers present. The rest of the interviews were done by the insider. After the four initial interviews, impressions and new insights were discussed to adjust the questions and directions of follow-up questions accordingly.

For the type (2) interviews, completely different questions were used that aimed to find out what Medima thinks would make DeviceX users join the online community and what they could imagine contributing in terms of support and resources to the community. All four interviews were conducted with one informant per interview, and all were situated within the same department in Medima that created DeviceX, making them knowledgeable informants in this matter. All internal informants have contact with customers and can share their perceived needs and issues and what they think an online community should look like. These interviews also lasted approximately one hour and consisted of ten questions in total.

In general, we tried to apply probing techniques whenever possible (Miles, Huberman, & Saldana, 2014; Patton, 1980) to get detailed accounts of our informants' opinions and experiences regarding online communities and in relation to Medima or DeviceX. By openly asking about concrete factors and features they can envision that would compel them to participate and descriptions of why that would be the case, we aimed to get as detailed and concrete accounts as possible for our subsequent analysis.

Table 3: Overview of Conducted Interviews

Interview ID	Function of Informants	Location of Informants	Interview Type
1	2x Researchers in a research group	Europe	Interview (version 1)
2	Staff scientist at chemical laboratory	Europe	Interview (version 1)
3	Professor and Group Leader in biology	Europe	Interview (version 1)
4	PhD researcher	United States	Interview (version 1)
5	Professor	Europe	Interview (version 1)
6	Group leader medical	Europe	Interview (version 1)
7	Principal investigator at medical laboratory	Europe	Interview (version 1)
8	Group leader in clinical research	Europe	Interview (version 2)
9	Clinical research manager in medicine	Europe	Interview (version 2)
10	Professor	Europe	Interview (version 2)
11	3x PhD researchers of medical research site	Europe	Interview (version 2)
12	1 x CEO and 1x lab manager of a research department	Europe	Interview (version 2)
Internal 1	Clinical Method Development	Europe	Internal interview
Internal 2	Manager of Service and Support	Europe	Internal interview
Internal 3	Field Application Manager	Europe	Internal interview
Internal 4	Field Application Specialist	Asia	Internal interview

All interviews were conducted virtually via a designated software by Medima, but the inside researcher physically went to Medima's offices to join meetings and discussions. We were able to record (audio) every interview, which was an important criterion for us when selecting and contacting informants, as we needed to be able to analyze transcripts for our interpretive approach. Subsequently, all interviews were transcribed either with the help of an artificial intelligence tool or by hand and in English. We agreed to treat all transcripts as confidential and ensure anonymity wherever possible to all participants and Medima.

C.4.3. Data Analysis

Our data collection in the form of interviews produced over 120 pages of single-spaced transcripts. For the following data analysis, we used a common software tool created for qualitative data analysis, specifically the coding of interviews. We employed a grounded

theory approach to our data analysis and started with open coding as a first step (Corbin & Strauss, 2014).

The first stage of open coding started after our first four interviews, where we wanted to gain a general understanding of our informants and their perceptions. After this initial short coding phase, we amended interview guides and sharpened our questions to better reveal concrete information and experiences from our informants. During this phase of open coding, our goal was to understand our informants' perceptions of online communities and stay as close to their wording as possible when creating codes (Charmaz, 2004). Transcripts were coded line-by-line, resulting in a vast amount of codes that covered many topics without filtering (Gioia et al., 2013), from medical technicalities of DeviceX to customer support complaints about Medima. Through discussions and cycling through our transcripts, we slowly identified and gathered similar codes into first-order categories that were kept close to our informants' language (Gioia et al., 2013). During this time, we decided to abandon all coding related to technical specifications or strictly operational codes about DeviceX (i.e., how the device functions) that were not associated with possible data sharing or knowledge sharing (Pratt, 2009).

The second stage started after the external customer interviews were done. We started to search for similarities and differences in our previously created first-order themes. This process yielded our second-order categories, which were thematically related and more abstract (e.g., "be present") or theoretical (e.g., "knowledge sharing") in nature (Pratt, 2009). During this stage, we used axial coding (Corbin & Strauss, 2014) driven by the search for theoretical frames that fitted our initial first-order codes (Gioia et al., 2013), such as previously identified roles in online communities. For this step, we consulted existing literature and our interview data in tandem, re-labeling codes and merging redundant codes whenever possible (Alvesson & Kärreman, 2007).

In the third stage, we finally looked for approaches to distill our second-order themes into aggregate dimensions (Gioia et al., 2013). This stage finally generated a data structure with three aggregate and theoretical dimensions (Gioia et al., 2013). During this process, the number of aggregate dimensions was very high (>10), which is unusual for this type of research method. Therefore, we went back to first-order categories to see if further codes could be merged to reduce the number of aggregate dimensions. During this time, we realized that to fully explain our emerging framework of how an online community could look in the case of Medima, we needed to break away from the idea of creating a singular data structure and ultimately a framework that only contains a single layer.

We will focus on presenting our findings as close to our informants' voices as possible and as rich as possible to visualize how our insights are linked to our findings (Gioia et al., 2013) and, ultimately, our framework consisting of aggregate dimensions embedded within layers. Accordingly, we will present citations (at points edited to preserve anonymity and confidentiality but without changes to the content and meaning), where confidentiality allows, to present our findings in the following subsection.

C.5. Findings

Our findings are based on multiple layers. While drawing mindmaps of how our aggregate dimensions were related and how they related to the design of an online community, we realized that we have dependencies among certain aggregate dimensions and independence between others. Instead of trying to merge or reduce aggregate dimensions into more general ones, we decided to create four layers of aggregate dimensions that built around each other, as illustrated in Figure 1.

The structure of our findings will be according to the layers built from the ground up towards the technical features on the top.

Our Layer 0, or the core of our framework, will consist of customers' expectations towards Medima. This represents an infrastructure layer that needs to be present for members to join and participate according to them.

Layer 1 relates to the motivations that community members have towards contributing to Layer 0.

Layer 2 consists of technical features of the community that are crucial for community members.

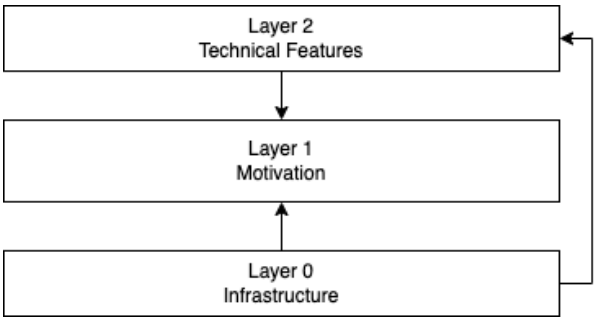

Figure 1: Illustration of layering according to our data structure

C.5.1. Layer 0 – Infrastructure Roles

Figure 2 depicts our data structure that underlies Layer 0, the infrastructure layer. This layer does not aggregate into technical capabilities that customers expect from Medima within the online community, as the name might suggest, but instead the functional roles (Administrator, Moderator, Peer) through which the customers expect the infrastructure to be delivered.

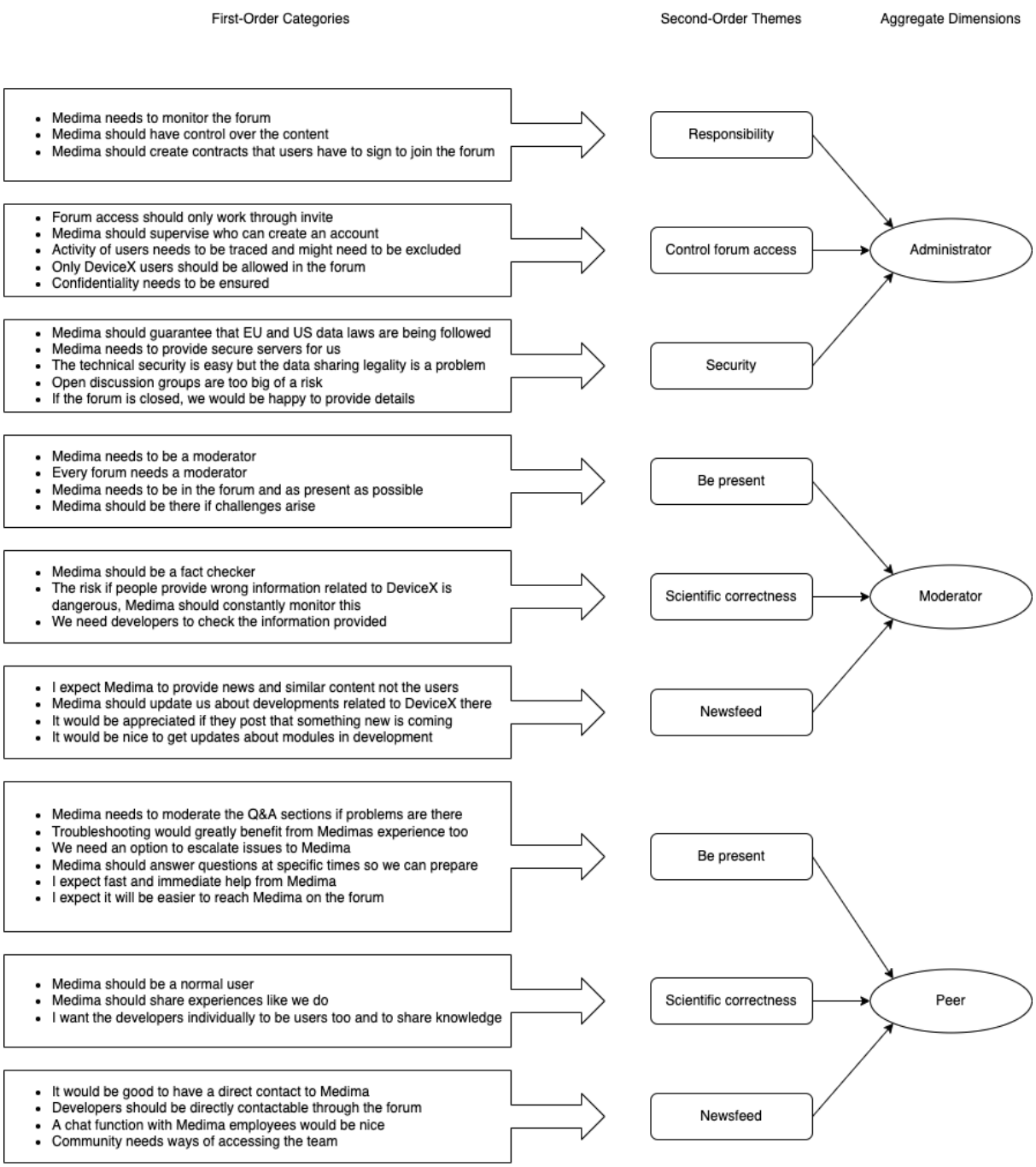

Figure 2: Customer expectation of Infrastructure provided by Medima roles

Administrator Role

The first role customers expect Medima to take up is the administrator of the online community. Previous research has noted that the administrator is important in creating trust and a safe space within a community to facilitate knowledge sharing (Akar et al., 2019). Through our research, we identified three tasks that the community expects Medima to handle as an administrator:

Responsibility

Customers actively demand Medima take responsibility for users, content, and exchanges within the community:

> *"Guidelines from Medima and their monitoring of the exchanges in the forum would be good"* *(Community member, customer 5)*

Further, as opposed to more traditional online communities where censorship and control over users are not seen as very desirable, the customers of this MedTech online community explicitly want Medima to create a specific set of rules and guidelines and to expel or punish members that do not adhere to the rules:

> *"There should be someone from Medima that has control over the content and who can disqualify someone who is not obeying the rules of the forum."* *(Community member, customer 4)*

While customers, in general, were open to the idea of sharing data to help out other members, they expect this help not to be used for commercial gains (but for research instead) and expect Medima to ensure this:

> *"If someone tries to get a commercial benefit out of the forum on behalf of the other users sharing data that would be a critical point."* *(Community member, customer 3)*

In a similar direction, regarding the content that is shared, and very opposed to a hallmark of online communities in general, a customer suggests that to be a member of this community, a contract between Medima and the customer wanting to join should be signed:

> *"If the forum is managed by Medima, there should be a contract between Medima and the users to maintain copyrights."* *(Community member, customer 6)*

Control Forum Access

Controlled access to the forum, not just in terms of public or private, has been a major concern for customers that have different reasons to expect Medima to act as a gatekeeping administrator:

> *"I think the person who wants to subscribe to the access should be selected and managed by someone, that not everybody can subscribe and enter."* *(Community member, customer 6)*

Other customers have specific criteria in mind to judge whether a customer should be able to join, such as owning a DeviceX in the lab to permit immediate entry to the community:

> *"Somebody that is not working with Device X should not give opinions in the forum."* *(Community member, customer 1)*

For most customers, the openness of the forum was never an option due to confidentiality concerns regarding their research and patient data. In addition, a concern for quality among the highly skilled informants was always present:

> *"You cannot ensure confidentiality if it is completely open, and you may compromise the quality. The discussions should not be trivialized."* *(Community member, customer 7)*

Security

Within the medical and MedTech industries, sharing data such as measurements based on human samples is extremely critical not only due to confidentiality concerns but also due to legal issues that might vary significantly across the globe. One customer already investigated the legal difficulties due to his own online activities:

> *"According to the EU court, any data stored in any server in the US by any company is insecure from the EU perspective. Therefore, the forum servers need to be in the EU, and we cannot exchange data to the US if it should remain private." (Community member, customer 2)*

This would technically mean that Medima might need to consider separating global regions for their online community if they were to allow data uploads to their own servers.

Summarizing the role of the administrator for Medima means that they will need to consider being the gatekeeper for a closed online community, as not a single participant was hypothetically willing to share information on an open online community but could envision themselves sharing within the DeviceX research community:

> *"If the forum has a closed community, we would be happy to provide our details." (Community member, customer 2)*

Additionally, Medima is even expected to guarantee the selection of members through contracts or screening and by making sure that only DeviceX users can join.

Moderator Role

As opposed to the restricting role of the administrator, customers expect Medima to take an active role within the online community. Moderators are important in facilitating engagement, encouraging knowledge sharing, and providing content. While the administrator role can be fulfilled in the shadows, the moderator must be visible.

Be Present

> *"I think Medima should be the moderator."* *(Community member, customer 9)*
> *"Every forum needs to be moderated in a way."* *(Community member, customer 10)*
> *"Medima should react if there are challenges that seem to be happening at several sites."* *(Community member, customer 10)*

The customers here expect Medima to have dedicated employees moderating the online community. This is not too uncommon anymore. Often, brands will employ community managers that show presence in the forum and support members where needed. The problem in our setting is that since content is medical and life-science-related, users expect Medima to moderate scientific content. Thus, the moderator will also need to be a knowledgeable scientific researcher.

Scientific Accuracy

In this online community, the moderator will be expected to "act as a fact-checker" (customer 11) because customers are afraid that wrong information could be posted about DeviceX that could have a detrimental effect on further research:

> *"I think the only risk you have if there is no supervision is that people might be able to provide unreal information. If there is a piece of information, which remains for a while posted, and nobody realizes that there is something wrong, it can cause problems along the line. So, I think it is necessary to have some maintenance from the developer's point of view."* *(Community member, customer 9)*

Newsfeed

Medima is expected to create content for the community but only with regards to updates and news based on DeviceX, especially since customers currently do not feel informed enough about work that is being done on DeviceX:

> *"I would expect Medima to feed the news to the community rather than the community publishing there, as I think Medima should supervise it."* *(Community member, customer 9)*

> *"I think it would be beneficial and appreciated if they post if something new is coming out, e.g., to hear from them about new programs and hardware or software releases."* *(Community member, customer 3)*

> *"It would be nice to be informed about new plug-ins, upgrades in the plug-ins, or changes because I think they are still developing these modules."* *(Community member, customer 1)*

Troubleshooting.

The biggest expectation from customers, next to the forum's security, was the ability to troubleshoot problems more quickly. The customers agree that currently, they do not know if their problems are unique or have been experienced by other users:

> *"I think it would be good to have a way of escalating issues, especially if there is a recurrent situation from different users. Therefore, I think Medima should supervise the forum."* *(Community member, customer 9)*

And that they would appreciate more direct input from Medima since the current support system via an online form is slow and perceived as extremely asynchronous:

> *"(...) a lot of troubleshooting will benefit greatly from Medima's input."* *(Community member, customer 3)*
>
> *"It should make it easier to reach Medima, because if you have a problem then it needs a quick solution."* *(Community member, customer 6)*

> *"If it comes to technical questions, it would be nice to have direct contact with Medima."* *(Community member, customer 6)*

Such a more direct system already exists in China, where customers can directly reach customer support via WeChat. Such a direct communication path makes Medima become more of a peer for the community than simply a moderator.

Peer Role

Besides unanimously agreeing that Medima should be an active moderator of the online community, half of the customers would like to see Medima join the community as a peer. Users see two key advantages if Medima would be a community member at the same level as they are.

Knowledge Sharing

The customers would expect Medima employees to share information on a more informal and direct basis as an individual instead of as an official function at Medima:

> *"If Medima is also a user in this forum, then Medima could share their experiences."* *(Community member, customer 12)*

> *"I would expect people who are involved in developing the platform to have a voice of their own, especially because we know them in the Device X community. And obviously, if I need something from one of them, I am going to trust it better than if it is someone else."* *(Community member, customer 9)*

Customers would trust the specialist sharing knowledge more than they would trust an anonymous Medima account. Furthermore, they underline the importance of direct contact with these expert individuals.

Direct Contact

Some customers already have direct contact with specific Medima employees after working with DeviceX for a very long time and would appreciate more direct contact possibilities through the forum. Others that do not have that yet would need a clear indication of whom they need to contact:

"It would be fantastic if Medima's employees were actively involved. I would vote for my favorite employee to be there." *(Community member, customer 2)*

"It would be perfect if Medima's employees that work with Device X had a user profile in the forum as well so that we could contact them directly. For other people that do not have a strong relationship with the company, it will probably be the most important way of communication between them." *(Community member, customer 7)*

Framework part 0: Visualization of relations between themes in Layer 0

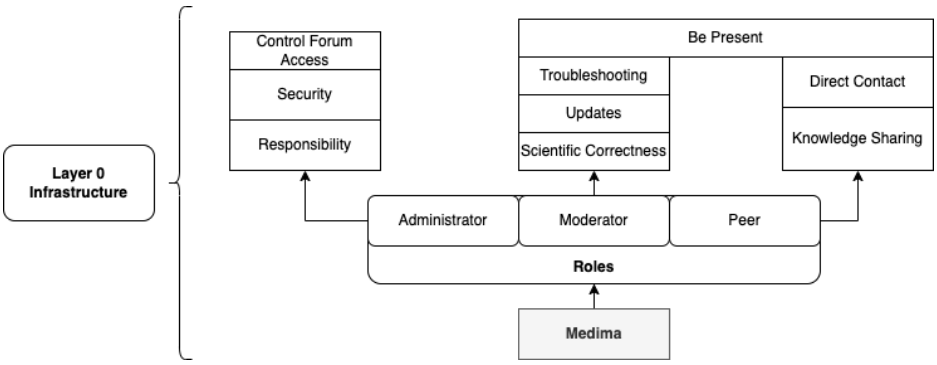

Figure 3: Framework of Layer 0 relations

C.6.1. Layer 1 – Motivation

In Layer 1, we will explore the intrinsic and extrinsic motivations of customers and Medima to participate in the online community, as depicted in Figure 4. Certain second-order themes reappear from Layer 0, such as Newsfeed and Troubleshooting. These are dependencies that relate across layers and won't be discussed again in this section. Participant motivation is the most important factor in creating a successful online community as it is the main driver behind engagement (Porter et al., 2011).

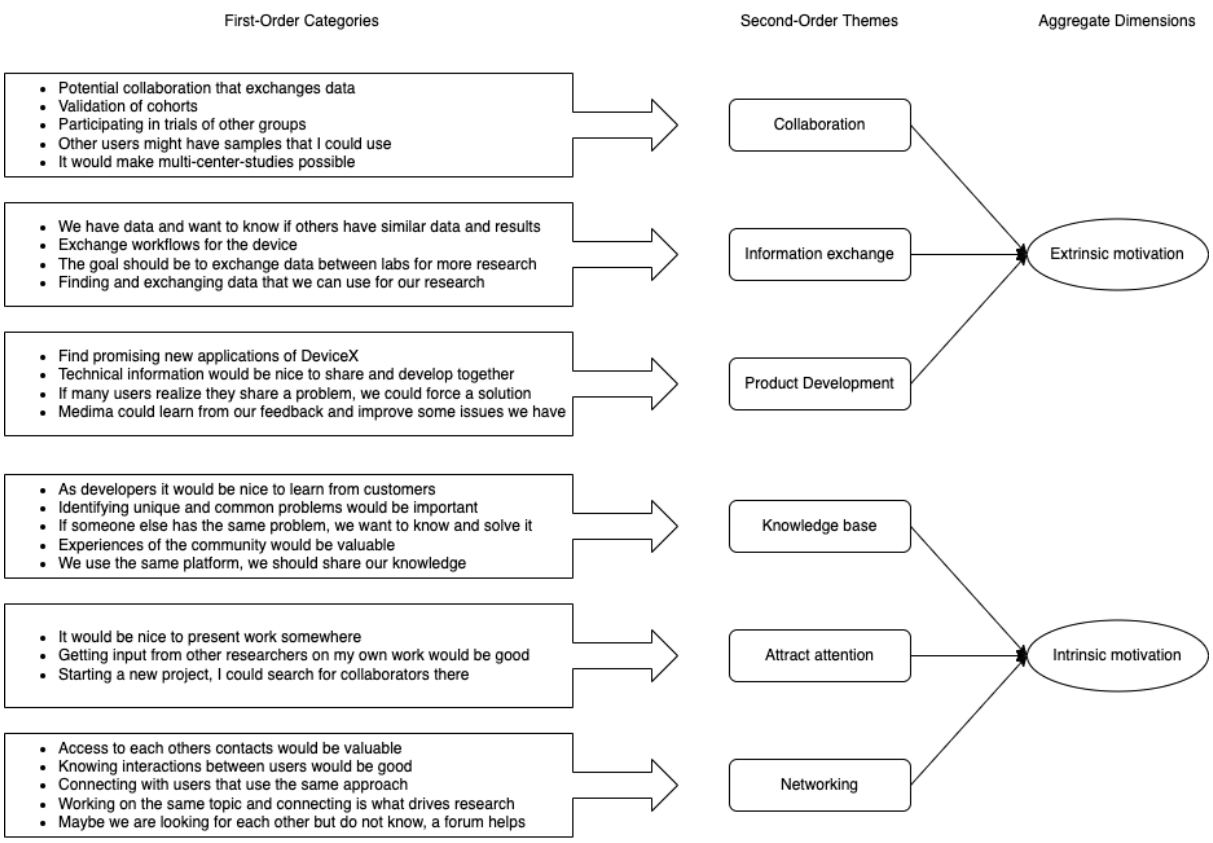

Figure 4: Extrinsic and intrinsic motivations of informants

We coded extrinsic motivations as actions that are driven by external factors, which we defined as the work-related needs of Medima's customers.

Collaboration.

As the research that DeviceX users conduct often overlaps, they expressed professional interest in the work of other users to improve their own work or collaborate on research:

> *"If you want to run a multicenter study and you know exactly at which sites there are groups using Device X protocols, then you know exactly who you could approach to find an organized patient cohort for the multicenter study."* *(Community member, customer 3)*

Information Exchange

Medima's customers voiced explicit interest in exchanging research and processing data with other members to validate their findings or improve their own work:

> *"We have data and want to know if other users also saw similar results to what we were analyzing."* *(Community member, customer 12)*

> *"(...) it is always nice to figure out how other people are doing things and see if you can improve your own workflows."* *(Community member, customer 8)*

> *"The final goal of such a network should be to know which data has been collected in other laboratories, which you could use for your own research."* *(Community member, customer 7)*

Product Development

Customers hope that if they collaborate on reporting problems or possible upgrades within the community, they might have higher chances of Medima addressing these issues with future updates that would benefit the customers:

> *"I would like to have a forum, where I could connect with other users that might have the same issues. And maybe together we could make a stronger case to push Medima to solve this."* *(Community member, customer 4)*

> *"The forum could also help Medima, in the end, to get several customers with several questions and several errors to make things better in the future, i.e., their instruments or programs for development."* *(Community member, customer 12)*

Intrinsic Motivations of Customers

We coded intrinsic motivation where informants expressed that it would benefit them personally instead of a direct outcome within their work. Intrinsic motivation comes from

inherently rewarding activities and the desire to engage in interesting and fun activities around an individual's passion.

Knowledge Base

Customers were interested in contributing knowledge to fellow researchers and expanding their own. They perceived participating as being rewarding on its own, and they did not expect a direct external reward for their contributions:

> *"It would be interesting to learn about a product from the customer's point of view instead of the developer's point of view. (Community member, customer 9)*

> *"If we are interested in the same problem, we can easily exchange data because we use the same platform." (Community member, customer 11)*

Attract Attention

Several customers mentioned the difficulties of finding peers to present their specific work to and gaining feedback. They were also not sure who currently works on something similar or might plan to do so. Therefore, visibility within an online community would be helpful:

> *"If I want to start a new project, searching for collaboration can be a good way of visibility." (Community member, customer 7)*

Networking

Networking was named the most within our interviews and often as the most important reason why the informant would join the online community. One customer stated that networking might be "the driving force of research" (Customer 4). The possibility of fostering direct C2C contact would be important as researchers might work in the same area unknowingly:

"Perhaps we are working in the same area, but we do not know each other, and then the forum could help us to communicate with each other." *(Community member, customer 12)*

Framework part 1: Connecting Layer 0 and Layer 1 into a relational framework

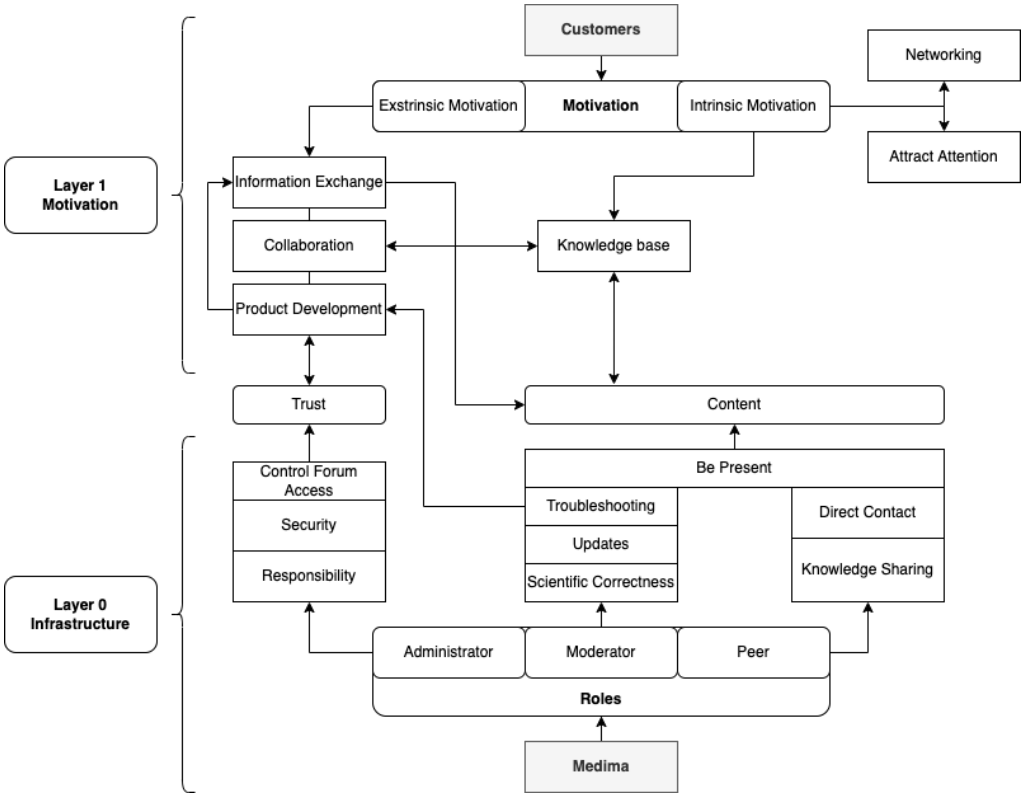

Figure 6: Framework part 1, connected Layer 0 and Layer 1

C.6.2. Layer 2 – Technical Features

Lastly, throughout our coding phases, we created codes on technical features the community wanted or described as possibly using and related them to aggregate dimensions that motivate community members intrinsically or extrinsically. Figure 7 shows the complete spectrum of technical features mentioned during our interviews and their relation to previously identified aggregate dimensions in Layer 0 and Layer 1. We briefly explain the requested technical features by Medima's customers in Table 3.

Table 3: Description of technical features requested by customers

Technical Feature	Description
Community Help Desk	The Community Help Desk category enables collaborative troubleshooting
Tips & Tricks	This category contains tips & tricks to facilitate the use of your Device X and the forum itself, e.g., videos and Device X manuals.
FAQs	The FAQs category contains answers to FAQs by Medima's customers
News	In this category, Medima will make announcements about everything related to Device X, for example, product upgrades, new releases, and upcoming webinars.
Scientific Paper Collection	The Scientific Paper Collection category is where all scientific publications related to Clinical Research with Device X, currently 100 files, can be collected by the community.
Discussion Board	The Discussion Board category helps to further delve into the forum's contents with a focus on Device X-specific or general clinical research discussions.
User Announcements	The User Announcements category can be seen as a blackboard where forum members can post their own announcements and advertisements.
Feedback	This section is designed to collect feedback about Device X or the forum's service

The descriptive inclusion of these technical features aims to deliver a holistic picture of how an online community can be structured and created for a specific, highly skilled userbase, such as in the case of Medima. With our final framework, we want to offer insights on how Medima should plan its online community to achieve as much engagement and participation as possible.

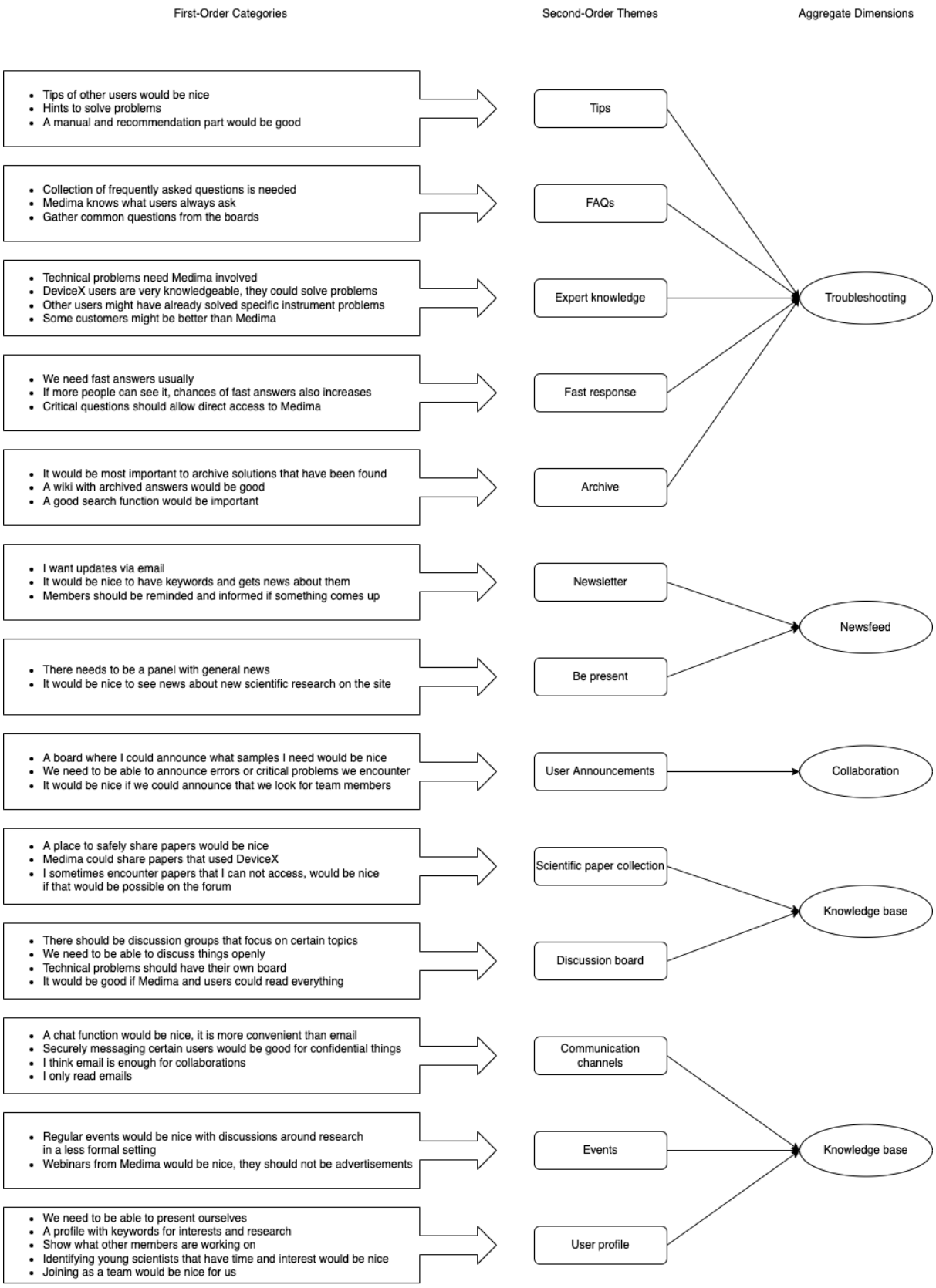

Figure 7: Technical features mentioned by customers

C.6.3. Final Framework: Combination of all identified Layers 0+1+2

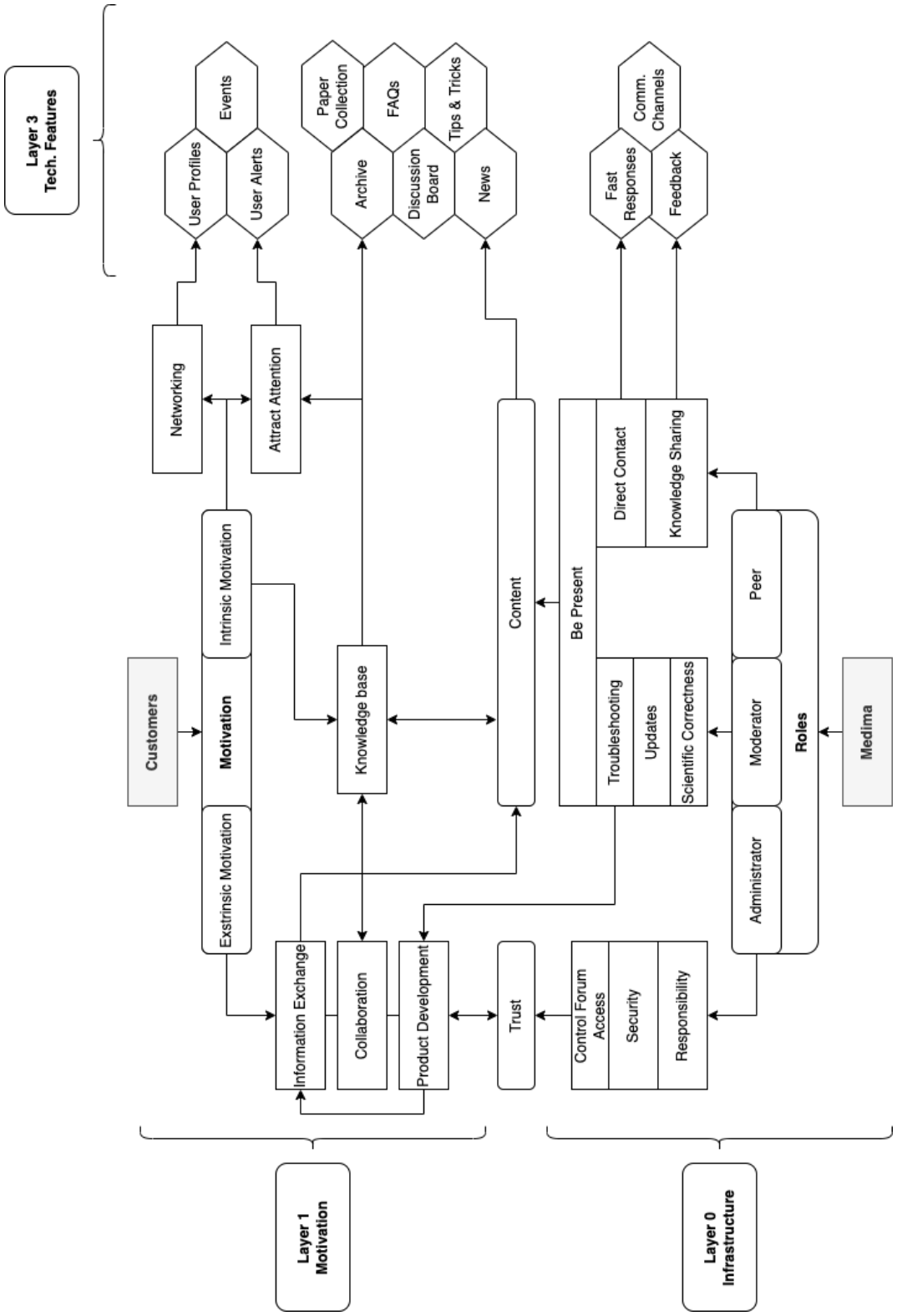

Figure 8: Final framework, connected Layers 0+1+2

C.7. Discussion

Literature and research investigating online communities have very heavily focused on open online communities (Faraj et al., 2016; Hara, Shachaf, & Stoerger, 2009; Ray et al., 2014; Von Krogh et al., 2003), and we know a lot about their potential advantages and disadvantages. This includes the motivation to participate and share knowledge based on the joy of performing the task (von Krogh et al., 2012) or the identification or sense of belonging to the community (Faraj et al., 2016). Our research has shown that motivation for customers of Medima did not come from a particular joy for the task of sharing or the sense of belonging to a specific online community. Instead, intrinsic motivation came through their shared goal of doing impactful research with the help of DeviceX.

Our research adds a very rare and hard-to-access case to the literature on online communities in general. We expand the literature on communities centered around a product with a highly skilled and professional userbase that depends on confidentiality (Hara et al., 2009). During our literature research, we struggled to find similar empirical studies that report how such a highly specialized community works behind closed doors.

As previous studies are centered around public brands, such as Apple, Ford, or Nintendo (Gruner et al., 2014), or products such as Garmin or the Mini Cooper (Schau et al., 2009), they are vastly different from our case. According to Gruner et al. (2014), a Restricted OBC (the closest approximation of our case in existing theory) has low community access, high activity control, and low host integration. While our case fits the low community access (governed by owning the product), we observed a desire for as much host activity as possible to make customers interested and no activity control (in the sense of restricting the ability to contribute). This high expectation of host activity and engagement also shows that in the case of a highly specialized product such as DeviceX, the host company will not reduce costs spent on customer support through the creation of an online community as previously

described by Wiertz & Ruyter (2007). In contrast, costs will most likely increase due to the expense of additional resources dedicated to the community through what we defined as Layer 0.

We can confirm the importance of transparently handling intellectual property rights and policies regarding commercialization, as users were less willing or unwilling to share knowledge if it was used for commercial gain (Nambisan & Nambisan, 2008). We attribute this to the fact that most informants were part of research institutions that conduct research not explicitly driven by commercial goals but by insights and advancing science.

While a significant amount of research exists on roles in online communities (Akar et al., 2019; Füller et al., 2008; Zheng, Ding, Li, & Zhang, 2021) and how they can be leveraged to improve customer experience, we show that for customers in our case, the role within the online community is not important. Instead, what matters most is the visibility of their "real-life" role and function to find possible collaborators and network successfully.

We also significantly expanded the role of the administrator, which has previously been characterized by the responsibility for the website's functioning and representing a contact point for users with technical problems (Gruner et al., 2014; Martínez-López et al., 2017). We argue that this role in the case of online communities that require confidentiality, security, and guarantees gets empowered into a guardian and gatekeeper for the community. At the center of our Layer 0, we found that with no trust in the administrator (Akar et al., 2019) and, consequently, the community's infrastructure, the community would most likely not even start to exist.

Lastly, our framework adds to important work done by Porter et. al. (2011), where they explain how community members can be engaged in a 3-stage process that is defined through activities (in open communities). In contrast, we offer a complementary 3-layer framework

that characterizes specific roles, motivations, and features in a connected way to map and plan possible engagement strategies.

C.7.1. Implications for Medima

Our final framework connects the three layers of *infrastructure*, *motivation,* and *technical features*. It illustrates how Medima, in this case, could start envisioning and planning its potential online community. The framework shall serve as a plan or directive on how online communities, more specifically, a closed online community with a specific highly skilled userbase, can be created and managed. We believe this the requirements that stem from users regarding confidentiality, privacy and content safeguarding have not been observed in any other online community, as they do not deal with health and patient related critical data. While online communities have had the most visibility when they are open and sizable, our research shows that there are motivations for customers, intrinsic and extrinsic, to join a specialized, closed, and product-related online community. We find that the expectations towards Medima are very high but justified and span across three traditional roles in online community research. Medima is expected to provide what we define as Layer 0, the infrastructure for the entire online community, going beyond the role of a host.

In particular, the role of Medima as an *administrator* is shown to be the most crucial factor for any further engagement that potential community members can imagine. According to our research, the *administrator* will function as a gatekeeper and guardian for the community, taking *responsibility* for users to know the rules and possibly even signing contracts with community members to ensure adherence to them and disqualifying members if needed. Medima is also expected to *control forum access* in a very restrictive configuration to ensure the presence of only DeviceX users so members can trust that opinions and suggestions come from experts, thus creating a community of highly knowledgeable members. As this research is conducted within a highly regulated and confidential industry,

Security is not optional and is expected to be provided by Medima. Users will only share data and engage in discussions if they feel safe to do so in terms of confidentiality and legality regarding the location of servers that process and store their data.

The role of Medima as a *moderator* is, in general, like the moderator role we know from existing online communities. Tasked with *being present, troubleshooting,* and *providing news,* the moderator has the operational function of keeping the forum civil and orderly. Surprisingly, customers explicitly mentioned and expected the moderator to take up the task of a "fact-checker." Ensuring *scientific correctness* goes beyond traditional content moderation as it puts the moderator into the role of judging shared knowledge based on science instead of propriety. This has implications for individuals that could be moderators. In the case of Medima, the individuals would need to be knowledgeable about DeviceX and the general research that customers are conducting with it. It is worth noting that while multiple customers stated the need for moderation and checking of content within the community, not a single time was a statement made about the possibility of the community moderating itself through community members.

Some users expressed the wish that Medima could be a *peer* within the online community. While a minority stated it would be beneficial if Medima participated as a normal user instead of a moderator, our research shows that the *peer* role would be nice to have. We deem Medima as an *administrator* and *moderator* as being vital for the success of the online community. When customers talked about *knowledge sharing* and *direct contact,* they often mentioned specific employees, i.e., "chat with my favorite employee" or "knowledge from certain developers." Therefore, the role of *peer* is seen as individual employees of Medima joining the community to participate, not a managed anonymous corporate account. Customers mostly agreed that having *direct contact* and open access to

specific DeviceX team members would benefit the community as issues with DeviceX might not be unique to individual customers that could learn from shared answers.

Our Layer 2 explores the specific reasons why and through what methods users and Medima itself, to some extent, can motivate its employees to participate and engage within the online community. In terms of *extrinsic motivation,* we found that most of it comes from topics related to DeviceX and the operational improvements that users would hope to find in an online community, such as *information exchange, troubleshooting,* and *product development*. These motivations are not surprising and are generally in line with traditional online communities with members predominantly looking for useful information or help.

A more unique *extrinsic motivation* that Medima could actively foster is the desire for very specific *collaboration*. DeviceX users share research areas and interests and expressed demand for the possibility of finding, for example, validators of studies that have been done on DeviceX. Further, researchers could profit by sharing certain medical samples or outputs since DeviceX offers standardized processes to make this possible. We coded these motivations as extrinsic as they directly relate to specific work the informants were doing and their formulations of how this could improve or enhance a specific task for them.

Regarding *intrinsic motivation,* we identified less of the traditionally assumed activity that is done because it brings the participant joy but more of a joy for the underlying job that users possess. Informants were passionate about their personal research and studies, so we deem their motivation to do better and further research as intrinsic. The identified factors within *intrinsic motivations* of customers, such as *getting attention, networking,* and *knowledge base,* are related to improving their general research and possibly enabling new research through connections created within the community. Users generally did not talk about making themselves more successful but more in terms of how they could conduct better and more impactful research. This type of intrinsic motivation is most likely unique to an

online community that consists of researchers and scientists because we deem the task of doing research a passion. In the case of Medima and other medical and life-science-related communities, our informants often talked about how improving their research could help their respective patients or study participants, which we consider a unique *intrinsic motivation* to participate in an online community.

To complete our framework on how a possible online community for Medima should theoretically look, we gathered the mentions by customers on what technical features they would like to use or have within an online community. We related them to second-order themes that belong to Layer 1 related to motivation to visualize how a certain motivation could be engaged or fostered. For example, *Networking* as a second-order theme in Layer 1 can be engaged through *communication channels, events,* and *user profiles* present in Layer 2. We believe these connections to be meaningful since we do not only want to answer the question of "why" users within the online community are motivated, but we also offer an explanation and examples of "how" a company could target specific motivations to foster engagement within the community.

We suggest following our framework in a bottom-up manner, starting with Layer 0 and working towards Layer 2. Our research has shown that Layer 0 is most important and critical to get right. Without a functioning Layer 0, users or customers will not feel the confidence and trust required to engage actively and openly within such a specialized community. Layer 1 will be more critical in the early days of the community, as the required motivation to initially create content and share knowledge in a new community will be higher. Layer 2 can be improved gradually over time; technical features such as FAQs and other repositories gain value over time as users and the host can populate them with information and knowledge.

C.7.2. Managerial Implications

Our study holds three important implications for practitioners considering creating an online community that hosts their expert customer userbase.

Firstly, while the imagination of highly involved users that govern the community and create all the content themselves to sustain its activity seems tempting, it is far from reality. Managers might hope that identification with their brand or the product is enough to intrinsically motivate users to participate (Martínez-López et al., 2017), but we found that professionals in this case identify with the work that is done with the product, not the product itself compared to more recreational products such as a car. The motivation of users must be earned by understanding and providing for the needs that their main users have (Iriberri & Leroy, 2009). This holds especially true when the potential userbase is small and centered around an expensive product or device that has a niche userbase scattered around the world.

Secondly, abandoning the idea of a laissez-faire community comes with substantial costs, we assume most of these costs will stem from creating and maintaining what we defined as Layer 0 and the included infrastructure. If the potential community is not trusting the infrastructure or feels in any way that participating in the forum might endanger their work due to legal or confidentiality problems, they will make sure to stay far away from it.

Thirdly, while in more open online communities the role of community managers and moderators can be fulfilled by a more generalist type of employee, the expectations towards the monitoring of content and discussions in a community centered around a MedTech product are much higher. Companies need to carefully consider who they will task with such a role as it most likely needs to be a scientist or product expert to have the ability of judging content on *scientific correctness*. The sentiment that we observed of existing expert employees moderate an online community ‘on the side’ next to their day-to-day activity seems optimistic and dangerous in the long run, as they might not be motivated to do so.

C.7.3. Limitations

In addition to the usual single case study limitations (Corley & Gioia, 2011; Gioia et al., 2013), our study comes with two significant limitations which should be carefully considered when interpreting the findings: We conducted this study within a very specific industry, MedTech, around a single company and a single product. Our informants, next to the company employees, were therefore users of this product and consisted of scientists, PhD researchers, senior researchers, or professors. While this sample of informants is very biased and far away from representing the general population, we believe it represents other possible online communities in the MedTech or life-science industries adequately. Similarly, DeviceX is a highly specialized device developed for a very specific task, but it represents most devices created for medical or life-science-related research well.

A major possible limitation resulting directly from our data collection comes from the potentially biased selection of informants (Miles et al., 2014). As we reported, we were only allowed to suggest potential interview candidates to the company based on their customer list and received a subset back that we were allowed to contact. We have no information on what the criteria were to filter our suggestions, but it might be possible that we were suggested very cooperative or loyal customers. These informants might hold overly positive feelings towards DeviceX and might have led us to underestimate how much work would be needed to convince users to join the online community and, inversely, to overestimate the willingness of possible community members to share and participate.

We believe it is most important that our results should are not considered generalizable to a broader online community setting. However, we believe they can be used for other potential online communities that exhibit similar traits, i.e., trust, confidentiality, professional users, and a research-oriented userbase as we believe our study to be representative of such communities.

C.7.4. Future Research

We would like to encourage future research to find other communities that already exist behind closed doors to validate our findings based on an online community that does not yet exist. It needs to be seen if our findings reflected overly positive statements by our informants or if they spoke in terms of truly participating in such a community. Furthermore, researchers have been focused on studying existing online communities mostly through their content, history, and users. This allowed us to understand online communities that exist, but we would welcome future research that concerns itself with online communities that have not yet emerged. We observed that our case only exists because of DeviceX and the digital output of data it can produce that, in return, could be shared electronically. This shift from insights that were hard to share to codified data that can be transmitted within an online community is most likely happening in various other domains too. Predicting where such shifts are happening could allow researchers to support and study the newly emerging communities around those new opportunities.

C.7.5. Conclusion

While the case of Medima and its potential closed online community is a quite unique case, we believe that similar highly skilled communities gathered around a certain product will become more adopted as time passes. New digital technologies are transforming work across industries with their ability to create sharable and comparable data, and there will always be users interested in more insights and data. However, these communities might not emerge by themselves, especially when they require high levels of security. We showed that the potential host must put in a significant amount of work and resources to start and maintain such a community.

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C.9. Appendix

C.9.1. Appendix A – Interview Guide Customers

#	Question
1	Could you briefly introduce yourself and why you are interested in clinical research?
2	Are you so far satisfied with the Device X? Why or why not? a. Have you ever experienced any challenges with the Device X software that could not have been dealt with the supplied SOP? b. If yes, what were these challenges?
3	Are you a part of other online communities and if yes, what do you like about them?
4	In your opinion, how many people in the world are using a Device X? a. Why do you think you can benefit from getting in touch with other Device X customers?
5	What information would you like to have about other forum users to interact with them? a. If you could search for forum users to discuss a certain topic, what search filters would you wish for?
6	When talking about the design of the Clinical Solutions Forum: a. What are important features that the forum should have to increase your user experience? b. What features would you name most important from the ones mentioned? c. How should the forum be designed? More traditional or modern style? d. Do you expect Medima to be actively involved in the forum activity or should it be a solely user-based community? If yes, how?
7	Would you appreciate a section in the forum that is called “troubleshooting”? a. What do you expect from the troubleshooting section? b. Could you imagine that you answer other users’ questions in the forum?
8	What would be a reason for you to actively participate in the forum?
9	It is intended that the community grows over time. Following the idea of a sharing economy combined with trade, under which conditions would you be willing to exchange (high quality) data with other forum members? a. Would you be willing to buy data on the forum, e.g., spectra measurement results, database of certain compounds (library)? b. Could you imagine selling spectra analyses or to run a sample for another institution that does not have a Device X?
10	Do you have any security concerns about using the Clinical Solutions Forum in the future? a. What security issues should be addressed from Medima’s side for you to feel safe using the forum?
11	a. Should the user profiles be openly visible, anonymous, or only visible under certain conditions? b. Would you be willing to share your profile, also if non-Device X-users can join? c. Would you want Medima to supervise, who can make an account, for people that do not own a Device X?
12	Assuming that there will be an active forum community established, how much time would you be willing to spend per week on the forum?

	a. Should there be the option for email newsfeed from the forum?

C.9.2. Appendix B – Interview Guide Internal

#	**Question**
1	Have you heard about a planned forum for Device X customers?
2	How often are you in contact with Device X customers?
3	Do you think the forum can be useful for Medima's customer support?
4	When talking about the design of the Clinical Solutions Forum: a. In your opinion, what are important features that need to be present in the forum? b. What do you think the interaction will look like?
5	What do you expect from the troubleshooting section? a. Could you imagine that you answer other users' questions in the forum? b. What questions do you think are most likely to be asked?
6	Could you imagine being part of the Clinical Solutions Forum yourself? a. What would be a reason for you to actively participate in the forum? b. What benefits would you get from getting in contact with customers in the forum?
7	What security issues should be addressed from Medima's side to enable a safe user experience?
8	Why do you think a community forum can be useful for Device X products?
9	Do you think the forum is an important differentiator for Medima compared to the competition? If so, why?
10	Assuming that there will be an active forum community established, how much time would you be willing to spend per week on the forum?

8.4 Appendix D – Curriculum Vitae

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