Chapter I: Introduction

Chapter I introduces the research topic and deduces the research problem underlying the thesis. Section 1 describes the status quo of the dissemination and the industrialization of personal data in the (European) information economy. In this context, the research problem becomes apparent materializing in the fact that growth and innovation potentials are impaired since large amounts of personal data (PD) are either processed without the consciousness of humans or remain unused at all. Building upon that, the thesis' overarching research question is defined in Section 2. Due to its complexity and the interdisciplinarity of the object under investigation, the research question is disaggregated into three constituting research objectives. They are encapsulated with their unique research outcomes while, at the same time, being interwoven into the thesis' all-embracing methodological framework entailing its structure. This structure is presented in Section 3 to provide a stringent overview about the entire research project.

I.1. Personal Data in the European Information Economy

The importance of data is constantly rising in the information economy (Einav and Levin 2014; McKinsey & Company 2022; Mian and Rosenthal 2016). In particular, PD comprise high value for both humans of whom the data are from and data processing organizations as the utilizers of that data. Likewise, the significance of PD as a subject of digitization has expanded over the years and nowadays encompasses multiple areas of human life entailing various economic benefits (Leidner and Tona 2021). For example, experts estimate that the amount of health related data available worldwide will exceed ten zettabytes by 2025 (Müller 2021). This includes data about medical histories, diagnoses, treatment suggestions and medical test results as well as data from laboratories, health insurance companies, wearables and fitness trackers. Naturally, other domains such as finance, smart living, social networking, and et cetera exhibit similar exponential growths (Leidner and Tona 2021). By sharing and processing this information about humans, both research and industry can gain valuable insights facilitating the creation of innovative products and services (Kariotis et al. 2020; Marjanovic et al. 2018). In this context, data spaces can provide a mean for large scale data allocation and (joint) utilization. However, while data spaces are increasingly emerging in B2B ambits (e.g., Catena-X, Manufacturing-X, International Data Spaces, Mobility Data Space, Resilience and Sustainability Data Space, Smart Connected Supplier Network), their development in B2C environments is stuck in a detrimental stage in terms of both theory (e.g., Koskinen et al. (2019), Rantanen and Koskinen (2020), Sambra et al. (2016)) and practice (e.g., SOLID, Human-X). In Europe, as both the birthplace and the development nucleus of the data space concept (Nagel et al. 2021; Otto et al. 2019a), a major pitfall of B2C data spaces is European data protection law. Those provisions predominantly ascribe human data subjects a need for data privacy while widely neglecting their economic participatory claims to data (Metzger 2020; Oehler 2016). Moreover, data spaces in B2C peripheries face a multitude of challenges in terms of ethical, technical, and economic constraints irrevocably bound to (jointly) processing PD in socio-technical networks (Spiekermann et al. 2015). Cumulatively, these interdisciplinary issues imply a high complexity of the architectural design of B2C data spaces impairing their effective development (Lehtiniemi 2017; Spiekermann et al. 2015). Due to the resulting lack of assertiveness of B2C data spaces, that also pertains to related systems[1], humans' data are fragmented in nowadays information economy (Meister and Otto 2019) and predominantly utilized by a few powerful providers (Nagel et al. 2021), e.g., hyperscalers (i.e., Google, Meta, Amazon). Thus, to promote a fair and thriving information economy, design knowledge is urgent to aid in the practical and theoretical development of these concepts. In particular, data spaces are an auspicious medium to remedy the prevailing problem of PD fragmentation and utilization as they can be envisaged to actively integrate humans with their data (Koskinen et al. 2019; Rantanen and Koskinen 2020), while leveraging economic incentive structures (i.e., market mechanisms) supporting network viability (Nagel et al. 2021; Otto et al. 2019a).

A definitional demarcation of the related notions "data space" and "data ecosystem" is urgent to ensure semantic consistency of these terms throughout the thesis. The Gaia-X AISBL describes a data space as "*a virtual data integration concept defined as a set of participants and a set of relationships among them, where participants provide their data resources and computing services*.[2]" Building upon this definitional approach, the Gaia-X AISBL further states that multiple data spaces emerge within one data ecosystem. Data ecosystems support actors in leveraging data as a strategic asset in an inter-organizational network that exhibits no restrictions in terms of a fixed defined actor. While data spaces emphasize the technical infrastructures, respectively the architectural designs, and the actors' networks emerging within them, data ecosystems rather focuses on the embedment of data spaces in an environmental setting. However, since the boundaries between those two terms are blurred in the literature, they often are used as synonyms. In the context of this thesis, the definitions of the Gaia-X AISBL are adopted for semantic consistency. Thus, the term data space is used to accentuate the focus on designing an architecture and its actor network that, in coalescence, describe a B2C data space for sharing, monetizing and utilizing PD. Following, the status quo of the dissemination and the industrialization of PD in the (European) information economy is outlined, amplifying the aforesaid challenges associated with processing PD in socio-technical and incentive-driven networks (e.g., PDMs, data spaces, PIMS).

Status Quo of Humans' Data Dissemination and Industrialization

Organizations pursuing data-driven business models in the information economy commonly leverage PD to create a better "knowledge" on customers or citizens, either as individuals or as homogenous groups of people (Lauf et al. 2022; Oehler 2016). They optimize their operations, enhance and tune their products, and improve the management of a company, city, or territory based on the generated knowledge. Processing PD meaningfully and effectively can even result in competitive advantages (Spiekermann et al. 2015). Thus, the availability of richer sets of data about humans is increasingly evolving as the key enabler for innovative products and services developed in constantly shortened development cycles (Oehler 2016; Spiekermann et al. 2015). In the

[1] The term related systems refers mostly to data trustees, personal data storages (PDS) and -information management systems (PIMS), personal data markets (PDMs), as well as digital rights management systems (DRM). Subsequent chapters provide further information.

[2] Gaia-X Architecture Document 21.12 release, p. 86, available via https://docs.gaia-x.eu/technical-committee/architecture-document/. This definition is no longer included in version 22.04.

year 2009, the former European Consumer Commissioner Meglena Kuneva already suggested that "*personal data will be the new oil, a valuable resource of the 21st century*" (cf. for example Spiekermann et al. (2015)). Indeed, in nowadays information economy, (personal) data are increasingly assuming a role comparable to that of oil in past centuries. For example, many products and services are offered and sold digitally, making data as important to these transactions as oil used to be. However, data in general and PD in particular comprise crucial differences to traditional economic goods, impeding their embedment in economic systems and corporate value chains (Oehler 2016). Firstly, data cannot be considered a private good according to the classification scheme postulated by Adams and McCormick (1987). This is caused by the ownership of data that is not *per se* exclusive. Rather, data can be made available to multiple parties without having to specify a greater or lesser degree of ownership to any of them (Metzger 2020). Secondly, the value of data gains disproportionately with increasing quantity and linkage. Due to *network effects* (Rogers 1995) the connection of different amounts of data creates significantly more value than it is the case with unconnected datapoints (Lauf et al. 2022). Thirdly, with respect to B2C environments, data comprise relatively low value for a single human, but is very valuable, especially in the aggregate, for data-processing organizations (Zechmann 2016). In the past, this discrepancy in terms of value conception resulted in individuals on the supply side of the information economy willingly disclosing their data for free, while enormous commercial benefit was created on the demand side without sharing any profit with the human "data sources" (Andrejevic 2014; Spiekermann et al. 2015). Currently, however, in addition to a growing desire of humans for data privacy (Jakobi et al. 2021; Smith et al. 1996; Véliz 2020), a gradually increasing understanding concerning the value of data becomes observable. This trend is suggested by multiple studies (e.g., Cvrcek et al. (2006), Huberman et al. (2005), Spiekermann and Korunovska (2017), Wang et al. (2018)). Supplemented by progresses in many jurisdictions worldwide (e.g., California Consumer Privacy Act, European Data Strategy, UK Data Protection Bill), this trend entails to rethink conventional data allocation and processing strategies that have been manifested in data-driven business models on the data demand side of nowadays information economy (Couldry and Mejias 2019; Oehler 2016). Following, the status quo of those manifested business models is elaborated.

In combination with the consistently advancing techniques for storing and processing data (e.g., Big Data and methods of profiling, scoring, and tracking), PD constitute the basis for many **data-driven business models** of the information economy (Oehler 2016). Oehler (2016) makes a distinction based on two classification criteria for such business models as applied in B2C contexts. These are, firstly, organizations trading in data (Group 1) and, secondly, organizations systematically processing data (Group 2). The term *data processing organization* denominates, for instance, the "tech giants" like Amazon, Meta, Netflix, and Google. They commonly process PD to develop recommender systems that are further advanced than the ones offered by their less data-driven competitors. In general, by systematically utilizing PD, organizations assigned to Group 2 can innovate products and services precisely tailored to the preferences of their customers, thus consistently increasing their revenues (Birch et al. 2021). In contrast, organizations of Group 1 are classified as *data brokers*. According to Oehler (2016), data brokers collect PD, e.g., through plug-ins or aggregation software, and sell them to third parties. Transparency in those market is low, and a multitude of data brokers frequently operates in legal grey zones (Spiekermann et al.

2015). Concurrently, humans are seldomly aware of those concealed markets, where their data are collected, allocated, and shared with neither their consciousness nor (informed) consent (Oehler 2016). If data brokers sell collected PD to Group 2 organizations (e.g., advertisers), the data subject is inevitably exposed to various risks. For example, financial institutions, insurance companies or other service providers might purchase collected PD and leverage them for purposes potentially harming the data subject (Oehler 2016). By now, PD can be analyzed in ways enabling far-reaching profiling and tracking of all recordable and measurable areas of humans' lives (Meister and Otto 2019). This encompasses, for instance, the overall financial and health situation, shopping behavior, lifestyle, or the current life stage (Leidner and Tona 2021). By means of massively allocating and combining data of humans, thorough analytical insights can be obtained from private households and specifiable groups of people based on selectable sensitive characteristics such as gender, age, marital status, religion, health status, living situation, hobbies or financial circumstances (Oehler 2016). In this context, original, processed, and enriched sets of PD become remunerated commodities (Birch et al. 2021). Hence, in the data-driven business models prevailing in many information economies worldwide, PD are frequently supplied for processing purposes to which the concerned human would never have consented (Lauf et al. 2022).

In Europe, the increasing dissemination and industrialisation of such inferior data-driven business models have caused the adoption of the General Data Protection Regulation (GDPR) in order to provide a **contemporary** and a **restrictive legal framework** for the advancing digitalisation of the rapidly evolving information economy (Aseri 2020; Metzger 2020). The GDPR attempts to reconcile data protection and privacy with innovative data processing activities, while consistently strengthening both aspects (Brunswick 2019). A key claim of the GDPR is the provision of appropriate information and the obtainment of informed consent of the data subject prior to data allocation and processing (Oehler 2016). In principle, the individual must be informed about who is collecting, processing, and linking which kinds of PD for what purposes. However, the European attempt to protect human rights to PD wildly lacks an innovation perspective since its protectionist provisions hinder (1) the emergence of novel concepts for sharing, monetizing, and utilizing PD and (2) the transition of existing B2B concepts to digital B2C environments (i.e., data spaces). This impedes the establishment of a uniform economic and legal framework in terms of PD in the European information economy (Oehler 2016). Consequently, B2C data spaces must be designed in a way adoptable to the restrictive legal provisions. In this context, one must pay attention to the practical implementation of data processing concepts of organizations while ensuring fair participation of humans in terms of profit resulting from the authorized processing of their data. Moreover, the design of these networks should promote data portability and interoperability.[3] Yet, such recommendations addressing B2C data spaces, as proposed by several consumer commissions in Europe, have hardly penetrated the consciousness of (European) policymakers (Oehler 2016). For example, in 2017, the German federal commissioner for data protection and freedom of information stated that "[…] *the GDPR and its implementation in German law (DSGVO) provide sufficient leeway for the German and European digital economy to develop*

[3] Baden-Württemberg Consumer Commission: Data sovereignty, data use and data exploitation – demands for an "update" of the economic and legal system as an opportunity for self-determined data use, opinion of the Baden-Württemberg Consumer Commission, No. 45, 2017.

innovative and intelligent business models that make the potential inherent in the existing enormous amounts of data economically exploitable while, at the same time, complying with data protection law" [author's translation].[4] The participation of humans on the economic exploitation potential of their data was not even addressed. Several years later, European data law still considers the data economy (i.e., data processing organizations) as the profiteer of data utilization only. In contrast, humans are merely assumed to have an interest in data protection and privacy (Oehler 2016). Consequently, the GDPR ignores the economic claims of European citizens to their data and impedes both the systematic generation and the fair distribution of the economic exploitation potential related to their PD (Oehler 2016). As a result, there are hardly any developments toward data spaces (or related systems) enabling the self-determined processing of PD in B2C contexts. Hence, the GDPR has predominantly failed so far to achieve its objective of facilitating data-driven business models and innovation (Oehler 2016). This problem prevailing in practice calls for research exploring how to design B2C data spaces effectively, while integrating the deficient legal framework in a way that still allows for a joint utilization of PD based on the GDPR. Concurrently, B2C data spaces must ensure humans their rights to data and a fair share of the economic profits. By now, (modern) personal data markets (PDMs) are, to the author's best knowledge, the only kind of systems for systematically sharing, monetizing, and utilizing *personal data* having achieved a sufficient saturation measured by their number of both representatives in practice and design-oriented literature (Parra-Arnau 2018). Since the economic structure of data spaces entails a market mechanism to orchestrate the sharing, monetization, and utilization of data (Nagel et al. 2021; Otto and Jarke 2019), one can deduce two assumptions for their application in B2C contexts. Firstly, the challenges faced by PDMs also pertain to B2C data spaces. Secondly, (higher-level) design elements of PDMs to circumnavigate these challenges are applicable by B2C data spaces as well. Importantly, the challenges of PDMs already are well-known and are sufficiently considered by pertinent literature.

Interdisciplinary Challenges of B2C Data Spaces

The sharing, monetization, and utilization of PD in socio-technical networks mainly comprise legal, economic, technical, and ethical constraints (Lauf et al. 2022). Regarding **legal** hurdles, an increasing number of jurisdictions worldwide (e.g., Europe, California, Great Britain) have enacted provisions to drastically restrict both the systematic processing of PD in organizational processes and PD sharing within and across jurisdictions (see above). For example, the GDPR in Europe states *strict data protection laws* encompassing a set of principles (e.g., data minimization, legitimate use, purpose binding, and informed consent) that leave little space for market negotiations between the data supply (i.e., humans) and demand side (i.e., data processing organizations), not to mention between third parties. This entails to design systems like B2C data spaces or PDMs in a way that PD are only processed in dedication to a legitimate interest (appropriation). This legitimate interest, in turn, must typically be based on the informed consent of the data subject. This requires the determination of and the adherence to a set of clearly defined processes for data exchange and processing to circumnavigate significant penalties faced in case of incompliance

[4] Federal Commissioner for Data Protection and Freedom of Information: General Data Protection Regulation, BfDI - Info 6, 2017, p. 7.

with data protection law. However, even if a legally compliant system for PD sharing, monetization, and utilization can be designed, the problem has yet to be solved that data comprise – in many respects – the *traits of a free commons* (Adams and McCormick 1987; Spiekermann et al. 2015). By its nature, (personal) data are non-rival, cheap to produce, easy to copy, and can be transmitted without any problems, making data substantially different from typical commodities (Schwartz 2004; World Economic Forum 2011). Thus, to function properly, alienability, rivalry, and excludability for PD must be established (Spiekermann et al. 2015). One possibility is to assign an ownership-like right to data (Metzger 2020) albeit there is no concrete design knowledge available about how to integrate such a solution in socio-technical networks. Furthermore, suppose PD actually become property, an additional legal challenge is to include and tailor *data property rights* in a way they are compatible with the notion of privacy as a fundamental right and able to define the initial allocation of property rights in the system. This is a binding condition to restrict alienability and exclusivity (Spiekermann et al. 2015). Property rights are also a prerequisite to establish scarcity of the data and competition in their use (Spiekermann et al. 2015), thus allowing to integrate incentivization mechanisms for PD sharing (Metzger 2020).

From an **economic** perspective, finding feasible and "fair" pricing models for heterogenous sets of PD is a yet unsolved research area (Malgieri and Custers 2018; Shen et al. 2016). Due to context-dependencies and contingencies affecting the costs and benefits arising from the protection, sharing, and utilization of (personal) data, the evaluation of their pecuniary value is a very complex endeavor (Berthold and Böhme 2010). The complexity becomes evident in the diversity of results suggested by multiple studies that tried to determine price tags for sets of PD (Cvrcek et al. 2006; Grossklags and Acquisti 2007; Huberman et al. 2005; Lesk 2012; Li et al. 2014; Niu et al. 2020; Shen et al. 2016). The diversity of their findings indicates the difficulty to map different data points into a consistent picture. This is caused, among others, by heuristics and biases significantly affecting the privacy preferences of humans which, in turn, determine their *self-valuations of PD* (Acquisti et al. 2013). The intricacy to consistently measure the pecuniary value of PD is also accompanied by further problems, such as (Spiekermann et al. 2015): (1) the design of effective *price discovery mechanisms* and their integration into system architectures; (2) the facilitation of price negotiations between data buyers and sellers given the existence of *information asymmetries* (e.g., in terms of data quality); (3) the determination of *"fair" prices* under the constraint of minimal information leakage; (4) a consistent and auditable *trade accounting*; and (5) *fraud detection* in terms of data quality and payment for data transactions. Furthermore, future uses of data might be anticipated and accounted for in the pricing mechanism, considering potentially arising *privacy externalities* by means of internalization (Cao et al. 2018). In "conventional markets", the standard solution to externalities is to facilitate bargaining among the supply and demand side (Coase 1960). However, given a B2C data space with a potentially arbitrary number of users on the data supply side, this goal may prove nearly impossible. The reason is that data demanders cannot be expected to negotiate about every small dataset comprised in a PD transaction. Contrarily, in B2B environments, there are relatively few but large datasets, respectively data suppliers (e.g., Catena-X, Mobility Data Space), and the number of negotiations is comparably low. Hence, B2C data spaces require *efficient mechanisms for data sharing (and payment)* to replace, firstly, time and cost consuming negotiations between market actors as well as, secondly, intricate price formulation and exchange procedures (Fernandez et al. 2020).

According to Spiekermann et al. (2015), the only way to enforce property-like rights for PD in socio-technical networks like B2C data spaces or markets is to mandate **technology** that "reverses" the laws of information goods, similar to endeavors applied in digital rights management (Kenny and Korba 2002). Adequate solutions for system implementation might be *privacy-preserving technologies* and (technically) enforceable methods for fine-granular *data usage control* (Zrenner et al. 2019) which are accompanied by their own challenges. Beyond providing means for technically controlling PD processing, a major technological issue is that cryptographic protocols require all transaction details to be known at the time of invocation (Spiekermann et al. 2015). This requirement is contrary to the need of a B2C data space as many features making PD (processing) valuable require *transaction flexibility* or a complete dissolvement of the association between data and the transaction. In this context, the enablement of *flow control* for all kinds of accountable information is vital (e.g., data, payments and associated meta-information) implying high documentation loads to be considered in the architectural design (Spiekermann et al. 2015).

Furthermore, a multitude of **ethical** concerns exists. Above all, the interpretation of PD as a tradable economic good entails a philosophical and ethical discourse about whether human's lives, materialized in their data traces, should be property at all, or not rather be considered inalienable from individuals (Spiekermann et al. 2015). In this context, the notion of the "*propertization of the human being*" touches upon fundamental discourses in philosophy, sociology, and political sciences addressing what is private and public in terms of PD, what constitutes a human's identity in the digital world, and how to behave as a responsible human in virtual environments with sufficient liberty to form preferences and opinions oneself (Nielsen et al. 2019; Spiekermann et al. 2015). Moreover, technological advances in the field of Big Data and (personal) data analytics pose the risk to render humans into exploitable "digital identities" to be traded and used in the information economy (Couldry and Mejias 2019). Thus, B2C data spaces must be evaluated with respect to whether and to which extend they are able to fulfill essential *ethical standards*. As a more general issue, critics from the domain of ethics exists that consider any monetization of PD a priori as coercively preclusive with data privacy. This statement can be traced back to the *privacy construct* proposed by Solove (2005) who per se denominates practices like the aggregation of PD, tracking and profiling, secondary use, exclusion, and decisional interference as privacy breaches (Solove 2005; Spiekermann et al. 2015). Consequently, the author's legal analysis of what Western cultures consider to be "privacy" suggests that B2C data spaces and PDMs would completely undermine or even dissolve this value (Spiekermann et al. 2015). Another moral issue refers to how the mere existence of such systems would affect society and human behaviour. In particular, behavioral research has already coined the notion of *strategic data subjects* that describes humans constantly striving for maximizing the value of their PD and thus their monetizable profit (Wang et al. 2018). To this end, they are likely to engage in strategic behavior, such as avoiding leaving traces that could impair the value of their PD (Wang et al. 2018), e.g., spatial data linking them to critical neighbourhoods. Finally, digitally networked humans might be urged to find global consensus on societal issues as it becomes much harder to preserve islands of idiosyncrasies (Spiekermann et al. 2015). Thus, implicit or explicit *nudging activities* carried out within networks like B2C data spaces would need to be identified and evaluated with respect to their appropriateness and potential (negative) effects on humans' self-determined behavior (Meister and Otto 2019).

I.2. Main Research Question and Subordinated Objectives

Summarizing Section 1, the status quo of the dissemination and the industrialization of humans' data in the European information economy is unsatisfying. On the one hand, the fraction of PD currently utilized by data processing organizations are regularly processed without the consciousness of the individual. On the other hand, interdisciplinary challenges, particularly the restrictive legal framework in Europe, impede the transition of the auspicious data space concept from digital B2B to B2C environments. In addition to this shortfall in practice, literature widely lacks design knowledge about B2C data spaces. To address this prevailing **research gap**, the thesis' overarching research question (RQT) is defined that exhibits broad implications for theory and practice:

RQT: *What is an abstract design for a B2C data space that is technically feasible, compliant with European data law, ethically defensible, and usable by humans?*

Due to its interdisciplinary nature and the widely unexplored research field addressed, the RQT is too complex for being answered through a single investigation. Consequently, it is divided into three subordinated research objectives (RO) that are pursued sequentially while being interwoven within an overarching research framework (cf. Fig. 1). These research objectives are further disaggregated into actually processable sub-questions, which entails the structure of the overall research project (cf. Section 3). Notably, this introductory chapter does not have a methodological viewpoint on the thesis. Rather, it presents the underlying partition of the overarching RQT in somewhat loosely coupled but logically interconnected research objectives, while amplifying how, in coalescence, they form a holistic picture of the research project described by the thesis.

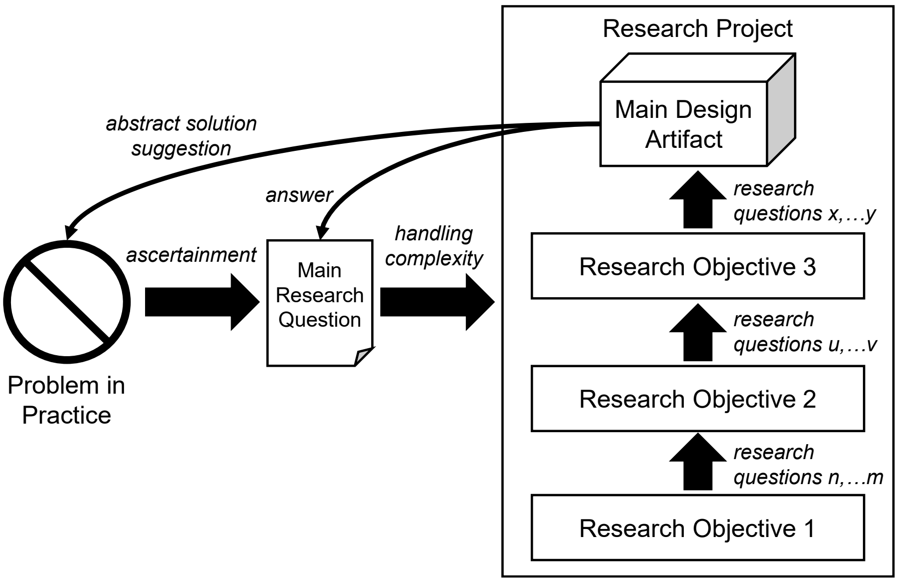

Fig. 1: Classification of research objectives

At the outset, the research project examines the phenomenon of PDMs by means of thorough investigations into theory and practice, generating an initial knowledge base. Starting with PDMs to curtail the broad and interdisciplinary field of B2C data spaces and to explore first relevant design elements with respect to RQT is justified by the reasons given in Section 1. Recalling this line of argumentation, PDMs currently represent, to the best of the author's knowledge, the only kind of socio-technical systems for systematically sharing, monetizing, and utilizing PD that exhibit a sufficient number of analysis objects in both literature and practice. The initial emphasis on PDMs is also reasonable due to progresses in practice encounterable over the past years. Albeit being confronted with various challenges impeding their viability (cf. Section 1), at present, a new generation of PDMs is recognized as emerging (Parra-Arnau 2018). The same holds true for design-oriented literature in the field. Hence, PDMs constitute an expedient starting point to develop a knowledge base for designing B2C data spaces, effectively, which cannot be provided by any other kind of related systems. Consequently, RO1 reads as follows.

RO1: *Identify the design elements of PDMs from both practice and theory!*

Apparently, systems such as B2B data spaces and markets (DMs), PDS, PIMS, data trustees as well as even the few initial approaches to B2C data spaces (e.g., SOLID, Human-X) are neglected by RO1. The reason is that those attempts miss at least one of the following characteristics: (1) the actual participation of humans and their PD; (2) the integration of all the fundamental functions required by B2C data spaces (cf. Section 1; i.e., PD sharing, monetization, and utilization); and (3) the aforesaid saturation in terms of investigable analysis objects existing in both practice and literature. Importantly, these initially neglected systems are considered in successive parts of the research project. Recalling Section 1, examining PDMs in RO1 is meaningful since their design must allow to systematically share, monetize, and process PD (Bruschi et al. 2020), thus entailing crucial design implications for B2C data spaces. However, research lacks conceptually and empirically grounded studies concerning the economic (i.e., business model) and technical (i.e., architecture) design elements of PDMs.[5] By now, research has either investigated data markets generally or developed use case-specific PDM models (e.g., Bataineh et al. (2020), Bruschi et al. (2020), Oh et al. (2019)). Consequently, scientific approaches to PDMs have widely neglected the generation of universally valid design knowledge, which could aid in the development and understanding of B2C data spaces, e.g., the inference of design elements and use case agnostic reference models. Consequently, design knowledge about PDMs is crucial for addressing RQT, which entails the following research questions (RQ):

- **RQ1.1:** *What are the design elements to structure Personal Data Markets from an economic and a technical perspective*?
- **RQ1.2:** *What are archetypes of Personal Data Markets?*

RO1 aims at establishing a comprehensive knowledge base to be continuously expanded in the course of the research project. Essentially, the insights yielded in RO1 serve to narrow down the scope of investigation in RO2 by demarcating a preliminary set of design elements pertaining to B2C data spaces from a marketplace-centric perspective. Building upon this narrowed scope, the goal of RO2 is to expand the initially allocated (RQ1.1) and aggregated (RQ1.2) design knowledge in terms of (meta-) requirements and supportive design principles (DPs). The reasons for choosing these kinds of artifacts are elaborated in Chapter III.2. In a nutshell, they allow to effectively develop a B2C data space of the type functionally curtailed by RO1. RO2 reads as:

[5] In the thesis, the term *design element* is defined as objects describing the composition of a system from an abstract design perspective.

RO2: *Identify (meta-) requirements and supportive DPs for a (type of) B2C data space!*

Since the expression "type of B2C data space" in RO2 corresponds to one of the archetypes resulting from RO1, RO2 can simply be disaggregated into the following RQs:

- **RQ2.1:** *What are (meta-) requirements for a (specific type) of B2C data space?*
- **RQ2.2:** *What are conceptually grounded and empirically validated design principles inferable from the (meta-) requirements?*

RO3 leverages the design implications curtailed by RO1 (i.e., taxonomy and archetypical classification) and specified by RO2 (i.e., (meta-) requirements and supportive DPs). Subsequently, it aims to design a conceptual model by means of a design science research approach. To implement the accumulated design implications, design features are extracted from both theory and practice. In this context, the scope of analysis objects is enlarged to the aforementioned kinds of systems neglected (e.g., PDS, PIMS, B2B data spaces, and DMs). RO3 embodies the main part of the thesis aiming to design and evaluate a B2C data space model eligible to answer RQT. Its completion terminates the research project. RO3 is defined as follows:

RO3: *Design a model for a (type of) B2C data space and infer reflective DPs!*

This model must comprise the attributes required by RQT. It must be adaptable to European data law in a way enabling the sharing, monetarization, and joint utilization of PD. Furthermore, the model must be ethically defensible and usable by humans (RQT). Concurrently, it must ensure each individual his or her rights to data and a fair share of generated economic profits. Provided a successful implementation of these intricate properties, the model serves to close the prevailing research gap outlined in Section 1 by answering RQT. For this purpose, a reference system architecture (RSA) is considered as the best-possible instantiation, as those kinds of models represent ideal-typical solutions for a class of architectures (Cloutier et al. 2009). Accordingly, the first RQ extracted from RO3 reads as follows:

- **RQ3.1**: *What is an abstract RSA for a B2C data space that is technically feasible, complies with European data law, and is usable by humans?*

Since the interdisciplinary nature of such an RSA entails the accumulation of a large fundus of architectural design knowledge, reflective DPs aggregating that knowledge represent a valuable addition to the design artifact (Cohendet and Meyer-Krahmer 2001). Consequently, RO3 is complemented by another subordinated research question:

- **RQ3.2**: *What generally valid DPs can be inferred from the RSA?*

Cumulatively, the constitutive research objectives contribute to data space research from both an academic and a practical perspective. On the one hand, they provide a meaningful methodological pathway throughout the thesis. On the other hand, they guide the generation of dedicated design knowledge. This design knowledge is accumulated in multiple artifacts that, in coalescence, bring the auspicious data space concept to digital B2C environments. Thereby, special attention is drawn to the integration of market mechanisms facilitating data sharing, monetization, and utilization as well as the active participation of data sovereign humans.

I.3. Structure of the Thesis

The thesis describing the research project is structured alongside the following chapters:

- *Chapter I* has introduced the research topic. Essentially, the research problem has been deduced from practice (i.e., an unsatisfying dissemination and industrialization of humans' data in the (European) information economy), while a corresponding research gap in literature has also been revealed (i.e., design knowledge about B2C data spaces). Therefrom, the main research question has been inferred and disaggregated into three research objectives to be processed sequentially in the further course of the thesis.
- *Chapter II* provides the theoretical foundations of the research project. Those encompass the evolution of the data space concept and the theoretical grounding in which the aforementioned reference system architecture embedded. Furthermore, the state-of-the-art in literature is outlined that materializes in a four dimensional field of tension pertaining to B2C data spaces. Corresponding to their challenges, the design of these networks necessitates a technical (i.e., data sovereignty), economic, ethical, and legal consideration. Due to its restrictive nature, European data law is the legal lens throughout the entire research project. The chapter concludes with the methodological foundations of the DSR approach, including the 4+1 View Model as the scaffolding for the RSA.
- *Chapter III* outlines the overarching methodological framework in which RO1 – RO3 are interwoven. In essence, a procedural model is described consisting of an analysis phase (RO1, RO2) and iteratively conducted design and evaluation phases (RO3). Within these phases, the individual methodologies of RO1 – RO3 are integrated and linked, whereby particular attention is drawn to the DSR approach applied in RO3 to answer RQT (cf. Section 2). Additionally, a modified 3+1 View Model is introduced which has been derived from the original version explained in Chapter II. The purpose is to provide an effective structure that considers the characteristics of the RSA in RO3, thus serving as justificatory knowledge informing its design.
- *Chapter IV* presents the results of the analysis phase. Those encompass, firstly, the explored design elements of PDMs materializing in a taxonomy and archetypes (RO1). Secondly, a requirements catalogue, a set of aggregated meta-requirements, and supportive DPs for a selected archetype (i.e., a type of B2C data space) are outlined (RO2). This accumulation of (model specific) design implications enables the DSR approach in RO3.
- *Chapter V* contains the design of the RSA resulting from the DSR approach in RO3. Starting with its aggregated summary, following sections delve into architectural details structured alongside the aforementioned 3+1 View Model. Specifically, the RSA is described from a functional, distribution, and process view as well as a role model perspective. Importantly, all these partial models are aggregated in the process view allowing to elicit the generic core of the RSA that answers RQT.
- *Chapter VI* demonstrates crucial parts of the RSA by means of prototyping. This method provides a (limited) proof of concept. Moreover, prototyping facilitates the understanding and the evaluation of the complex conceptual design explained in Chapter V.

- *Chapter VII* presents the results of a multi-dimensional evaluation strategy that exceeds prototyping and is applied to assess the RSA from multiple perspectives. Specifically, descriptive, analytical, and observational evaluation methods are used to guarantee its holistic evaluation.
- *Chapter VIII* presents an elaborate discussion of the evaluated RSA, delving into essential design elements within the architectural framework. In this context, two distinct technological concepts regarding the implementation of the RSA are duly contemplated, accompanied by an elucidation of a conceivable consent mechanism. Furthermore, reflective DPs are formulated to augment RO3, followed by a discussion on a meta-model.
- *Chapter IX* concludes the research project and summarizes the thesis. It refers to the underlying theory, completes final discussion points, and formally answers RQT. Above all, the chapter comprises an appreciation of the outcomes resulting from the analysis phase (RO1, RO2) and the design and evaluation phases (i.e., the DSR approach; RO3), while also referring to their limitations and future research implications. Ultimately, potential societal, economic, and political implications of “RSA-based” data spaces are outlined.

Summarizing the structure of the thesis, the research objectives RO1 and RO2 are carried out in a preliminary analysis phase in advance of RO3 as the main DSR approach. They serve to establish a comprehensive knowledge base enabling to design and evaluate the RSA that represents the thesis’ key artifact. Thus, albeit making essential contributions to the research project by generating supportive “auxiliary artifacts”, RO1 and RO2 are somewhat encapsulated and detached from the actual DSR approach. Likewise, they are separated in the textual structure and acknowledged in different parts of the thesis, whereby the outlined chronological sequence is underlined.