D7.1
Sustainable Business Model for TRUSTS Data Marketplace I

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Additional Information: The deliverable focuses on developing business model taxonomies, which will subsequently inform the design of business models for TRUSTS in the second phase of the project.

TRUSTS Trusted Secure Data Sharing Space

D7.1 Sustainable Business Model for TRUSTS Data Marketplace I

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Glossary of terms and abbreviations used

Abbreviation	Description
APIs	Application Programming Interfaces
B2B	Business-to-Business
B2C	Business-to-Consumer
BM	Business Model
C2B	Consumer-to-Business
CPC	Cost per Click
CR	Caruso
DIY	Do It Yourself
DSR	Design Science Research
E2E	End to End
EU	European Union
GA	Grant Agreement
GDPR	General Data Protection Regulation
HE	HERE applies location technology to improve connected driving experiences. The HERE data marketplace has open access for any data seller, data buyer and third-party service provider to exchange data.
IDSA	International Data Spaces Association
IN	INRIX is a privately owned company and applies location analytics to make road transportation more intelligent. INRIX trades data bilaterally with their commercial data sellers and buyers and serves public organizations.
IT	Information Technology
IOT	Internet of Things
IOTA	IOTA is funded by the non-profit IOTA Foundation. IOTA focuses on the IoT market with the goal to enable secure data transactions between data sellers and buyers.
ICT	Information and Communication Technology
MSMBs	Micro, Small and Medium Businesses
NPO	Non-profit Organization
OE	Objective ending conditions for taxonomy development
OP	Ocean Protocol is a non-profit organization based in Singapore. Their data marketplace has open access to create an environment in which many data sellers and buyers can exploit data
PAAS	Platform-as-a-Service
SE	Subjective ending conditions for taxonomy development
SMEs	Small and Medium-sized Enterprises (SMEs)
STOF	Service Technology Organization Finance

TRUSTS	Trusted Secure Data Sharing Space
TT	TomTom is a privately owned company that uses location technology to sell mapped data.
USPs	Unique Selling Propositions
WP	Work Package

Executive Summary

This deliverable is part of the Work Package 7 "Business Model, Exploitation & Innovation Impact Assurance" of the "TRUSTS - Trusted Secure Data Sharing Space" project and focuses on developing business model taxonomies, which would subsequently inform the design of business models for TRUSTS. This is the first version of the project's deliverable titled "Sustainable business model for TRUSTS data marketplace," addressing Task 7.1 "Sustainable business models", along with the work that has been performed under WP7. The primary function of the developed taxonomies is to:

1. Contextualize and position TRUSTS within the developed taxonomies, and
2. Explore the potential of business models for TRUSTS.

A significant highlight of this report is to emphasize TRUSTS' roles in the EU data economy, which goes beyond that of a 'basic' data marketplace. TRUSTS will also be a federator and an ecosystem facilitator of data marketplaces. Thus, the business model taxonomies were developed considering these roles.

In total, **four business model taxonomies** were developed. The first two taxonomies specifically explore business models of data marketplaces and build on desk research. Whereas the first taxonomy considers data marketplaces that are not specific for a given industry, the second taxonomy explores the automotive industry. The third taxonomy is created concerning the TRUSTS role as a federator and an ecosystem facilitator of data marketplaces. Because a taxonomy is generally developed based on characteristics of existing phenomena, the development of the third taxonomy was complemented with experts opinion from workshop participants with expertise in data marketplaces, business models, and technical requirements. Finally, a unified taxonomy was developed to contextualize the previous three taxonomies for TRUSTS' needs. The third and unified taxonomy development is informed by workshops organized with technical experts and business actors. Accordingly, the taxonomies developed in this report are empirically and theoretically informed grounded in an understanding of practical considerations of the envisaged roles for a sustainable data marketplace. After describing the taxonomies, the report also presents risks, opportunities, and business requirements that TRUSTS should consider.

1. Introduction

A wide variety of business models for data marketplaces exist (Spiekermann, 2019). With ongoing technology developments (e.g., privacy-preserving technologies) and policy (e.g., EU data strategy), the diversity of business models for data marketplaces will likely increase even more. Since TRUSTS has the ambition to create a data marketplace platform and federate existing ones, it is essential to develop a broad and grounded understanding of the breadth of data marketplace business models that exist today and emerge in the future. Against this backdrop, the present deliverable seeks to develop such an understanding of the business model options of data marketplace platforms.

In addition, the ambition to federate existing data marketplaces reveals TRUSTS’ roles in the EU data economy, which go beyond that of a ‘basic’ data marketplace. TRUSTS will be

1) a federator and
2) an ecosystem facilitator of data marketplaces.

However, business model options for these two roles are relatively unknown. Therefore, this deliverable also explores possible business model options for TRUSTS, especially considering the two mentioned roles.

Business model taxonomies can be a starting point to explore business model options because they can be used to classify business models. A taxonomy is a classification scheme that seeks to depict a set of possible characteristics of a phenomenon. Hence, this deliverable focuses on developing business model taxonomies, which will subsequently inform the design of business models for TRUSTS. The primary purposes of the D7.1 are to:

1. Contextualize and position TRUSTS within the developed taxonomies and
2. Explore potential TRUSTS, business models.

Existing taxonomies of data marketplace business models have a limited scope, focusing only on market-oriented data marketplaces, and omitting more hierarchical or aggregator-type data marketplaces. Moreover, business model taxonomies for a federator and an ecosystem facilitator of data marketplaces have not been investigated in the existing literature. For these reasons, **four business model taxonomies were developed** and documented in this deliverable based on conducted desk research, interviews, and workshops during the taxonomy development processes.

The first two taxonomies were particularly developed to explore business models of data marketplaces. Whereas the first taxonomy (#1 taxonomy) does not have an industry-specific focus, the second taxonomy (#2 taxonomy) explores specifically the automotive industry. The #1 and #2 taxonomy employ the design science research and grounded theory for the taxonomy development approach, respectively. The third taxonomy (#3 taxonomy) was created concerning TRUSTS’ role as a federator and an ecosystem facilitator of data marketplaces. Finally, a unified taxonomy was developed to contextualize the previous three taxonomies for TRUSTS needs.

Based on the developed taxonomies, business model opportunities will be explored for TRUSTS in the further course of the project. To achieve the objectives, this task closely interacts and leverages outputs of Task 2.1, “EU and worldwide data market,” specifically the insights on the definition of data marketplaces and the positioning of TRUSTS.

1.1 Mapping Projects' Outputs

The purpose of this section is to map TRUSTS Grant Agreement (GA) commitments, both within the formal Deliverable and Task description, against the project's respective outputs and work performed. It begins with a summary of D7.1 and then provides justifications for the task undertaken.

Table 1 Adherence to TRUSTS GA deliverable and tasks descriptions

TRUSTS Task Description **T7.1 Sustainable business models**	**Respective Document Chapter(s)**	**Justification**
The aim of this task is to select a viable, feasible and sustainable business model for the data marketplace platform developed in the project. Practical business models will be developed following the method of action design research which gives a structure for structuring a scientific design project in a practice-oriented situated setting. The artefact of the action design research is a set of presumably viable business models. The business model will be developed by applying tools for business model innovation as developed in TUD's award-winning platform businessmakeover.eu. The tools will be applied in workshops with project participants and, later on in the project, outside stakeholders. To inform the business model development, first, through desk research and interviews, a range of potential data marketplace business models will be explored, leading to a taxonomy of possible business model design options. In doing so, this task will closely interact and leverage outputs of "T2.1 EU and worldwide data markets". The taxonomy will be structured using components from three approaches:	Chapter 3 Chapter 4 Chapter 5 Chapter 2 Chapter 3	Chapter 3 discusses business model taxonomies for data marketplaces in the existing literature, and develops new, unified taxonomies based on the gaps identified. The developed taxonomies will be the basis for selecting a viable, feasible, and sustainable business model TRUTS, with starting points described in Chapter 4. Chapter 5 provides business model challenges, opportunities, and requirements for TRUSTS. Empirical data collections to develop the taxonomies are presented in Chapter 2 and 3.
(1) business model components for digital systems in general, derived from TUD's STOF ontology for multi-stakeholder business models;	Chapter 2 Chapter 3	Chapter 2 provides the STOF ontology description and relevance for TRUSTS.

TRUSTS Task Description **T7.1 Sustainable business models**	**Respective Document Chapter(s)**	**Justification**
(2) business model components that are specific for data marketplaces (e.g., degree of curation, semantification, aggregation of data provided); (3) multi-sided platform aspects that affect value creation (e.g., shaping of boundary resources that mediate between the marketplace and its users, launch strategies and cross-subsidization models to overcome critical mass problems).	Chapter 5	Chapter 3 presents the developed taxonomies that consider business model components specifically for data marketplaces. It also considers multi-platform aspects.
Evaluation of business models will be done in three ways: (1) by conducting a summative evaluation on the implications of business model choices on critical success factors that measure the viability of the business model; (2) by informing T7.5 on concrete actions and activities needed to realize the business model and testing the feasibility of these actions based on T7.5 findings; (3) by applying TUD’s method of business model stress-testing to evaluate the sustainability of the business models in different future scenarios (e.g., different levels of citizen trust in data economy or different levels of regulatory regimes).		Chapter 5 discusses the outlook for the next phase of the deliverable, including evaluating the developed business models for TRUSTS.

TRUSTS Deliverable
D7.1. 'Sustainable business model for TRUSTS data marketplace I' Report describing the designed business model to sustain TRUSTS after the project end. It will focus on the taxonomy for data marketplace business models.

1.2 Deliverable Overview and Report Structure

Chapter 1 "Introduction" of the deliverable describes the project outputs, deliverable overview, report structure, the roles of TRUSTS project, and interdependencies of T7.1 with other tasks within the TRUSTS project.

Chapter 2 "Methodology and Framework" is dedicated to the methodology used in developing the deliverable outcomes and also reflects the approach and iterative steps taken to achieve its aim. This chapter also discusses the key concepts used in this deliverable:

a. Data marketplace definitions,
b. a federator and an ecosystem facilitator of data marketplaces, and
c. business model taxonomies.

The primary work of the deliverable is presented in **Chapter 3** "Business Model Taxonomies" which consist of the development of four business model taxonomies and the positioning of TRUSTS within the unified taxonomy.

Chapter 4 of this report, "Challenges and Opportunities for TRUSTS", focuses on the challenges and opportunities for TRUSTS. The challenges and opportunities are discussed along with the roles of TRUSTS as a data marketplace, TRUSTS as a federator, and TRUSTS as an ecosystem's facilitator of data marketplaces. This chapter also provides a summary of business model requirements.

Chapter 5 "Business Model for TRUSTS" elaborates on business model recommendations for TRUSTS.

Finally, the "Conclusion and Next Actions" mark the last chapter of this deliverable, elaborating the outlook for the T7.1 plan towards the second phase of the project (M36: December 2022).

1.3 The Roles of TRUSTS Project

Interpreted from the three project mandates, Figure 1 describes the roles of the TRUSTS project in the EU data economy. TRUSTS will fulfil its roles as

a) a data marketplaces,
b) a data marketplace federator (meta-platform), and
c) an ecosystem facilitator.

A detailed elaboration regarding these roles will is provided in Section 2.2 - Literature Review.

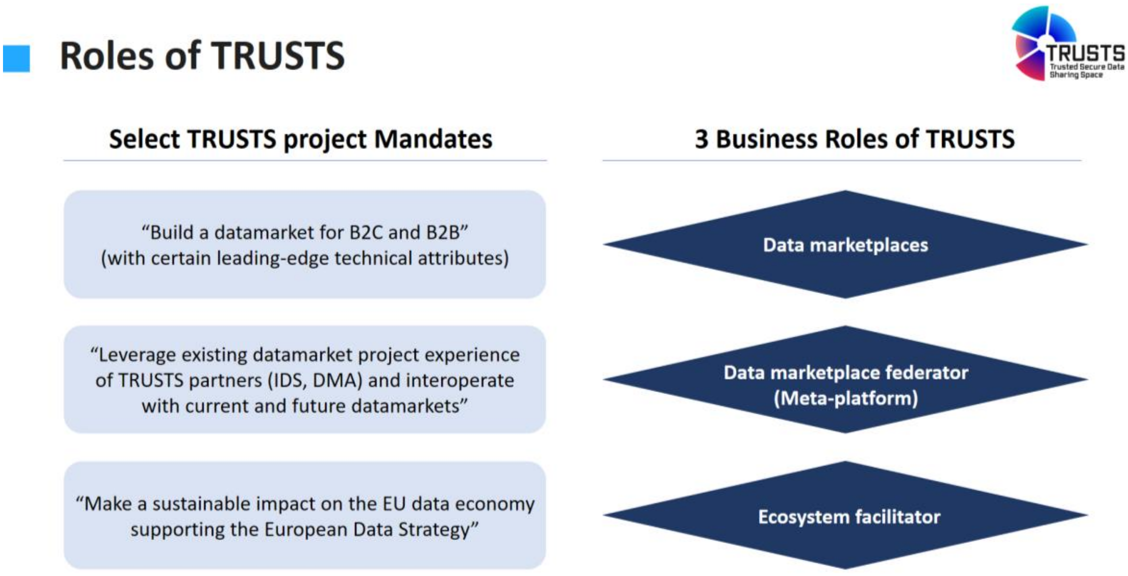

Figure 1 The Roles of the TRUSTS project in the EU data economy

1.4 Interdependencies of T7.1 with Other Parts of TRUSTS

In general, the T7.1 work can be divided into two phases. The first phase is presented in the indicated D7.1 with the objective to develop business model taxonomies. Subsequently, this phase contextualizes and positions TRUSTS within the developed taxonomies. This phase also explores potential TRUSTS business model recommendations based on the developed taxonomies.

The second phase of T7.1 will specifically select the most suitable option for TRUSTS' business models and will also provide an evaluation to assess the success of TRUSTS' business models.

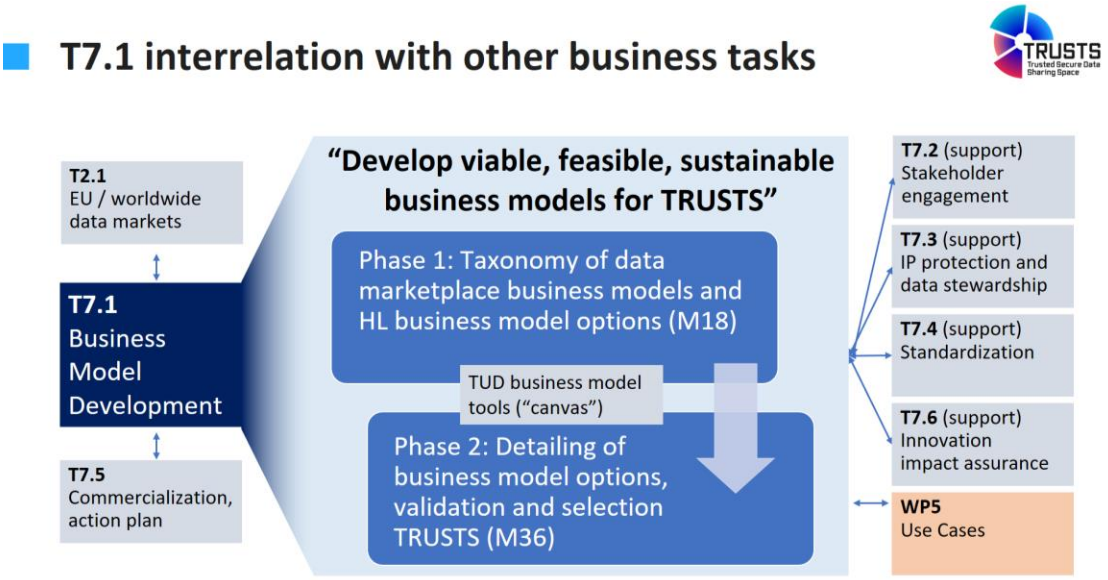

Figure 2 T7.1 interrelation with other business tasks

Figure 2 presents the T7.1 interrelations with other business tasks. T7.1 interrelates closely with T2.1 "EU and worldwide data markets" by consuming the insight related to data marketplace definitions and characteristics. T7.5 "Commercialization initiatives and action plan" also profoundly interrelates since the business model options from T7.1 will be translated into actionable commercialization actions. In addition, T7.1 also supports other tasks such as T7.2 "Stakeholder engagement," T7.3 "IP protection and data stewardship," T7.4 "Standardization," T7.6 "Innovation impact assurance," and generally WP5 related to the project's use cases and pilot demonstrations.

Finally, Figure 3 below summarises the interrelation between the business domain of T7.1 towards the technology and legal domain, including core questions for the future alignment.

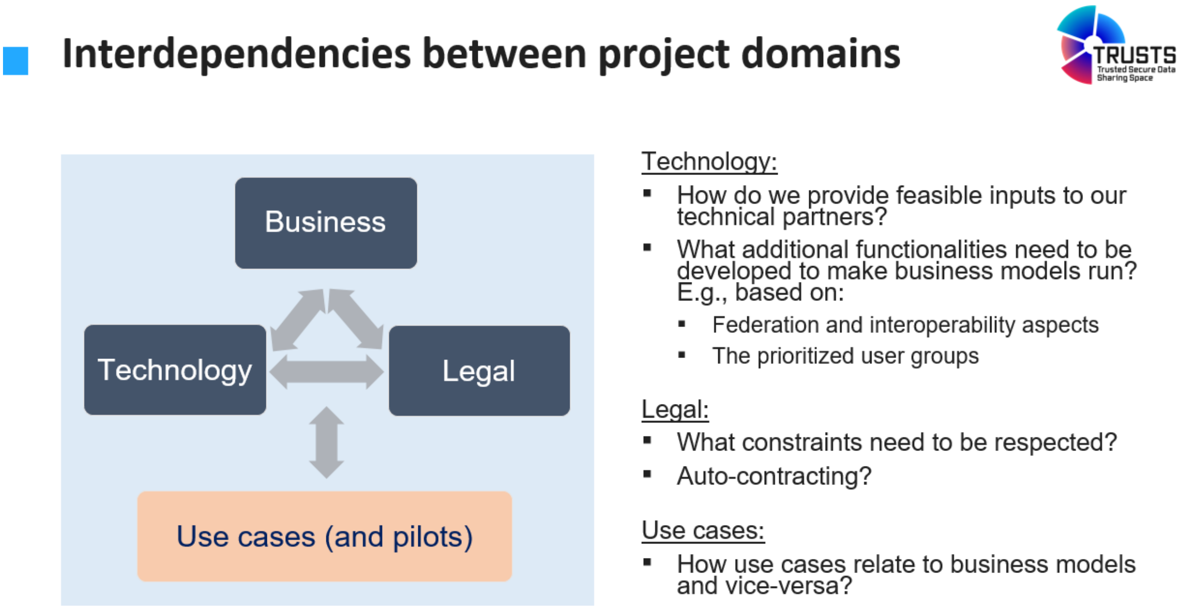

Figure 3 Interdependencies between project domains

2 Methodology and Framework

The section below describes the methodology used to develop the unified TRUSTS taxonomy. It also discusses the relevant concepts such as:

1. data marketplaces working definition;
2. a federator and an ecosystem facilitator of data marketplaces;
3. and a business model taxonomy.

2.1 Methodology

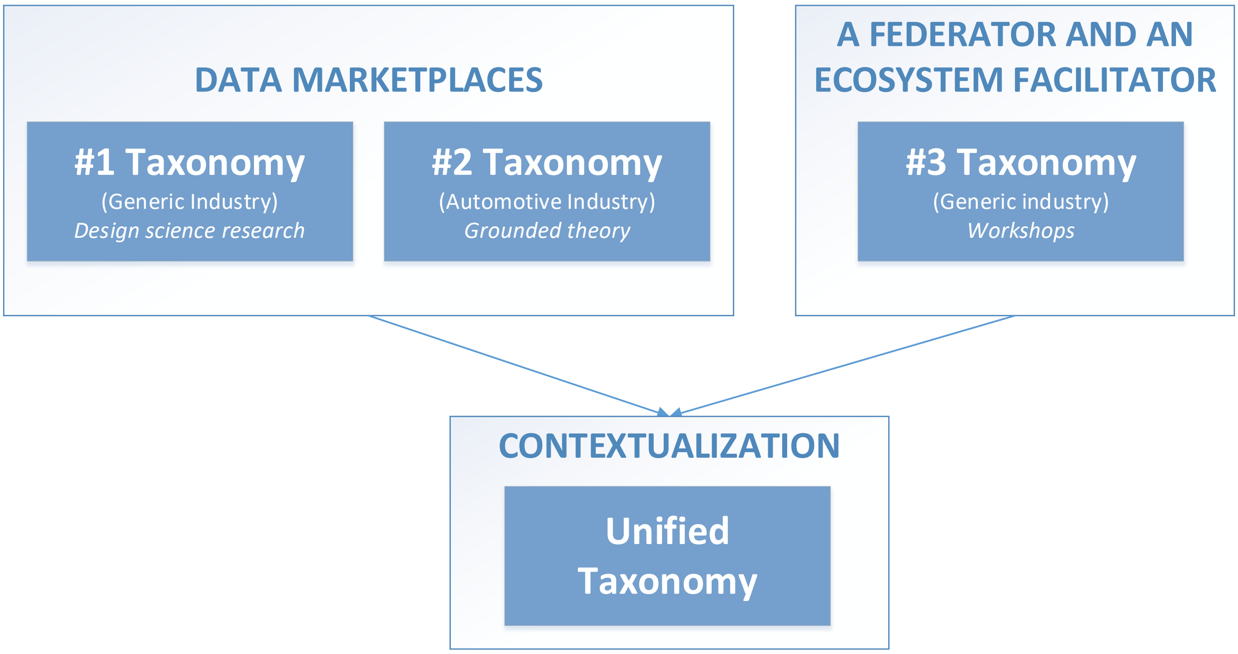

Figure 4 A high-level methodology to develop a unified taxonomy for TRUSTS

Figure 4 above depicts an overarching sequence on how the unified taxonomy for TRUSTS is developed. The methodology guides the organization of research activities, which together will provide a logical answer to the main task of this deliverable. The object of interest is the development of taxonomies to improve the understanding of a viable business model for TRUSTS. The research activities were divided into four primary steps. These are for the development of a business model taxonomy:

1. Data marketplaces in the generic industry (#1 taxonomy)
2. Data marketplaces in the automotive industry (#2 taxonomy)
3. A federator and facilitator of data marketplaces (#3 taxonomy)
4. TRUSTS contextualization (unified taxonomy).

The first taxonomy was developed as part of an MSc graduation project of Montijn van de Ven, which took place within the TRUSTS project, supervised by the TUD team (De Reuver, Abbas) (van de Ven, 2020). The second taxonomy was developed as part of the TRUSTS MSc graduation project of Romy Bergman, supervised by TUD (De Reuver) (Bergman, 2020). The #1 and #2 taxonomies were developed considering TRUSTS’s role as a data marketplace.

In contrast, the #3 taxonomy was created concerning TRUSTS’ role as a federator and an ecosystem facilitator of data marketplaces.

Finally, the Unified Taxonomy was developed to contextualize the previous three taxonomies for TRUSTS’ needs. A detailed explanation of the taxonomy development method will be presented in the respective subsections (see chapter 3: Foundational R&D: Business Model Taxonomies).

2.2 Literature Review

2.2.1 Data Marketplace Working Definition

In the TRUSTS project, a working definition for data marketplaces as presented in D2.1 (refer to the report of D2.1 "Definition and analysis of the EU and worldwide data market") was adopted. A Data Marketplace is ***a digital system where data is traded as an exchangeable economic good. It connects data providers and data buyers and facilitates data exchange and financial transactions.*** The D2.1 report also distinguished data marketplaces based on orientation and ownership determinants (refer to Figure 5). It is to be noted that the term data is used in this context to describe data assets, i.e., data sets and data apps, and data services.

Orientation refers to whether the data marketplace owner coordinates data trade in a hierarchical or market trading structure. The data marketplace owner determines the data price and what data providers and buyers are allowed in data marketplaces with a hierarchical orientation. In data marketplaces with a market orientation, prices are determined by data providers and buyers depending on competitive offerings.

Ownership indicates whether one private company, several companies, or an independent party owns the data marketplace. The summary of these types can be seen in Figure 5.

As suggested by D2.1, WP7 positions TRUSTS within this classification framework. Therefore, this report reflects on this classification schema from the ownership determinant. TRUSTS is a third-party data marketplace. Whereas a future TRUSTS operator may also embark on the trading of harvested and cleaned public data as an enriching complement, as per the project target output, TRUSTS does not own datasets but aims to facilitate data trading between data providers and data buyers.

Moreover, TRUSTS has a market orientation trading structure, implying that prices are determined by data providers and data buyers, depending on competitive offerings. Therefore, TRUSTS can be classified into many-to-many/two-sided data marketplaces.

Data marketplace definition for TRUSTS TRUSTS as a data marketplace is a digital platform, acting as an independent third-party that connects and facilitates data trading and financial transactions between data providers and data buyers.

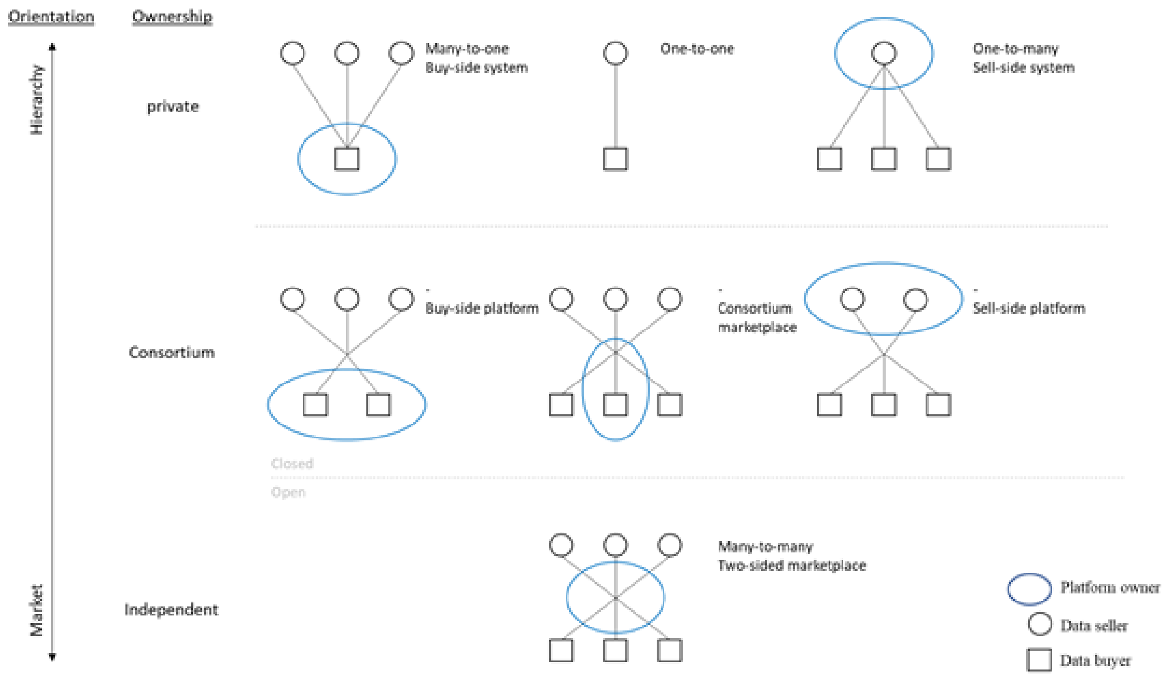

Figure 5 Data marketplace types

Adapted from Koutroumpis, et al. (2017) and Stahl et al. (2016)

2.2.2 A Federator and An Ecosystem Facilitator of Data Marketplaces

2.2.2.1 A federator of Data Marketplaces

As stated in the introduction, one of TRUSTS’ roles in the data economy is to act as a federator of data marketplaces. It implies that TRUSTS will act as a coordinator and be interoperable with other data marketplaces. Therefore, the concept of a federator can be derived from the notion of *meta-platforms*. A meta-platform is a platform of platforms that coordinates, federates and integrates different platforms’ resources and solutions (Billhardt et al., 2020; Burkhardt, Frey, Hiller, Neff, & Lasi, 2019; Savković, Schweigkofler, Savković, Riedl, & Matt, 2020). Meta-platform functionalities include a one-stop-shop via standardized portals, information dissemination & aggregation, and the establishment of shared services (Floetgen et al., 2021; Hoffmann, Rupp, & Sander, 2020). Meta-platforms enable the increase of demand-side users (e.g., data providers and data buyers) to discover data, avoid switching costs and demonstrate legal compliance (Basaure, Vesselkov, & Töyli, 2020). Meta-platforms can potentially create value for participating actors by facilitating collective efforts such as common policies, standards, and infrastructures (Chia, Keogh, Leorke, & Nicoll, 2020; Floetgen et al., 2021)

In the TRUSTS context, the federation is initially established as a simple hub & spoke model (1:n), meaning that TRUSTS can act as a keystone player and act as a coordinator of the federation by enforcing shared governance and standards. Therefore, the term federator is loosely used here as referring to the roles TRUSTS could play in coordinating and integrating different data marketplaces and resources. Figure 6 presents an overview of TRUSTS as a federator of data marketplaces (and comparably rich data sources or intermediaries to data sources).

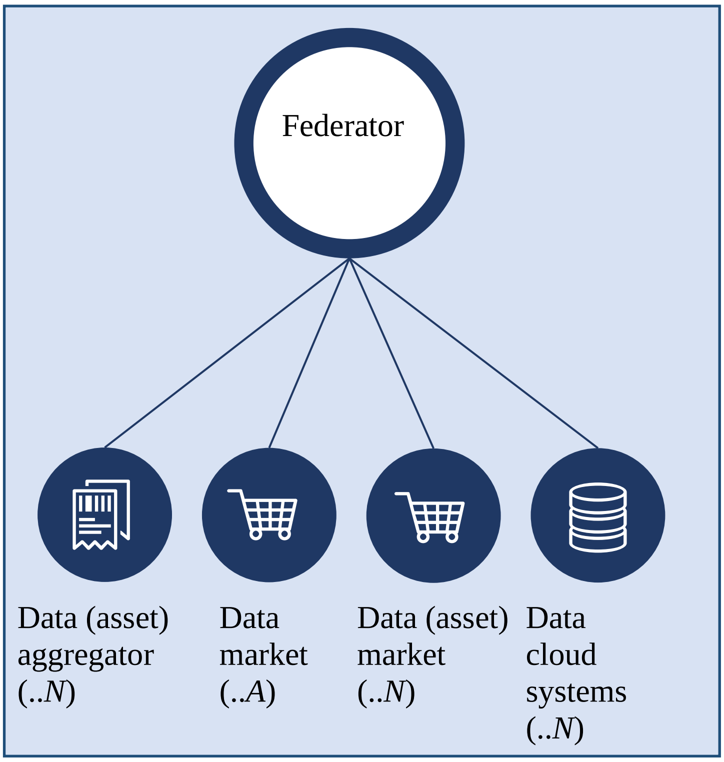

Figure 6 TRUSTS as a federator of data marketplaces

> A federator of data marketplaces
>
> As a federator of data marketplaces, TRUSTS is a platform with a simple hub & spoke model (1:n) that coordinates and integrates different data marketplaces’ resources and solutions (e.g., data listing) via centralized efforts to organize collective actions by enforcing common policies, standards, and infrastructures.

2.2.2.2 An Ecosystem Facilitator of Data Marketplaces

As mentioned earlier, TRUSTS is also envisioned to play the role of an ecosystem facilitator of data marketplaces. In ecological studies, the concept of an ecosystem is used to depict the close interactions of organisms as an inseparable part of their environment (Tansley, 1935, p. 229). Within business and innovation studies, the use of an ecosystem has been popularized from the works of Moore (see e.g. J. F. Moore, 1993; J. F. Moore, 1996). When used within business studies, a key aspect of the concept is to characterize the interrelation and interdependence of businesses (Adner & Kapoor, 2010; J. F. Moore, 1996). For example, (J. F. Moore, 1993; J. F. Moore, 2006) posited that rather than to consider a business as totally distinct and isolated from its environment, it made more sense to consider that the fate of businesses lies in interactions and interdependencies of other organizations in that environment. Thus, when referring to a business ecosystem, it could generally be understood as the multitude of organizations innovating, competing, collaborating, and relying on resources across multiple organizations and industries (Moore 1993). Due to the interdependence of different organizations and technologies in the ecosystem, vulnerabilities and errors can render the network to a high degree of instability affecting the whole network

(Albert, Jeong, & Barabási, 2000). Such is typically the case where a key actor or an essential node ensuring the robustness is removed, disrupting the entire network (Albert et al., 2000). Accordingly, the interconnections among organizations in the ecosystem interweave the fate of partners' actions to that of the ecosystem (Iansiti & Levien, 2004a; Peltoniemi & Vuori, 2004). This means that firms in the ecosystems depend primarily on each other for their mutual survival (J. F. Moore, 1996, 2006). Because in such ecosystems, organizations vary in size, shape, competence, and relations with other organizations, ecosystems over time evolve with certain organizations more specialized in certain activities and distinct roles. The network literature suggests that such roles are likely to emerge due to structural holes in the network where novel ideas or knowledge are often unequally distributed among actors (Burt, 2004).

Furthermore, because of the interdependence of firms in the ecosystem and the fact that industries can span boundaries (e.g., an automobile company becoming at the same time a software company), it is important to consider that distinct firms or specific data domains are not necessarily an essential factor in determining the limits of the ecosystem. Rather a focal point to consider in the ecosystem lies in the specific type of relations and interactions as key units in the ecosystem (Iansiti & Levien, 2004b). Firms can adopt varying strategies and roles within an ecosystem to influence the overall health and robustness of the ecosystem by assuming three overarching roles: keystones, dominators, and niche firms (Iansiti & Levien, 2004b). The roles are discussed subsequently.

Keystones or key players are usually essential for holding stability in the ecosystem (Albert et al., 2000; Iansiti & Levien, 2004b). They serve as the hub acting as the keystone species in the ecosystem to help its overall health and providing mutual benefits for participating actors in the ecosystem. The keystone species maintain the ecosystems' overall health, performing specific roles such as presiding, holding checks, encouraging the renewal of the ecosystem for change, and mutual benefits for other organizations (Iansiti & Levien, 2004b). The dismissal of the keystone species affects the ecosystem as it can result in the collapse of the community or has disruptive effects on other species, resulting in their extinction (Christianou & Ebenman, 2005; Stahl, Schomm, Vossen, & Vomfell, 2016). Because the absence of other species in the ecosystem makes the keystone species irrelevant, an essential role of the keystone is maintaining the ecosystem's overall health (Iansiti & Levien, 2004b).

Dominators, on the other hand, do not necessarily care for the overall health of the ecosystem. Instead, they tend to assume roles and functions of other species as they dissipated from the ecosystem. They are like species that invade and take over areas of other species without necessarily performing the specific roles the initial species performed. A distinction is further made between keystones and dominators. Keystones organizations tend not to occupy the entirety of an area (e.g., industry sector) of an ecosystem that they find themselves in. At the same time, dominators do without necessary performing the functions the species did (Iansiti & Levien, 2004b, p. 19).

The third key role played in the ecosystem is niche roles. Niche players individually have a far lesser impact on the ecosystem. However, they focus on specific domains in the ecosystem or industry, constituting an important role and part of the ecosystem. In business terms, these could be start-ups or established firms focused on promoting a specific type of technology.

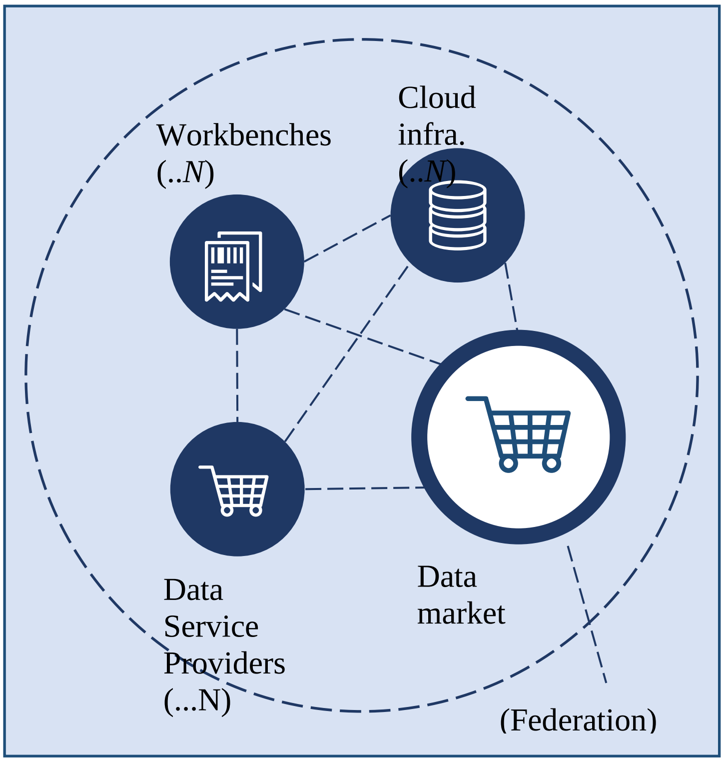

Figure 7 TRUSTS as an ecosystem facilitator of data marketplaces

Accordingly, when conceptualized as an ecosystem facilitator, the role of TRUSTS can be conceived as a facilitator that seeks to ensure a viable ecosystem is built where data marketplaces and other data services could compete and collaborate simultaneously to foster the broad goal of ensuring a viable ecosystem competitive landscape. Because of the interdependence in the ecosystem, the role of such a facilitator should focus on ensuring integration and interoperability that ensure the impact and synergy of the data marketplaces is greater than the individual sum of their role in the EU data landscape. Figure 7 provides a visualization of TRUSTS as an ecosystem facilitator of data marketplaces.

An ecosystem facilitator of data marketplaces

As an ecosystem facilitator, TRUSTS role goes beyond coordinating and integrating different data marketplaces. TRUSTS facilitates the complex web of services and communities that constitute the evolving data ecosystem through facilitating access to vital resources and encouraging collaborations, presiding, and ensuring checks so that different stakeholders participating in a data ecosystem can benefit from the interactions and integration of resources for the overall sustainability of the ecosystem.

2.2.3 A Business Model Taxonomy

2.2.3.1 Business Models

When referring to the term "business model" in this study, the business model framework by Bouwman, Faber, Haaker, Kijl, and De Reuver (2008), i.e., the Service-Technology-Organization-Finance (STOF) model, was used.

The STOF model is a generic framework to deconstruct a business's logic and ecosystems (Bouwman et al., 2008). The STOF model is suitable for this report since it is explicitly designed for ICT-enabled services like data marketplaces. Bouwman et al. (2008) define a business model as "a blueprint for a service to be delivered, describing the service definition and the intended value for the target group, the sources of revenue, and providing an architecture for the service delivery, including a description of the resources required, and the organizational and financial arrangements between the involved business actors, including a description of their roles and the division of costs and revenues over the business actors" (p. 3).

Central in the STOF model to business model design is the *customer value*. Subsequently, the organizational, technological, and financial arrangements are developed to offer a service that provides value to customers and service providers (Bouwman et al., 2008).

The service domain represents the demand side of the service offering, and the organization, technology, and finance domains represent the supply side of the service offering (Faber et al., 2003). In the STOF model, business model design starts with the definition of the demand side. Therefore the service offering is specified first in the service domain of the STOF model (Bouwman et al., 2008). In the service domain, the focus lies on the value proposition that is offered to the customer. The service definition is central in the STOF ontology and serves as a reference point to the other domains in the model.

Next, the technical functionality needed to actualize the product or service offering is defined in **the technology domain** (Bouwman et al., 2008). In the STOF ontology, technology is viewed as an enabler of customer value, and therefore user requirements play a significant role in the technology domain. After having specified the service and the required technology, the way resources are made available in organizational arrangements are specified in **the organization domain** (Bouwman et al., 2008). Finally, the revenue model and pricing strategies are defined in **the finance domain** (Bouwman et al., 2008).

2.2.3.2 Business Model Taxonomies for Data Marketplaces

A taxonomy is a classification scheme of an object of interest to make broader generalizations (Lambert, 2015). In this report, business models of data marketplaces are the main object of interest. Specifically for TRUSTS that aims to be a federator and ecosystem facilitator of data marketplaces, it is essential to know what the TRUSTS platform will be interoperable with. In doing so, TRUSTS can identify its value proposition, e.g., recommending users to go to data marketplaces with specific value propositions or monetization schemes. Besides, TRUSTS can identify (potential) business model incompatibilities that may arise, e.g., if one data marketplace offers a dataset for free and the other charges a price, they cannot be easily federated without additional coordination and resolution mechanism.

Attribute	Characteristic				
Value proposition	Transaction-centric	Data-centric			
Market positioning	Data supplier	Neutral			
Market access	Closed	Hybrid	Open		
Integration	Domain-specific	Domain-unspecific			
Transformation	Raw data	Normalisation	Aggregation	Quality assurance	
Architecture	Central	Hybrid	Decentral		
Price model	Free	Fixed price/ subscription	Package	Pay-per-use	Progressive price
Revenue model	Free	Freemium	Flat rate	Fee	
	Listing fee	Transaction fee /commission	Service fee	Storage fee	

Figure 8 A business model taxonomy for data marketplaces by Spiekermann (2019)

The discussion starts by examining previous studies that discuss business model taxonomies for data marketplaces. Spiekermann (2019) identifies eight business model dimensions and twenty-nine characteristics in his taxonomy (refer to Figure 8). Fruhwirth, Rachinger, and Prlja (2020) developed a taxonomy that considers dimensions of value proposition, creation, delivery, and capture in their taxonomy. Moreover, they identify four data marketplace archetypes:

I. centralized data trading,
II. centralized data trading with smart contracts,
III. decentralized data trading, and
IV. personal data trading.

The archetypes differ regarding platform infrastructure, privacy, and access type. In contrast to Spiekermann (2019), Fruhwirth et al. (2020) do not consider the platform owner's market positioning and data transformation activities. At the same time, Spiekermann (2019) does not consider the dimensions of time relevancy and payment currency, which Fruhwirth (2020) does consider. Considering these differences, the development of business model taxonomy for TRUSTS cannot simply build directly on one of the two existing taxonomies.

	Dimension	Characteristics					
Value Creation	Platform infrastructure	Centralized (13/20)	Decentralized (7/20)				
	Data origin	Internet (1/20)	Self-generated (10/20)	User (3/20)	Community (2/20)	Authority (4/20)	
	Review System	User reviews (2/20)	Reviews by marketplace (2/10)	None (9/20)	*No info (7/20)*		
Value Proposition	Privacy	Anonymized (6/20)	Encrypted (2/20)	Both (2/20)	*No info (10/20)*		
	Data quality guarantee	Yes (14/20)	No (6/20)				
	Time relevancy	Static (3/20)	Dynamic (11/20)	Both (6/20)			
	Pre-purchase testability	None (12/20)	Restricted access (7/20)	*No info (1/20)*			
Value Delivery	Data output type	CSV/XLS (6/20)	JSON (4/20)	Report (1/20)	Multiple options (4/20)	*No info (5/20)*	
	Type of access	API (7/20)	Download (4/20)	Specialized Software (3/20)	API/Download (4/20)	*No info (2/20)*	
	Additional purchase support	With additional costs (8/20)	Included in price (3/20)	No (9/20)			
	Domain	All / Any (5/20)	Finance (2/20)	Geo (2/20)	Address (2/20)	Sensor (4/20)	Personal (5/20)
	Marketplace participants	B2B (9/20)	C2B (3/20)	Any (8/20)			
	Smart contract with blockchain	Yes (9/20)	No (11/20)				
Value Capture	Pricing model	Usage based (7/20)	Package pricing (3/20)	Flat fee tariff (5/20)	Freemium (4/20)	*No info (1/20)*	
	Price discovery	Fixed prices (11/20)	Set by sellers (6/20)	Set by byers (1/20)	Auction (1/20)	Negotiation (1/20)	
	Payment currency	Cypto (6/20)	Fiat (13/20)	Both (1/20)			

Figure 9 A business model taxonomy for data marketplaces by Fruhwirth et al. (2020)

Both taxonomies are exclusively based on data marketplaces with a market orientation. However, market-oriented data marketplaces appear challenging to launch, and many initiatives fail (Koutroumpis, Leiponen, & Thomas, 2017). Spiekermann (2019) argues that market-oriented data marketplaces fail because data sellers fear losing control over their data, data users are unwilling to pay for data, and legal frameworks are lacking. Several researchers have developed mechanisms to resolve some of these issues (Mao, Zheng, & Wu, 2019; Park, Youn, Kim, Rhee, & Shin, 2018; Perera et al., 2017), but such mechanisms are hardly adopted in practice (Constantinides, Parker, & Henfridsson, 2018). Given the exclusive focus on market-oriented data marketplaces in existing taxonomies and the high rate of failure of precisely this type of data marketplace, insight is limited into what business models other types of data marketplace owners apply in practice.

Moreover, because the data economy is emerging and new data marketplaces are being set up, new business model alterations may have been produced in practice that is not considered in the existing taxonomies. By considering newly set up data marketplaces and novel alterations of data marketplace business models, the taxonomy updates and refines the knowledge about the object of interest.

3 Foundational R&D: Business Model Taxonomies

3.1 Business Model Taxonomies for Data Marketplaces

In this subsection, two business model taxonomies for data marketplaces are developed. Each taxonomy development study constituted an MSc graduation project, carried out within the frame of TRUSTS. Using a different approach, scope and theoretical basis, two different taxonomies developed, which allows for a rich understanding while compensating for potential weaknesses in each study (see Table 2.

For instance, whereas the first taxonomy considered data marketplaces from any industry to attain a broad perspective, the second taxonomy only considered data marketplaces from one specific industry to attain an in-depth perspective.

Table 2 The comparison between research perspectives in the first and second taxonomy for data marketplaces

Perspective	Taxonomy 1	Taxonomy 2
Research philosophy	Normative	Inductive
Research approach	Design science research	Grounded theory Case studies
Scope of data marketplaces surveyed	Any industry	Automotive industry
Theoretical basis for taxonomy development	STOF model	Canvas model

Although these two taxonomies were developed employing a different approach, general guidance for taxonomy development by Nickerson, Varshney, and Muntermann (2013) was followed (See Figure 10). The Nickerson approach offers a systematic way to develop a taxonomy and is widely used in the literature on digital business models (see, e.g., Langley et al., 2020; Szopinski, Schoormann, and Kundisch, 2019).

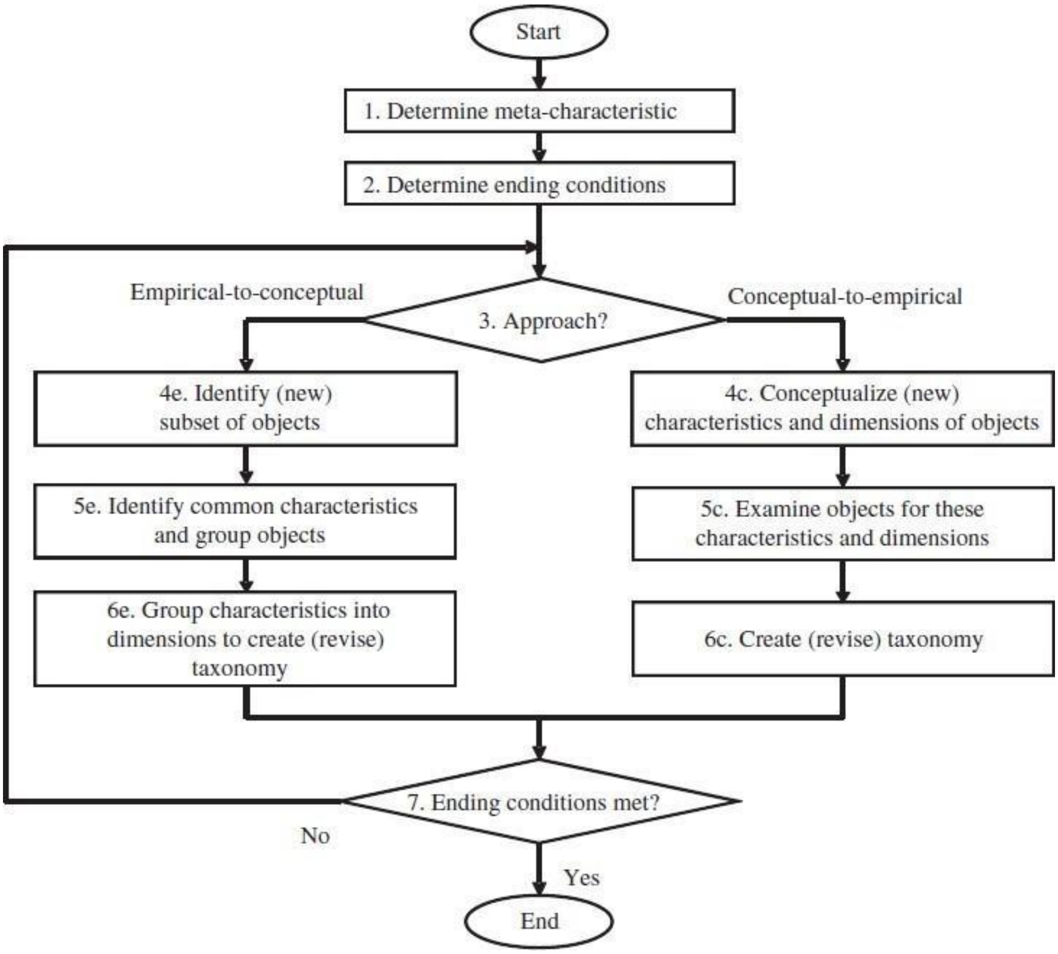

Figure 10 Taxonomy development approach by Nickerson et al. (2013)

To start the taxonomy development, one should identify meta-characteristics and ending conditions (step 1 and 2 in Figure 10, respectively) (Nickerson et al., 2013). The meta-characteristics identified in these two taxonomies are different because they employ different theoretical lenses.

Nevertheless, the ending conditions for these two studies are the same. The objective (OE) and subjective (SE) ending conditions from Nickerson et al. (2013) (refer to Table 3) is adopted. After determining this step, identifying the characteristics and dimensions for the taxonomy by conducting either *empirical-to-conceptual* or *conceptual-to-empirical* steps were then started. In the empirical-to-conceptual step, concepts from existing objects are induced. In the conceptual-to-empirical step, concepts are deduced from literature. The combination of both approaches leads to the design of TRUSTS’ taxonomy.

Table 3 Taxonomy ending conditions

Ending Conditions	
OE1	All objects or a representative sample of objects have been examined
OE2	No object was merged with a similar object or split into multiple objects in the last iteration
OE3	At least one object is classified under every characteristic of every dimension
OE4	No new dimensions or characteristics were added in the last iteration
OE5	No dimensions or characteristics were merged or split in the last iteration
OE6	Every dimension is unique and not repeated (i.e., there is no dimension duplication)
OE7	Every characteristic is unique within its dimension (i.e., there is no characteristic duplication within a dimension)
SE1	Concise: the taxonomy is meaningful without being overwhelming
SE2	Robust: the dimensions and characteristics suffice to differentiate objects
SE3	Comprehensive: all objects can be classified
SE4	Extendible: new dimensions and characteristics can be added
SE5	Explanatory: the dimensions and characteristics explain an object

3.1.1 #1 Taxonomy for Data Marketplaces - Design Science Research (DSR) Approach[1]

The first developed business model taxonomy employs the *Design Science Research* (DSR) approach. The DSR aims to develop innovative artifacts to solve real-world problems (Hevner, 2007; Hevner, March, Park, & Ram, 2004). A DSR study comprises three complementary cycles of research activities: the rigor, relevance, and design cycle (Hevner, 2007). Scientific theories, methods, and expertise are examined in the rigor cycle to provide a theoretical foundation for the research. In the relevance cycle, design requirements are derived from problems and opportunities in the real-world environment. Central in design science research is the design

[1] The #1 taxonomy was developed as part of Master’s Thesis in TUD undertaken by van de Ven (2020), supervised by Mark de Reuver and Antragama Ewa Abbas. A latter version of the thesis has been accepted for publication in the proceedings of the 34th Bled eConference (van de Ven, Abbas, Kwee, & de Reuver, 2021).

cycle that comprises an iterative process of building and evaluating design artifacts. The research activities are visualized in Figure 11.

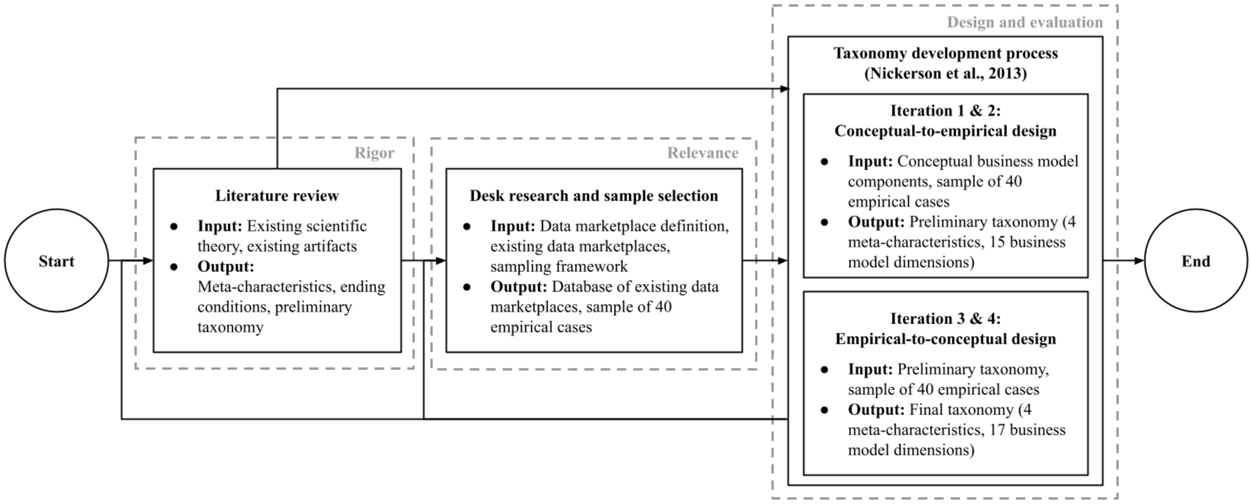

Figure 11 Research activities to develop the #1 taxonomy

3.1.1.1 The Relevance Cycle: Desk Research and Sample Selection

To account for the practical relevance of the to-be-designed artifact (Hevner, 2007), desk research was conducted to constitute a database of empirical cases of data marketplaces. Different sources that link to data marketplace websites were considered. Sixty-five websites mentioned in existing studies of data marketplaces were included in the database (Carnelley, Schwenk, Cattaneo, Micheletti, & Osimo, 2016; Koutroumpis et al., 2017; Koutroumpis, Leiponen, & Thomas, 2020; Prlja, 2019; Spiekermann, 2019; Stahl et al., 2016).

The data discovery platform (Datarade.ai), a website that provides an overview of over 1,800 data providers over 200 data platforms, was consulted. In total, the search in the repository of datarade.ai in early 2020 resulted in the discovery of an additional set of 187 data marketplaces. To complement the database with data marketplaces that were not considered in the existing studies or part of the datarade.ai database, the search engine Google was utilized to conduct desk research. The keywords "data marketplace," "data market," and "data trading platform" were applied during the search. Fifteen additional data marketplaces were added to the database.

To ensure that the sample of empirical cases contained relevant data marketplaces, five criteria were applied.

i. Firstly, out-of-business data marketplaces were excluded from the database.
ii. Secondly, only data marketplaces that fit our working definition were considered in this study.
iii. Thirdly, data marketplaces that did not have an English version of their website or of which the English version seemed outdated compared to the webpage in the native language were excluded from the database.
iv. Fourthly, data marketplaces that only provided open data, such as governmental organizations and NGOs, were excluded from the database, as these platforms adopt non-commercial business models (Carnelley et al., 2016).

v. Lastly, data marketplaces that were still in the construction phase were excluded.

Applying these five criteria to the cases resulting from desk research led to the exclusion of 89 cases. Therefore, the final database consisted of 178 cases of data marketplaces (please refer to the following link to access the database: https://doi.org/10.4121/14679564.v1).

A representative sample was taken from the database of cases to analyze the business models of existing data marketplaces. The empiricist philosophy of classification prescribes building a taxonomy based on the consideration of many characteristics (Lambert, 2015). Therefore, the cases of data marketplaces in the database were first segmented into groups based on the similarity of their characteristics to ensure that the sample size included data marketplaces with varying characteristics.

The website of datarade.ai categorized data marketplaces based on the type of data traded on the platform. This variable was selected as a leading sampling variable to explore the variation between cases in the database. As business model choices are not directly observable, it was not possible to sample the cases based on the variables of interest in the taxonomy. Based on the available information on datarade.ai, 138 cases in the database could be labeled by the data type traded on the platform. The websites of cases were inspected to check whether the categorization by database.ai was correct. The remaining 40 cases in the database were labeled based on the classification of the cases in existing scientific classification studies (Fruhwirth et al., 2020; Spiekermann, 2019) and through the manual inspection of the companies' websites.

The segmentation of data marketplaces by type of data traded on the platform reveals that some data marketplace types in the database were overrepresented. This is especially the case for audience data marketplaces, constituting over 60% of the cases (N=112). Audience data is combined data about a particular target group of customers, which is much sought after by marketers. Thus, instead of random sampling, disproportionate stratified sampling was applied to compensate for the overrepresentation of some types of data marketplaces in the database (Daniel, 2011). A sample of N=40 cases was taken from the database. The final sample of 40 data marketplaces consisted of ten data marketplaces on which any type of data is traded (25% of the sample), four financial and alternative data marketplaces (10%), nine audience data marketplaces (22.5%), six sensor and mobility data.

3.1.1.2 The Design and Evaluation Cycle: Taxonomy Development Process

Iterations 1 & 2: Conceptual-to-empirical design. In the conceptual-to-empirical design phase, the dimensions and characteristics in the preliminary taxonomy were applied to the 40 sampled data marketplaces from the empirical database. If the identified business model characteristic of a data marketplace was not yet specified in the preliminary taxonomy, the newly discovered characteristic was added to the existing dimension and considered in the subsequent design iterations. Following the iterative nature of the taxonomy development process, the pre-specified ending conditions were checked after every iteration. If the ending conditions were not met, a new iteration was conducted.

Iterations 3 & 4: empirical-to-conceptual design. Two empirical-to-conceptual iterations were conducted, which resulted in adding two final binary dimensions to the taxonomy. After iterations 3 & 4, the ending conditions were met.

3.1.1.3 *Final Taxonomy*

The final taxonomy consists of 4 meta-dimensions, 17 dimensions, and 59 characteristics (refer to Table 4). In the following sections, the business model dimensions and characteristics are discussed per meta-characteristic.

Table 4 #1 Taxonomy for data marketplaces in a generic industry

<table>
<tr><th>Meta</th><th>Dimension</th><th colspan="6">Characteristics</th></tr>
<tr><td rowspan="7">Service domain</td><td>Value proposition</td><td colspan="2">Easy data access and/or tooling</td><td>Secure data sharing</td><td colspan="2">High quality and unique data</td><td>All services in a single platform</td></tr>
<tr><td>Enterprise data marketplace</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Data processing and analytics tools</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Marketplace participants</td><td colspan="2">B2B</td><td colspan="2">C2B</td><td colspan="2">Any</td></tr>
<tr><td>Industry domain</td><td>Any data</td><td>Geo data</td><td>Financial & Alternative data</td><td>Health & Personal data</td><td>Audience data</td><td>Sensor & Mobility data</td></tr>
<tr><td>Geographic scope</td><td colspan="2">Global</td><td colspan="2">Regional</td><td colspan="2">Local</td></tr>
<tr><td>Time frame</td><td colspan="2">Static</td><td>Up-to-date</td><td colspan="2">(Near) real-time</td><td>Multiple</td></tr>
<tr><td rowspan="3">Technology domain</td><td>Platform architecture</td><td colspan="3">Centralized</td><td colspan="3">Decentralized</td></tr>
<tr><td>Data access</td><td colspan="2">API</td><td>Download</td><td colspan="2">Specialized software</td><td>Multiple options</td></tr>
<tr><td>Data source</td><td colspan="2">Self-generated</td><td>Customer provided data</td><td colspan="2">Acquired data</td><td>Multiple sources</td></tr>
<tr><td rowspan="2">Organi-zation domain</td><td>Matching mechanism</td><td colspan="2">One-to-one</td><td>One-to-many</td><td colspan="2">Many-to-one</td><td>Many-to-Many</td></tr>
<tr><td>Platform sponsor</td><td colspan="2">Private</td><td colspan="2">Consortium</td><td colspan="2">Independent</td></tr>
</table>

Meta	Dimension	Characteristics				
Finance domain	Revenue model	Commissions	Subscriptions	Usage fees		Asset sales
	Pricing model	Freemium	Pay-per-use	Flat fee tariff	Package based pricing	Multiple
	Price discovery	Set by buyers	Negotiation	Set by marketplace provider		Set by external sellers
	Smart contract	Yes		No		
	Payment currency	Fiat money		Cryptocurrency		

Service Domain

The **value proposition** is a set of statements that indicate the proposed value an enterprise intends to deliver to customers (Bouwman et al., 2008). It often describes how customers can benefit from using the service and how the enterprise aims to set itself apart from the competition. Four value propositions can characterize data marketplaces: easy data access and/or tooling; secure data sharing; high quality and unique data; and all services in a single platform.

Some data marketplaces offer an **enterprise data marketplace** as an additional service. An enterprise data marketplace, sometimes referred to as 'data exchange' services, enables organizations to share data within the company or with external partners, such as suppliers, customers, and other players invited by the focal organization.

The **data processing and analytics tools** refer to the tooling, i.e., data apps or data services, where data buyers can perform analytic activities on their purchased data. Some companies offer various tools on top of their data, while other companies do not offer tooling and focus solely on the data offering on their marketplace.

Data marketplaces can choose to direct their platform to individual consumers or businesses on both the supply-side and the demand-side (Fruhwirth et al., 2020). Three types of **marketplace participants** are distinguished. B2B data marketplaces direct themselves specifically to organizations and businesses willing to become more data-driven or possess a large amount of data that they wish to monetize or commercialize. Many C2B data marketplaces act as harvesting data marketplaces that gather users' personal data in exchange for rewards. Lastly, some data marketplaces are open for any party, business or consumer, to register and exchange data on the marketplace (Schomm, Stahl, & Vossen, 2013)

Data marketplaces provide their data goods and services in many **industry domains**. Many data marketplaces allow the exchange of any type of data. Geo data refers to data that has a link with a location on the Earth. The finance and alternative data industry domain refers to data marketplaces that offer finance data (data about the financial state of a company, such as a companies' assets, liabilities, and equity) and alternative data (finance-related data published by sources outside of the company). Data marketplaces in the health and personal data industry domain offer health data, such as trends of medical treatments of individuals or populations. Audience data is combined data about a specific target group of customers. Marketers aim to gather as much data about their envisioned audience as possible to target them with highly personalized and relevant offers. Data marketplaces in the sensor and mobility data industry provide sensor data gathered by Internet-of-Things (IoT) sensors, such as smart city data, traffic data, parking data, and automotive data.

The **geographic scope** describes the regions in which the data marketplace is operating and available to users. A distinction is made between global data marketplaces, regional data marketplaces, and local data marketplaces (K Täuscher, 2016; Karl Täuscher & Laudien, 2018). Global marketplaces serve clients across two or more continents. Regional data marketplaces focus on multiple countries in a single continent or region. Lastly, local marketplaces solely focus on a single country.

The data traded on the data marketplace may have a specific temporal context in a **time frame** that describes whether or not the data needs frequent updates to maintain the relevancy of the data (Schomm et al., 2013). A distinction is made between static datasets, up-to-date datasets, (near) real-time datasets, and data marketplaces that offer datasets with multiple time frame relevancies. Up-to-date datasets are essentially static datasets repeatedly updated by the marketplace provider or the external data sellers on the data marketplace. Many data marketplaces offer real-time or near-real-time data. This type of data is often generated by IoT sensors or online data trackers, such as websites and stock market trackers.

<u>Technology Domain</u>

Data marketplaces may adopt two types of **platform architectures**: centralized or decentralized. In the centralized approach, data providers offer their data products via a predefined location central on the platform, such as a cloud repository. The data assets remain at the data provider in decentralized platforms, and the data is traded, e.g. using distributed ledger technologies (Koutroumpis et al., 2017).

Platform providers may provide **access to the data** in several different ways (Schomm et al., 2013). Data marketplaces that offer data access via APIs develop a predefined software protocol to establish an interface that enables access and interaction with the platform. In the download option of data access, the data is accessed via a download file, and there is no need for developing a software component. Some data marketplaces develop specialized software to provide access to the data on the marketplace. Many data marketplaces in the sample offered multiple options to access the data, either via APIs, direct download options, and specialized software.

The **data source** dimension describes the origin of the data gathered or collected by the data marketplace platform (Hartmann, Zaki, Feldmann, & Neely, 2014). Data marketplaces may have generated data themselves, by, for instance, gathering data manually or harvesting it automatically from the internet. Furthermore, the data marketplace may also invite customers to provide their proprietary datasets on the platform. Lastly, some data marketplaces retrieve data from multiple types of sources.

Organization Domain

The **matching mechanism** of a data marketplace determines the number of parties on each side of the platform (Koutroumpis et al., 2017). Data marketplaces that adopt a one-to-many matching mechanism mediate between a single seller and many buyers (Koutroumpis et al., 2017). This type of data marketplaces is also called dispersal data marketplaces. Many sellers are trading data with a single buyer in many-to-one matching simultaneously, which is used in harvest marketplace designs (Koutroumpis et al., 2017). Finally, data marketplaces that adopt the many-to-many matching model allow users to upload (or make accessible) and maintain datasets on the platform (Schomm et al., 2013).

The **platform sponsor** constitutes and holds the property rights of the platform components, rules, and ecosystem (Eisenmann, Parker, & Van Alstyne, 2009). The platform can be sponsored by a private individual or group, a consortium of buyers or sellers on the supply or demand side of the platform, or an individual or group that is independent of other market players (Stahl, Schomm, Vomfell, & Vossen, 2017; Stahl et al., 2016).

Finance Domain

Financial **revenue** may come directly from the buyer of the good or service, but there are also other primary sources of revenue for an enterprise (Bouwman et al., 2008). In the commission or transaction fee model, the data marketplace receives a certain fee for every transaction on the platform (Spiekermann, 2019; K Täuscher, 2016; Karl Täuscher & Laudien, 2018). In the subscription model, the data marketplace signs a contract with platform users to provide a specific service for a recurring fee. In the service sales model, the data marketplace sells services that are not standardly offered to all users (K Täuscher, 2016; Karl Täuscher & Laudien, 2018). Data marketplaces may charge a fee for the usage of their platform or services. In the asset sales revenue model (Osterwalder & Pigneur, 2010), the primary source of revenue comes from the sales of data assets.

The **pricing model** specifies how the final price for the data asset is composed. The data marketplace provides basic functions for free in the freemium model, but marketplace users will need to pay a fee to use premium functions (Fruhwirth et al., 2020; Spiekermann, 2019). Under pay-per-use or usage-based pricing, customers pay the price proportional to the number of units consumed by the data marketplace user (Fruhwirth et al., 2020; Spiekermann, 2019). The flat fee tariff or flat-rate pricing model provides marketplace participants full access to the marketplace for a recurring fee (Fruhwirth et al., 2020; Schomm et al., 2013). In the package-based pricing model, data goods or services are bundled in certain packages, of which the price may decrease by a certain discount rate when the size of the package increases (Fruhwirth et al., 2020; Schomm et al., 2013; Spiekermann, 2019). On some data marketplaces, the pricing of the data products and services are based on multiple pricing models.

A **price discovery** function allows buyers and sellers on the marketplace to determine a transaction price that they both agree on (Bakos, 1998). The data marketplace may decide to let data buyers set the prices for the datasets they wish to buy. In the negotiation model, data marketplaces may allow data buyers and sellers to negotiate about the price before agreeing. The data marketplace provider may also decide to set prices for the data goods and services on the platform. Lastly, the data marketplace may allow external sellers to set the prices for their data offering on the marketplace.

Data marketplaces may implement **smart contracts** to enhance transparency and enforce trust among marketplace participants (Fruhwirth et al., 2020). A smart contract comprises a contractual agreement that is coded into a script that is automatically executed when the terms in the contract are met. The use of smart contracts by data marketplaces is emerging to introduce transparency and automatically handle payments made on the marketplace (Lawrenz, Sharma, & Rausch, 2019).

The **payment currency** dimension explicates which currencies are accepted by the data marketplace for the payments made by data buyers on the platform (Fruhwirth et al., 2020). Data marketplaces may handle their payments via cryptocurrencies or fiat money. Data marketplace companies that use cryptocurrencies as payment methods are emerging.

3.1.1.4 Discussion and insights for TRUSTS

After developing the taxonomy and examining 40 data marketplaces, some takeaways can be highlighted for TRUSTS development consideration.

First, the taxonomy can help to explore the options of setting up TRUSTS as a data marketplace. The taxonomy can guide TRUSTS platform owners in making business model design choices. It describes the most important dimensions and characteristics of data marketplace business models applied in practice. These dimensions and characteristics are essential because there is no commonly accepted, uniform definition of data marketplaces. The terms “data marketplace”, “data exchange”, and “data platform” are often interchanged, causing confusion and ambiguity when developing viable business models.

Second, the taxonomy were found to expose the emergence of novel technological applications in the industry that enhance trust among data marketplace participants, such as enterprise data marketplaces, decentralized platform architectures, smart contracts, and cryptocurrencies as payment methods. This finding aligns very well with the current TRUSTS visions, and the technical project partners implement the mentioned technologies within TRUSTS. Furthermore, many data marketplaces offer additional services such as data analytics and tooling in addition to the data offered on data marketplaces. This resonates with Koutroumpis et al. (2020) findings that data marketplaces often exchange access to data and data-related services rather than explicitly sell data assets. Consequently, TRUSTS should consider to go beyond facilitating the trade of raw data.

Third, this study exposes the existence of companies that gather personal data of consumers to exchange it for commercial purposes, i.e., harvesting data marketplaces. This type of data marketplaces is emerging and enables individuals to monetize their personal and health data. TRUSTS also can consider these options in the business model choices.

Fourth, as identified, *audience data* marketplaces are the most common type and constitute over 60% of the cases (N=122) in the database. Audience data is combined data about a particular target group of customers, the 'audience', which marketers often gather to target the envisioned audience with highly personalized and relevant offers. Considering the industry perspective, data marketplaces were identified to primarily exist in the financial and automotive industries. Combined with these two insights, TRUSTS can consider the audience type of data within the financial or automotive industry to be one of its core target markets.

3.1.2 #2 Taxonomy for Data Marketplace - Grounded Theory Approach[2]

The #2 taxonomy complements the first taxonomy in two ways. First, it employs the grounded theory approach to gather empirical data from data marketplaces owners. By starting to listen to the concerns and needs of data marketplace owners, the expectation is to uncover business model dimensions that are most relevant in practice. The grounded theory approach is used when inducting business model dimensions from semi-structured interviews. Second, the #2 taxonomy focuses on the automotive industry because this industry has established data marketplaces as identified by Martens and Mueller-Langer (2018), and this proposition is confirmed in the discussion from the previous taxonomy. By focusing on a specific industry, more in-depth insights on the business model options can be uncovered. Further, we can identify business model components that data marketplace owners successfully apply in practice by investigating this specific industry.

[2] The #2 Taxonomy was developed as part of Master’s Theses in TUD undertaken by Bergman (2020), supervised by Mark de Reuver. A latter version of the thesis is currently under review for a publication in a journal.

3.1.2.1 Taxonomy Development Process

Eight iterations have been conducted to develop the taxonomy and meet the ending conditions. These iterations are described as follows (see Table 5).

Table 5 The iterations to develop the #2 taxonomy

Ending Conditions		Iterations							
		1	2	3	4	5	6	7	8
OE1	All objects or a representative sample of objects have been examined							x	x
OE2	No object was merged with a similar object or split into multiple objects in the last iteration	x	x	x	x	x	x	x	x
OE3	At least one object is classified under every characteristic of every dimension					x	x	x	x
OE4	No new dimensions or characteristics were added in the last iteration							x	x
OE5	No dimensions or characteristics were merged or split in the last iteration	x	x	x		x	x	x	x
OE6	Every dimension is unique and not repeated (i.e., there is no dimension duplication)						x	x	x
OE7	Every characteristic is unique within its dimension (i.e., there is no characteristic duplication within a dimension)						x	x	x
SE1	Concise: the taxonomy is meaningful without being overwhelming								x
SE2	Robust: the dimensions and characteristics suffice to differentiate objects								x
SE3	Comprehensive: all objects can be classified								x
SE4	Extendible: new dimensions and characteristics can be added								x
SE5	Explanatory: the dimensions and characteristics explain an object								x

In iteration 1, a two-layer meta-characteristics was defined to start the taxonomy development process. First, the business model components elaborated by Teece (2010) as well as Osterwalder and Pigneur (2010) were selected to anchor the first layer and second layer of meta-characteristics, respectively. These two previous works have been widely recognized in business model literature and are being used as a standard language within practitioner works. Therefore, these generic components were a profound starting point to start #2 taxonomy’s first iteration.

Teece (2010) describes three main components of business models: value creation, value delivery, and value capture. First, **value creation** is the process of making something that brings worth to the customer. The sub-components of *value proposition*, *customer segment*, and *customer relationships* were assigned to the main component of value creation. Second, **value delivery** is about the asset arriving at or activity interacting with the customer. The *channels, key resources, key activities, and key partners* contribute to value delivery. Third,

businesses can conduct value capture by defining *review streams, pricing models, and cost models.*

In iteration 2, business model dimensions were induced from interviews with data marketplace owners. These dimensions were induced using the Grounded Theory Method. Grounded theory is constructed through inductive reasoning, starting with information gathered from interviews, reports, and other data materials. Seven interviews were conducted with data marketplace owners to learn about their business models (see Table 6).

Table 6 Grounded theory interview respondents

Code	Type	Job title	Other relevant experience
DM1	Mixed hierarchy market, consortium	Business development	Previously worked as a marketing and business development consultant for four years
DM2	Market, independent	Product owner	Over five years of experience as a data scientist and business consultant at various multinationals
DM3	Market, independent	Unknown	Seven years of experience in advising ministries about traffic and mobility data
DM4	Market, independent	Business Development	Over five years of experience as a freelance consultant
DM5	Market, independent	Innovation Manager Smart Mobility	Previously worked as a consultant for national agencies and has over five years of experience working on smart mobility projects
DM6	Market, private	Director Business Development	Over ten years of experience at various IT service providers as sales manager
DM7	Hierarchical, private	Head of Enterprise Business Development	Over eight years of experience in corporate development at a multinational

In iteration 3, dimensions were deduced from the existing taxonomies of Spiekermann (2019) and Fruhwirth et al. (2020). The induced dimensions (from iteration 2) and deduced dimensions (from iteration 3) were aligned to create our preliminary taxonomy.

In iterations 4 – 6, through content analysis**,** the preliminary taxonomy was refined with induced business model characteristics from selecting existing data marketplaces. Six data marketplace cases from three data marketplace types for theoretical sampling and theoretical replication were analyzed:

(i) Data marketplaces with hierarchical orientation and private ownership,

(ii) Data marketplaces with a mixed hierarchy and market orientation and consortium-based ownership, and

(iii) Data marketplaces with market orientation and independent ownership. Based on the selection criteria (automotive, business-to-business, past the conceptual stage, documentation in English), TomTom, INRIX, HERE, Caruso, IOTA, and Ocean Protocol were included.

In iterations 7 – 8, the dimensions and characteristics in the taxonomy were revised. All objective ending conditions were met. To assess the subjective ending conditions, semi-structured interviews were conducted with Spiekermann (2019) and Fruhwirth et al. (2020), who are consider experts in developing business model taxonomies for data marketplaces.

3.1.2.2 Final #2 Taxonomy

The final taxonomy contains thirteen business model dimensions (see Table 7). the business model characteristics of TomTom (TT), INRIX (IN), HERE (HE), Caruso (CR), IOTA, and Ocean Protocol (OP) were specified in the taxonomy.

Table 7 #2 Taxonomy for data marketplaces in the B2B automotive industry

	Component	Dimension	Characteristics				
Value Creation	Customer segment	Domain	Location (TT, IN, HE)	Automotive (CR)	All industries (IOTA, OP)		
Value Creation	Customer segment	Participants	Data sellers, data buyers, internal & external developers (TT, IN, HE)	Data sellers, data buyers & external developers (CR, IOTA, OP)			
Value Creation	Value proposition	Data service	Customized map service (TT, IN)	Data brokering service (CR, IOTA, OP)	Both (HE)		
Value Creation	Value proposition	Data output	Aggregated data (TT, IN)	Standardized data (CR, IOTA, OP)	Both (HE)		
Value Creation	Value proposition	Data quality	Reviews by marketplace (TT, IN)	User reviews (IOTA, OP)	No info (HE, CR)		
Value Creation	Value proposition	Privacy	Anonymized (TT, IN, CR)	Encrypted (HE, IOTA, OP)			
Value Creation	Customer relationship	Contract	Negotiated (TT, IN, CR)	Standardized (IOTA, OP)	Both (HE)		
Value delivery	Key channels	Platform access	Closed (TT, IN, CR)	Open (HE, IOTA, OP)			
Value delivery	Key resources	Platform infrastructure	Centralized (TT, IN, HE, CR)	Decentralized (IOTA, OP)			
Value delivery	Key activities	Data processing activities	All (TT, IN, HE)	Limited (CR, IOTA, OP)			
Value capture	Revenue streams	Revenue streams	Usage-based (TT, IN)	Usage-based & freemium (HE)	Commission (CR)	Donations (IOTA)	No info (OP)
Value capture	Pricing model	Data pricing mechanism	Set by data marketplace owner (TT, IN)	Set by data seller (CR, IOTA, OP)	Both (HE)		
Value capture	Pricing model	Payment currency	Fiat currency (TT, IN, HE, CR)	Cryptocurrency (IOTA, OP)			

Value creation

The **customer segments** of data marketplaces is specified with the dimensions *domain* and *participants*. The *domain* shows in what market the data marketplace is active, whereas the dimension *participants* refer to the actors matched to a data marketplace to trade data. The **value proposition** consists of the dimensions of *data service, data output, data quality,* and *privacy*. The *data service,* specifies what service the data marketplace owner offers to their participants. The *data output* shows what data the data marketplace owner trades*; data quality* entails who controls and preserves the data quality from the data seller; *privacy* indicates how stored data at a data marketplace is protected. The **consumer relationship** has the *contract* dimension. Data marketplace owners need to define the agreement that enforces data trade between the data seller and data buyer.

Value delivery

The *platform access* of a data marketplace defines the degree of openness for participants to enter the platform, and this dimension belongs to the **key channels** component. Next, the **key resources** have the *platform infrastructure* dimension*,* specifying how data is stored at data marketplaces. Finally, the **key activities** have the component of *data processing activities* to add value to data. The primary data processing activities are data collection, standardization, cleansing, storage, analysis, and distribution.

Value capture

The **revenue streams** indicate how the data marketplace owner generates revenue. The characteristics of the revenue streams of data marketplaces are *usage-based, usage-based & freemium, commission, donations, and no info*. The *data pricing mechanism* indicates how prices of the data are established between the trading entities. Prices can be set by the *marketplace owner, set by the sellers, or both*. Lastly, **the payment currency** is the currency in which the payment is transferred. The characteristics are *fiat currency* and *cryptocurrency*.

3.1.2.3 Business Model Archetypes

Four archetypes to group data marketplaces with the same business model characteristics were developed (see

Table 8). These archetypes were created to observe which types of data marketplace business models are viable in practice:

1 aggregating data marketplace,
2 aggregating data marketplace with an additional brokering service,
3 consulting data marketplace,
4 facilitating data marketplace.

Table 8 Business model archetypes for data marketplaces in the B2B automotive industry

Archetype	**Aggregating data marketplace**	**Aggregating data marketplace with additional brokering service**	**Consulting data marketplace**	**Facilitating data marketplace**
Case	*TomTom and INRIX*	*HERE*	*Caruso*	*IOTA and Ocean Protocol*
Orientation	*Hierarchical*	*Mixed hierarchical/market*	*Mixed hierarchical/market*	*Market*
Ownership	*Private*	*Consortium*	*Consortium*	*Independent*
Domain	Location	Location	Automotive	Cross-industry
Data service and data output	Customized map service Aggregated data	Both customized map service and data brokering service Both aggregated data and standardized data	Data brokering service Standardized data	Data brokering service Standardized data
Data quality	Reviews by data marketplace owner	Reviews by data marketplace owner	No info	Reviews by users
Privacy	Anonymized	Encrypted	Anonymized	Encrypted
Contract	Negotiated contract	Both negotiated and standardized contract	Negotiated contract	Standardized contract
Platform access	Closed	Open	Closed	Open
Platform infrastructure	Centralized	Centralized	Centralized	Decentralized
Data pricing mechanism	Set by data marketplace owner	Both set by data marketplace owner or data seller	Set by data seller	Set by data seller

Aggregating Data Marketplace

TomTom and INRIX apply the *aggregating data marketplace* archetype. They create value for their customers by aggregating the data from their data sellers to provide tailored maps for their customers. Through *bilaterally negotiated contracts*, data marketplace owners establish *close customer relationships* with the data marketplace participants. In addition, data marketplaces have *well-understood customer segments* in the *location* domain. This leads to the *customized value proposition* that the data marketplace owner creates by offering a *customized map service*. Data quality is assured by the data marketplace owners who review and clean data. Data marketplace owners handle the payments, contracts and provide the infrastructure for all participants to satisfy their needs. The aggregating data marketplace has *closed platform access*.

Data marketplace owners need to approve data seller or buyer registration before data can be sold or bought on the data marketplace. This contributes to a controlled environment in which participation can be denied. Furthermore, observed aggregating data marketplaces utilize a *centralized platform infrastructure*. The centralized platform infrastructure is connected to the customer Information technology(IT) systems and realizes a central access point for the data marketplace owner to modify the data and perform their service. At data marketplaces of the aggregating data marketplace archetype, *the data marketplace owners set the price of the traded data*. The aggregated data output is owned and sold by the data marketplace owner. The data sold leads to direct, usage-based revenue streams for data marketplace owners.

Aggregating Data Marketplace with Additional Brokering Service

This archetype comprises of the *aggregating data marketplace* with an *additional brokering service* archetype, and thus provides two distinct value propositions. One value proposition is similar to the value proposition of the *aggregating data marketplace*. In addition to this, data marketplace owners offer a second, standardized value proposition which is the *data brokering service*. This service enables standardized data trade directly between data sellers and data buyers at the data marketplace. The standardized contract enables automated assistance. Data marketplace owners use negotiated contracts for their customized value proposition and standardized contracts for their standardized value proposition. The application of both contracts enables data marketplace owners to offer tailored assistance to some customers while simultaneously serving many other participants through automated assistance.

The aggregating data marketplace with an additional brokering service has *open platform access*. Anyone who creates a user account can enter the platform. The data marketplace owner deploys a *centralized platform infrastructure*. To capture value, the data marketplace owner maintains two data pricing mechanisms. The *data marketplace owner sets the price* for the aggregated data produced with the customized map service, and the *data sellers set the price* for the standardized data they sell via the brokering service.

Consulting Data Marketplace

In our study, Caruso is identified as applying the *consulting data marketplace* archetype. They offer a *standardized value proposition* like the *aggregating data marketplace with additional brokering service* archetype. Significant for the brokering service of the data marketplace with *consulting data marketplace* archetype is that the data marketplace owner pairs the service with negotiated contracts. The data marketplace owner negotiates the contract conditions with their participants bilaterally. Data marketplace owners gain knowledge about their participants' data needs and price preferences and align the needs of their data sellers and data buyers. If a data seller wants to sell specific data assets at the marketplace, there needs to be a data buyer interested in buying those segments and vice versa. The participants are individually assisted on a bilateral basis by the data marketplace owner through negotiated contracts. Similar to the contracts of the aggregating data marketplace, these contracts lead to *strong customer relationships*.

The studied consulting data marketplace has *closed platform access*. Participants may enter the platform after the data marketplace owner vets them. This provides controlled provision and purchase of data at the marketplace. Furthermore, consulting data marketplaces have a *centralized platform infrastructure*. Data marketplace owners store and publish metadata about the datasets in the centralized platform infrastructure. The metadata is analyzed to create insights about the platform usage patterns. The consulting data marketplace archetype is significant because the exchanged data sets are not stored on their infrastructure. Only metadata about the datasets is stored. The consulting data marketplace allows *the data seller to determine the price* of the sold data. The data marketplace owner consults with their participants about possible data pricing mechanisms and contractual terms. The revenue streams for the exchanged data are transferred between the data seller and buyer. Data marketplace owners receive a commission and are for their provided service.

Facilitating Data Marketplace

IOTA and Ocean Protocol apply the *facilitating data marketplace* archetype. They coordinate transactions between data sellers and buyers through data brokering services without interference from data marketplace owners. Participants process standardized data and review data quality themselves, with minimal interference from data marketplace owners. Data marketplace owners do not offer tailored assistance like that of data marketplace owners who apply the *consulting data marketplace* archetype but use standardized smart contracts. This foresees a high number of transactions between participants and *automates the trading process*. The facilitating data marketplace has *open platform access*: anyone can join the ecosystem. In addition, the facilitating data marketplace is the only business model archetype that includes a *decentralized platform infrastructure*. The marketplace owners who apply the facilitating data marketplace archetype enable *data sellers to set the price* for the traded datasets.

Figure 12 provides the summary of business model archetypes for data marketplaces in the B2B automotive industry.

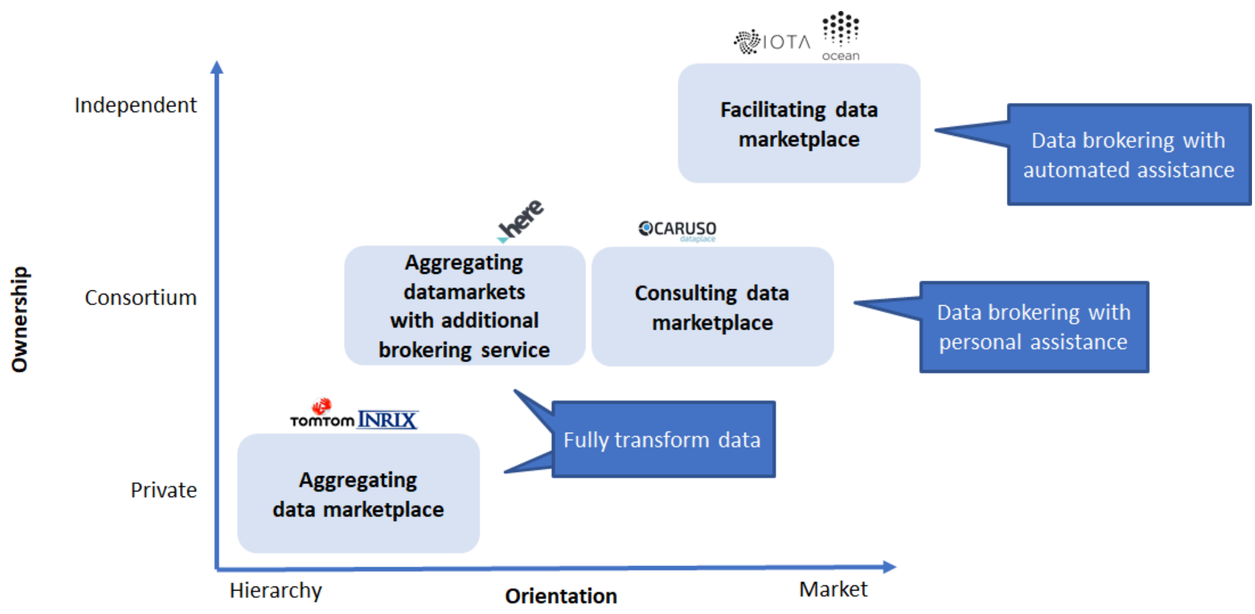

Figure 12 Business model archetypes for data marketplaces in the B2B automotive industry

3.1.2.4 Discussion and insights for TRUSTS

After developing the taxonomy and archetypes, the following considerations and recommendations can be highlighted for TRUSTS development consideration.

A value proposition that offers a solution instead of an 'item' – Compared to other archetypes, the *facilitating data marketplace* remains conceptual and hardly reaches commercial exploitation. Data marketplace owners who apply the *facilitating data marketplace* archetype focus on data forwarding with their brokering service. Their value proposition entails trade in data items. However, this does not appear to be the solution for their customers. Data sellers and buyers remain absent. The value proposition of the facilitating data marketplace represents the problem that Teece (2010) describes as the sale of 'items' instead of the sale of a solution. Data assets, or 'items', could be described as 'intangibles', 'know-how', and 'technological components'. These goods are difficult to price and are rarely traded in market structures (Koutroumpis et al., 2017; Powell, Staw, & Cummings, 1990; Teece, 2010). According to Teece (2010), it is a common problem that the sale of assets that do not have perfect property rights leads to market failure. Business owners who apply business models based on selling intangibles may not capture significant value with their value proposition. Therefore, companies who trade intangible assets need to bundle them into a solution. Therefore, as a data marketplace, TRUSTS needs to go beyond facilitating raw data trading. A future TRUSTS operator should consider providing value-adding services such as cleaning data to ensure data quality, analyzing data to create aggregated data sets, and offering personal assistance in data sale and acquisition.

Strong customer relationships work better than competitive pricing – The *facilitating data marketplace* needs to set up a competitive environment and keep product prices low, thus aiming for competitive pricing. However, competitive pricing in the *facilitating data marketplace* remains unapplied because of the chicken-and-egg problem; it requires high numbers in demand and supply. On the other hand, the other three archetypes aim to build strong customer relationships. Data marketplace owners in these archetypes offer tailored assistance to their customers regarding data sales and purchases. Koutroumpis et al. (2020) call negotiated contracts in these archetypes "relational contracts" that are long-term and enable repeated interaction between the data marketplace owner and their participants. Actors who trade in these organizations are driven by routines and have less room to display opportunistic behavior (Powell et al., 1990; Williamson, 1973). This causes participants to return to data marketplaces. Hence, to increase the business sustainability of its data marketplace, a future TRUSTS operator should investigate the offering of tailored assistance to their customers regarding data sales and purchases. This becomes even more amplified during the start-up process of the data market, with a limited number of suppliers and buyers.

The potential of open platforms for data exchange is limited in the automotive industry. According to the findings, successful platforms are private or maintain closed communities. Fully open data marketplaces hardly receive traction in the automotive industry, possibly because the automotive / OEM space is dominated by a limited number of strong players that do not wish to disclose their data. Some interviewees commented that large players would not avail their data unless demanded to do so by law. Therefore, TRUSTS can focus on a limited number of key industries as a starting point, such as the automotive, banking, or telecommunication industry, where a mass amount of the data is available. TRUSTS could then leverage the value of the platform to other users who could then enroll on the platform.

3.2 Business Model Taxonomy for A Federator and An Ecosystem Facilitator of Data Marketplaces

In this section, a taxonomy for a federator and an ecosystem facilitator of data marketplaces is discussed. As a starting point, we synthesize two taxonomies from the literature provided by Lis and Otto (2021) and Gelhaar and Otto (2020). These two taxonomies are relevant because they discuss data sharing in an 'ecosystem' context, including platform-to-platform interactions. Following this, two workshops with TRUSTS project partners were conducted:

1. 1st workshop: the representatives from six partners from WP7 - Business Model, Exploitation & Innovation Impact Assurance discussed the previous two taxonomies by Lis and Otto (2021) and Gelhaar and Otto (2020). The first workshop discussed which elements from these taxonomies can be beneficial to build a new taxonomy for a federator and an ecosystem facilitator of data marketplaces. Thus, initial dimensions and characteristics were identified.
2. 2nd workshop: fifteen participants from eleven organizations attended the workshop, including the technical partners from TRUSTS. We discussed the taxonomy and attempted to position TRUSTS within the taxonomy. The final taxonomy for a federator and an ecosystem facilitator in Table 9.

Table 9 #3 taxonomy for a federator and an ecosystem facilitator of data marketplaces

Meta	**Dimension**	**Characteristics**					
Interaction	**Purpose**	Control	Value creation	Conflict resolution	Federation		
	Geo coverage	Local	Regional	Global			
	Ecosystem members	Data marketplaces operators	Open government data agencies				
	Target domain	Scientific community	Government	Industry			
Governance	**Confi-guration**	Centralized	Decentralized	Semi-centralized (union)			
	Mecha-nisms	Formal	Relational	Mix			
Technical	**Infra-structure**	Centralized	Distributed				
Finance	**Revenue streams**	Member-ship fee	Listing	Sponsored search auctions	Cost per Click (CPC)	Pay-per-transaction	Advertisements

The first meta-characteristic describes the **Interaction** within a data marketplace ecosystem. It has four dimensions. The **purpose** of an ecosystem can be to *control* data flows, whereby ecosystem members can track down data usage and compliance towards agreed contracts. It also enables new *value creation for* its ecosystem members, such as establishing shared services for generic functionalities of data marketplaces. In some cases, an ecosystem is also expected to *resolve conflict* among its members, for instance, related to incompatible and multiple data exchange standards. An ecosystem must stimulate innovation, enable knowledge sharing, raise transaction volumes, or *federate* existing data marketplaces by providing and enforcing governance and technological standards. In most cases, an ecosystem also has **geographical coverage.** Its members can be from a single country *(local)*, multiple countries in a region such as the European Union (EU), or not limited to a particular geographical coverage. **Ecosystem members** can primarily target *commercial data marketplaces* like Dawex or IOTA, or *open government data agencies* such as data.europa.eu, or both.. Lastly, the **target domain** of an ecosystem can be the *scientific* community, *government/public administration, industry,* civic society, or any combination thereof.

The next meta-characteristic is **governance.** ***Configuration*** "…refers to the positioning of the governing body in the ecosystem. It determines the degree to which extent decision-making authority over data can be executed…" (Lis and Otto, 2021, p. 6069). *Centralize*d configuration implies that dominant actors regulate policies and interactions within an ecosystem, whereas *decentral* configuration focuses on shared visions and consensus among ecosystem members. In between, *semi-centralized (union)* configuration also exists to keep power within dominant actors while still considering the perspective of non-dominant actors. Three modes can distinguish the application of governance through control **mechanisms**. First, *formal* control like contractual agreements, monetary incentives, and penalties, or technical enforcement like Application Programming Interface (API) can be implemented to guide members' behavior. Second, *relational* control like social norms or social pressures can be informal instruments to govern an ecosystem. Thirdly, the combination of these two mechanisms also exists.

The **technical** meta-characteristics determine the **infrastructure** design used to share and/or trade data assets within an ecosystem. It can be *centralized***,** implying that all actors use infrastructure provided by the ecosystem owners. Often, a central platform is used in this mode, and ecosystem members need to upload their datasets. In contrast, all actors can use a *distributed* infrastructure, whereby the platform provides a core of common services for coordination, trade facilitation, and execution. Actors then need to provide some infrastructure capabilities by themselves and retain full control of their data assets. In this case, peer-to-peer or distributed ledger technology is often employed.

Finally, the **finance** meta-characteristic determines **revenue streams** for ecosystem owners. Actors may pay a *membership fee* and/or pay for the *data listed* in ecosystem channels. In contrast, the revenue may be calculated only when a transaction occurred, referring to this as *pay-per-transaction*. This listing mechanism can further be improved by *sponsored search auctions*, a mechanism to short the listing result based on an auction outcome. Moreover, revenue can also be generated based on *Cost per Click (CPC)* mechanisms. For instance, data buyers may click the data listed in ecosystem channels. Then they are redirected to a federated focal marketplace. Therefore, the data marketplace needs to pay ecosystem owners. Finally, ecosystem members can also put their *advertisements* in the ecosystem channel like its website.

3.3 Contextualization for TRUSTS: A Unified Taxonomy

3.3.1 Overview

The previous three taxonomies were contextualized to form a unified taxonomy for TRUSTS needs. Therefore, the object of unified taxonomy contains the characteristics of:

1. basic data marketplaces,
2. a federator, and
3. an ecosystem facilitator of data marketplaces.

For clarity, this subsection will use the term **ecosystem,** and it will refer to all three characteristics. Table 10 provides an overview of the unified taxonomy. The previous taxonomies were used as input to develop the unified one. For instance, the geographic scope and time frame dimension are inspired by the first taxonomy (see Table 4). Another example is the dimension of *contract* and *platform infrastructure*, extracted from the second taxonomy (see Table 7). The dimensions related to the federation and ecosystem facilitation, such as *federation objects,* are inspired by the third taxonomy (see Table 9). The unified taxonomy has also considered other sources such as deliverable D2.1, "Definition and analysis of the EU and worldwide data market." In doing so, specific dimensions such as *data exchange standards and frameworks* are included in the final taxonomy.

Table 10 Contextualization for TRUSTS: A Unified Taxonomy

Meta		Dimension	Characteristics					
Value creation	Federation focus	Sector	Government	Scientific community	SMEs	Enterprises	Civic Society	
		Industry coverage	Focus	Multiple industries				
		User groups	Data sellers	Data buyers	3rd party data service providers	Data brokers	3rd party Data marketplaces	Open data providers
		Geographic scope	Global	Regional	Local			
	Value proposition	Value discipline	Operational excellence	Product or service leadership	Customer intimacy	Value chain coordination		
		Completeness of vision	Data exchange	Data trading	Collaboration	Ecosystem access		
		USP	Privacy	Security	Sovereignty	GDPR compliant	Inter-operability	Unique or high quality data
		Sovereignty features	Anonymization	Encryption	Smart Contracts			

<table>
<tr><th colspan="2">Meta</th><th>Dimension</th><th colspan="5">Characteristics</th></tr>
<tr><td rowspan="17">Value Creation</td><td rowspan="6">Data ssets</td><td>Data source</td><td>Self-generated</td><td colspan="2">Customer-Provided</td><td colspan="2">Acquired</td></tr>
<tr><td>Types of data assets</td><td>Datasets</td><td colspan="2">Services</td><td colspan="2">Applications</td></tr>
<tr><td>Supply-demand side-bias</td><td colspan="2">Supply sided (Domain-focused)</td><td colspan="3">Demand sided (Solution-based)</td></tr>
<tr><td>Data time frame</td><td>Static datasets (fire and forget)</td><td>Up-to-date</td><td colspan="2">Near real time (latency >3sec)</td><td>Real time (latency <3sec)</td></tr>
<tr><td>Data enhancemen</td><td>Raw</td><td colspan="2">Standardized data</td><td colspan="2">Aggregated</td></tr>
<tr><td>Data asset discovery</td><td colspan="2">Meta-search engine</td><td colspan="3">Brokerage services</td></tr>
<tr><td rowspan="11">Ecosystem operator services</td><td>Onboarding mechanisms</td><td>Framework-based</td><td colspan="2">Algorithmic support</td><td colspan="2">Consulting service</td></tr>
<tr><td>Data pricing mechanisms</td><td>Set by data provider</td><td>Set by data buyer</td><td colspan="2">Negotiated</td><td>Indicative Pricing Benchmarking</td></tr>
<tr><td>Contracting support</td><td>DIY</td><td colspan="2">Contract-based support</td><td colspan="2">Smart contract engine</td></tr>
<tr><td>Data quality measures</td><td colspan="2">Self-declared</td><td colspan="3">User reviews</td></tr>
<tr><td>Metadata quality</td><td>Self-declared</td><td colspan="2">Quality check by an ecosystem operator</td><td colspan="2">Quality check by a third party</td></tr>
<tr><td>Data service enabler</td><td>None</td><td colspan="2">Proprietary stack of an ecosystem</td><td colspan="2">App store</td></tr>
<tr><td>Computing and storage infra-structure</td><td colspan="2">Infrastructure provision</td><td colspan="3">Infrastructure Brokerage</td></tr>
<tr><td>On-ecosystem</td><td>None</td><td colspan="2">Basic analytics</td><td colspan="2">Sandbox environments</td></tr>
<tr><td>Data service validation</td><td>None</td><td colspan="2">human-based</td><td colspan="2">machine-based</td></tr>
<tr><td>Review system</td><td>Ecosystem operators</td><td>Data marketplace operators</td><td colspan="2">End-users (e.g. data buyers)</td><td>3rd parties (e.g. data brokers)</td></tr>
<tr><td>Promotion (on the website)</td><td colspan="2">Vendor profiles</td><td colspan="3">Dataset showcases</td></tr>
</table>

Meta		Dimension	Characteristics				
Value Creation	Transaction	Contract	Standardized	Negotiated			
		Transaction execution	On-ecosystem (centralized)	On-ecosystem (decentralized)	Referred		
		Interfaces	Web-based interface	Standardized connector	Application Programming Interfaces (APIs)		
Value delivery	Delivery channel	Ecosystem access	Open	Close	By proxy (federation)		
	Key resources	Platform infrastructur	Centralized	Decentralized			
		Record keeping	Traditional database	Blockchain record			
		Data exchange standards	GAIA-X	IDSA	CKAN	Industry-specific standards	
		Cross-data marketplace transfer	Decentralized point-to-point	Proxy node	Central		
	Coordination and governance	Decision-making	Centralized	Decentralized	Semi-centralized (union)		
		Authenti-cation	Centralized ("ecosystem DAPS")	Decentralized			
		Federation object	Commercial data marketplaces	Public / open data clouds			
		Ecosystem owner	Private	Consortium	Public	PPP	Independent (e.g.NPO)
		Ecosystem operator	Private	Consortium	Public	PPP	Independent (e.g.NPO)
	Key activities	Value chain positioning	Data asset orchestration	Data asset exchange	Data asset trading	Data processing	Consultation
		Type of trading	Pure data asset brokerage (link demand and supply)	Hybrid: brokerage and proprietary trading (e.g. harvested data)			
		Data processing	Data collection	Data cleansing	Data storage	Data analysis	Data distribution

<table>
<tr><th colspan="2">Meta</th><th>Dimension</th><th colspan="8">Characteristics</th></tr>
<tr><td rowspan="4">Value capture</td><td rowspan="2">Revenue model</td><td>Revenue streams</td><td>Eco-system access (member-ship)</td><td>Data listing</td><td>Spon-sored search</td><td>Broker-age fee</td><td>Trading (trans-action fee)</td><td>Data asset sales</td><td>Service fee</td><td>Adver-tisement</td></tr>
<tr><td>3rd party Revenue sharing model</td><td colspan="4">Fixed (absolute or %)</td><td colspan="4">Sliding scale (absolute or %)</td></tr>
<tr><td rowspan="2">Pricing model</td><td>Operator pricing model</td><td colspan="2">Transactional</td><td colspan="2">Subscription</td><td colspan="2">Licensing</td><td colspan="2">Freemium</td></tr>
<tr><td>Payment currency</td><td colspan="4">Fiat</td><td colspan="4">Cryptocurrency</td></tr>
</table>

3.3.2 Value Creation

3.3.2.1 Federation Focus

<table>
<tr><th>Dimension</th><th colspan="30">Characteristics</th></tr>
<tr><td>Sector</td><td colspan="6">Government</td><td colspan="6">Scientific communities</td><td colspan="6">SMEs</td><td colspan="6">Enterprises</td><td colspan="6">Civic society</td></tr>
<tr><td>Industry coverage</td><td colspan="15">Focus</td><td colspan="15">Multiple industries</td></tr>
<tr><td>User groups</td><td colspan="5">Data sellers</td><td colspan="5">Data buyers</td><td colspan="5">3rd party data service providers</td><td colspan="5">Data brokers</td><td colspan="5">3rd party data marketplaces</td><td colspan="5">Open data providers</td></tr>
<tr><td>Geographic scope</td><td colspan="10">Global</td><td colspan="10">Regional</td><td colspan="10">Local</td></tr>
</table>

The first meta-characteristic in value creation is the **federation focus**, referring to the target of federation members. It consists of four dimensions. The first one is the **sector,** describing the target market with similar operational characteristics. An ecosystem could focus on *government, scientific* communities, *Small and medium-sized enterprises (SMEs), enterprises, or civic society*. Next, the **industry coverage** describes the breadth of federator coverage. For instance, an ecosystem can *focus* on a specific industry or consider *multiple* industries as its federation coverage. The **user groups** refer to federation actors that engage in data asset trade activities. These are *data sellers, data buyers, third-party data service providers (and developers), data brokers, 3rd party data marketplaces, and open data providers.* The **geographic scope** describes the regions in which an ecosystem is operating and available to users. A distinction is made between *global*, *regional* (multiple countries in a region like the EU), and local (single country).

3.3.2.2 Value Proposition

Dimension	Characteristics					
Value discipline	Operational excellence	Product or service leadership	Customer intimacy	Value chain coordination		
Completeness of vision	Data exchange	Data trading	Collaboration	Ecosystem access		
USP	Privacy	Security	Sovereignty	GDPR compliant	Interopera bility	Unique or high-quality data
Sovereignty features	Anonymization	Encryption	Smart Contracts			

The next meta-characteristic is the **value proposition** indicating the distinctive value an ecosystem intends to deliver to its members. First, the **value discipline** describes the vision positioning that guides every decision and act of an ecosystem (Tapp, 1995). It can focus on operational competence, and therefore achieving total cost reduction and *operational excellence*. It can also differentiate its products and achieve *product leadership*. An ecosystem can also aim for *customer intimacy* by consulting/providing solutions to their problem. Lastly, acting as a *value chain coordinator* to align data-sharing processes between federator members can also be an alternative.

Completeness of vision, based on Gartner’s definition, describes an ecosystem’s focus of innovation. An ecosystem may focus more on *data exchange* processes between two actors or may direct its attention to *data trading,* emphasizing data as economic goods. Besides, a *collaboration* between members to create innovative products, services and data-based solutions can also be the primary focus. Finally, *ecosystem access* to provide basic infrastructure, for instance, shared-service of common technological stacks, can also be the prime vision.

Unique Selling Proposition (USP) is the proclaimed main benefit of an ecosystem that distinguishes it from its rivals. One USP of an ecosystem can be to guard data *privacy*, such as performing data analysis without revealing personal information. Another core differentiator can be *security*, implying that an ecosystem has soft and hard mechanisms to protect itself from internal and external attacks. In addition, data *sovereignty* also can be seen as a novel USP. It implies that data providers still have control over their data after being shared to assess whether the data is used according to a contract or not. Legal compliance, such as *GDPR compliance,* is also a USP of an ecosystem because not all data trading platforms possess this compliance. Next, *interoperability* towards other data marketplaces can also be considered as USP. Finally, trading only *high-quality or unique data* can also be a differentiator. While possible, an ecosystem can adopt this value by harvesting or aggregating datasets, therefore, ensuring high-quality and unique data.

The last dimension in this meta-characteristic is **sovereignty features,** which have intentions “to meaningful control, ownership, and other claims in data” (Hummel, Braun, Tretter, &

Dabrock, 2021, p. 15). Therefore, features like *smart contracts, encryption,* and *anonymization* are highly desirable to protect data sharing activities.

3.3.3 Data Assets

Dimension	**Characteristics**			
Data source	Self-generated	Customer-Provided		Acquired
Types of data assets	Datasets	Services		Applications
Supply-demand side-bias	Supply sided (Domain-focused)		Demand sided (Solution-based)	
Data time frame	Static datasets (fire and forget)	Up-to-date	Near real time (latency >3sec)	Real time (latency <3sec)
Data enhancement	Raw	Standardized data		Aggregated
Data asset discovery	Meta-search engine		Brokerage services	

The meta-characteristic of **data assets** focuses on the ‘data’ as a unit of analysis, classified into six dimensions. The **data source** of an ecosystem can be *self-generated*, for instance, by gathering data manually or automatically from the internet. *Customer-provided* data is the most common data source of data providers to derive and trade their datasets. *The acquired* data source is the classification where federator owners acquire data from external data providers outside a federation ecosystem. **Types of data assets** traded in an ecosystem can be *datasets, data services (e.g.,* data cleansing and analytic), and *applications*. Whereas data services run on the infrastructure of the associated service provider, applications (apps) of third-party providers can be purchased/licensed by data marketplace users to enhance and extract value from other data assets.

The **supply-demand side-bias** describes the trading orientation of an ecosystem, i.e. whether it is *supply-sided (domain-focused) or demand-sided (solution-based).* In the first option, supply-sided orientation puts more data providers’ efforts on enriching datasets catalog, and data buyers can seek the data whenever they need it. In contrast, data trading activities are triggered by data buyers’ needs in the demand-sided orientation. Data providers often provide data where there are requests from data buyers. The data traded in an ecosystem may have a particular temporal context in a **time frame** that describes whether or not the data needs frequent updates to maintain the relevancy of the data (Schomm et al., 2013). A distinction is made between *static datasets, up-to-date datasets* in a certain period, *near-real lime datasets (latency >3sec), and real-time datasets (latency <3sec)*.

Data enhancement has two main characteristics; standardized and aggregated data. *Standardized data* refers to ecosystem capabilities in providing services like data normalization, data cleaning to achieve high-quality data based on the ‘standard’ of an ecosystem. Moreover, an ecosystem can also aggregate existing datasets, e.g., from open data portals to create additional insight. **Data asset discovery** describes the processes of discovering datasets within an ecosystem. This can be done using a *meta-search engine,* a recommender system to suggest relevant data sources to a particular solution or choice of a problem. Such a meta-search engine will search the datasets throughout the entire ecosystem. In contrast, data asset discovery through *brokerage services* relies on intermediaries who can facilitate the process of discovering relevant data.

3.3.3.1 Ecosystem Operator Services

Ecosystem operator services are possible services that an ecosystem can provide to its actors. For example, **onboarding mechanisms** to join an ecosystem can be done via a *framework-based* mechanism, in which human interventions are needed to assess the onboarding applications of actors. It can also be done via algorithmic support in which the actors try to comply and implement specific standards of an ecosystem, e.g., API, connector, and a member. Lastly, *consulting support* is also possible by providing close guidance to actors who want to onboard an ecosystem.

<table>
<tr><th>Dimension</th><th colspan="6">Characteristics</th></tr>
<tr><td>Onboarding mechanisms</td><td colspan="2">Framework-based</td><td colspan="2">Algorithmic support</td><td colspan="2">Consulting service</td></tr>
<tr><td>Data pricing mechanisms</td><td>Set by data provider</td><td colspan="2">Set by data buyer</td><td colspan="2">Negotiated</td><td>Indicative Pricing Benchmarking</td></tr>
<tr><td>Contracting support</td><td colspan="2">DIY</td><td colspan="2">Contract-based support</td><td colspan="2">Smart contract engine</td></tr>
<tr><td>Data quality measures</td><td colspan="3">Self-declared</td><td colspan="3">User reviews</td></tr>
<tr><td>Metadata quality</td><td colspan="2">Self-declared</td><td colspan="2">Quality check by an ecosystem operator</td><td colspan="2">Quality check by a third party</td></tr>
<tr><td>Data service enabler</td><td colspan="2">None</td><td colspan="2">A proprietary stack of an ecosystem</td><td colspan="2">An app store</td></tr>
<tr><td>Computing and storage infrastructure</td><td colspan="3">Infrastructure provision</td><td colspan="3">Infrastructure Brokerage</td></tr>
<tr><td>On-ecosystem analytics</td><td colspan="2">None</td><td colspan="2">Basic analytics</td><td colspan="2">Sandbox environments</td></tr>
<tr><td>Data service validation</td><td colspan="2">None</td><td colspan="2">human-based</td><td colspan="2">machine-based</td></tr>
<tr><td>Review system</td><td>Ecosystem operators</td><td colspan="2">Data marketplace operators</td><td colspan="2">End-users (e.g., data buyers)</td><td>Third parties (e.g., data brokers)</td></tr>
<tr><td>Promotion (on the website)</td><td colspan="3">Vendor profiles</td><td colspan="3">Dataset showcases</td></tr>
</table>

Data pricing mechanisms describe how prices for data-related products or services are determined. Prices can be set by buyer, seller, or negotiated. Prices can also be determined based on *indicative pricing benchmarking*. This involves settling on an agreed price based on a relative comparison with the prices of similar products or services or based on a closed competitor.

Contracting support describes support or auxiliary services that an ecosystem facilitator could perform that add value to constituent participants in the ecosystem. However, these services do not necessarily constitute critical services in the ecosystem; however, their absence could negatively affect the ecosystem's overall health. Because these support services are rather auxiliary, they range from *Do it yourself (DIY), contract-based to smart contract engine*. *DIY* means the user performs these necessary activities without any support from the ecosystem facilitator. On the other hand, the contract-based variant extends to templates, contracting support, or even professional services that the ecosystem facilitator could provide for data providers and users and data marketplaces to ensure issues among the different parties involved in a data trade are properly mitigated both from a legal aspect. The *smart contract engine* aspect consists of smart contracts to minimize intermediaries' need to facilitate trade between actors in the ecosystem.

Data quality measures describe measures that ecosystem operators can implement to ensure data quality. These measures are:

1. predetermined based on the data provider's self-declaration and
2. based on user reviews.

Metadata quality "is information about the quality level of stored data in organization databases, and is measured along different dimensions such as accuracy, currency, and completeness" (Moges et al. 2016, p. 33). The metadata quality measures (e.g., accuracy, currency, and completeness) can vary along with three characteristics; *self-declared, quality check by an ecosystem operator, quality check by a third party*.

Data service enabler describes how data services are ensured within an ecosystem: This can range from *none*, *a proprietary stack of an ecosystem*, or *an app store*. A proprietary stack ensures data services are provided merely by ecosystem owners, whereas an app store allows third parties to develop services on top of an ecosystem environment.

Computing and storage infrastructure describes the overall hardware needed to ensure the successful operations of an ecosystem and transactions between trading parties. An ecosystem facilitator can assume the role of an *infrastructure provision* or *infrastructure brokerage***.** As an infrastructure provider, the role of an ecosystem facilitator would be to provide, for example, infrastructure spaces and computing power for different data marketplaces in an ecosystem. As an infrastructure brokerage, the role of an ecosystem facilitator is to assist and fulfill the infrastructure needs of actors by commissioning infrastructure of 3rd party providers.

On-ecosystem analytics describes the plausible range of deployed analytics services to enable data exploration in an ecosystem. These can range from *none* to *basic analytics* (e.g., data cleansing) and *sandbox environments*. **Data service validation** describes *human-based* or *machine-based* processes that ensure an ecosystem has undergone checks to ensure service quality. **The review system** describes the dataset and service quality in an ecosystem assessed by involved actors. This ranges from reviews from *ecosystem operators, data marketplace operators, end-users (e.g., data buyers)* to *third parties (e.g., developers).* **The Promotion** (on the website) describes the promotion activities an ecosystem facilitator could offer to data marketplace participants. These include displaying *vendor profiles* or *dataset showcases* as advertisements.

3.3.3.2 Transaction Processing

Dimension	Characteristics		
Contract	Standardized		Negotiated
Transaction execution	On-ecosystem (centralized)	On-ecosystem (decentralized)	Referred
Interfaces	Web-based interface	Standardized connector	Application Programming Interfaces (APIs)

Transaction processing describes the approach of an ecosystem facilitator to dataset transaction processing. Most data trading is conducted using either a *standardized* or *negotiated* **contract.** In addition, The **transaction can be executed** *on-ecosystem centralized* where datasets should be stored in a central storage to be traded, or either *on-ecosystem decentralized* where datasets stay in the end-users (e.g., data providers) without the need of uploading the dataset to a central registry. In addition, an ecosystem can merely *refer* the traffic to specific data marketplaces based on the meta-search engine query result.

The user interface describes the point of contact required between actors and an ecosystem. This can be done through a web-based interface, standardized connectors, or Application Programming Interfaces (APIs).

3.3.4 Value Delivery

3.3.4.1 Ecosystem Access

The ecosystem access defines the degree of openness for participants to enter the ecosystem, and this dimension belongs to the **delivery channels** dimension.

Dimension	Characteristics		
Ecosystem access	Open	Close	By proxy (federation)

An ecosystem can be *open* to all potential actors or *closed* by only allowing certified actors to join an ecosystem. Ecosystem access *by proxy (federation)* is also possible. For example, if a data provider is part of an ecosystem, the data provider can automatically access the ecosystem offerings.

3.3.4.2 Key Resources

Dimension	Characteristics				
Platform infrastructure	Centralized		Decentralized		
Record keeping	Traditional database		Blockchain record		
Data exchange standards and frameworks	GAIA-X	IDSA	CKAN	Industry-specific standards	
Cross-data marketplaces transfer	Decentralized point-to-point	Proxy node	Central		

The **key resources** describe essential resources for the ecosystem facilitator to sustain the proper performance of its roles and functions to sustain the ecosystem's overall health. The **key resources** have the **platform infrastructure** dimension, specifying how data is stored at data marketplaces, i.e., *centralized* or *decentralized*. Centralized infrastructure implies the infrastructure is tied together. This means the ecosystem's facilitator plays a role in the storage of the data. On the other hand, a decentralized infrastructure lets data providers store datasets. The **record-keeping** of an ecosystem can be either a *traditional database* or *blockchain record.* The **Data exchange standards and frameworks** can refer to widely-used ones in the European Union, such as *GAIA-X*[3], *IDSA*[4], *CKAN*[5], *or* industry-specific standards. **Cross-data marketplaces transfer** describes how data is flown between a data marketplace to others. It can be *decentral point-to-point* where a data provider in a data marketplace can sell their data to data buyers from another data marketplace. It can flow through a *proxy node* provided by an ecosystem or stored *centrally* in an ecosystem.

[3] https://www.data-infrastructure.eu/GAIAX/Navigation/EN/Home/home.html accessed by June 3, 2021

[4] https://internationaldataspaces.org/ by June 3, 2021

[5] https://ckan.org/ by June 3, 2021

3.3.4.3 Coordination and Governance

Coordination and governance describe measures to influence actors within an ecosystem. It aligns various interests of participants with the overall objective of an ecosystem.

<table>
<tr><th>Dimension</th><th colspan="8">Characteristics</th></tr>
<tr><td>Decision-making</td><td colspan="2">Centralized</td><td colspan="3">Decentralized</td><td colspan="3">Semi-centralized (union)</td></tr>
<tr><td>Authenti-cation</td><td colspan="4">Centralized ("ecosystem DAPS")</td><td colspan="4">Decentralized</td></tr>
<tr><td>Federation object</td><td colspan="4">Commercial data marketplaces</td><td colspan="4">Public / open data clouds</td></tr>
<tr><td>Ecosystem owner</td><td>Private</td><td colspan="2">Consortium</td><td colspan="2">Public</td><td colspan="2">PPP</td><td>Independent (NPO)</td></tr>
<tr><td>Ecosystem operator</td><td>Private</td><td colspan="2">Consortium</td><td colspan="2">Public</td><td colspan="2">PPP</td><td>Independent (NPO)</td></tr>
</table>

Decision-making refers to the process of determining:

1. what decisions need to be taken,
2. how decisions will be chosen, and
3. who are eligible to make decisions in an ecosystem (Tiwana, 2013).

Decision-making in the ecosystem can be *centralized*, *decentralized*, or *semi-centralized (union)*. Centralized decision-making implies an ecosystem facilitator acting as the keystone (Iansiti & Levien, 2004a). The keystone tends to follow a hierarchical structure. On the other hand, decentralized decision-making implies that decision rights about the development of an ecosystem are distributed among actors. For example, strategic decisions related to the vision of an ecosystem might be taken by an ecosystem facilitator while allowing data providers to take decisions related to a specific choice of data or format that should be released. Semi-centralized (union) decision-making implies that decision rights vary along with a mixture of centralized/decentralized. Decision-making of a union type implies ecosystem members delegate decision-making for the facilitator to act on their behalf.

Authentication in an ecosystem are processes that ensure control and integrity in the ecosystem. It can be done through *centralized ("ecosystem DAPS") or decentralized*. **The federation object** of an ecosystem facilitator can be *commercial data marketplaces* or *public/open data clouds*. Commercial data marketplaces share and trade business data, while public/open data clouds focus on publicly available data (generated from public sector activities or taxpayers’ funds). An **ecosystem owner**, responsible parties who owns the property rights and are responsible for developing ecosystem core technology, and also **ecosystem operators**, responsible parties who operate an ecosystem when it runs as a business, can be attributed to *private, consortium, public-private partnership (PPP), or independent (Non-profit organization).*

3.3.4.4 *Key Activities*

Dimension	Characteristics				
Value chain positioning	Data asset orchestration	Data asset exchange	Data asset trading	Data processing	Consultation
Type of trading	Pure data asset brokerage (link demand and supply)		Hybrid: brokerage and proprietary trading (e.g. harvested data)		
Data processing	Data collection	Data cleansing	Data storage	Data analysis	Data distribution

The **key activities** of an ecosystem facilitator include **value chain positioning** and **type of trading**. Value chain positioning refers to the position of the marketplace along the data value chain. It can focus on *data asset orchestration, data exchange, data trading, data processing, and consultation.* The type of trading describes whether an ecosystem *purely links the demand and supply of data assets or harvests* the data itself by *providing proprietary data assets (hybrid mode)*. Finally, **data processing activities** in an ecosystem can include *data collection, cleansing, storage, analysis, and distribution*

3.3.5 Value Capture

3.3.5.1 *Revenue Model*

Dimension	Characteristic							
Revenue streams	Ecosystem access (member-ship)	Data listing	Sponsored search	Broker-age fee	Trading (transacti on fee)	Data asset sales	Service fee	Adverti-sement
3rd party revenue sharing model	Fixed (absolute or %)				Sliding scale (absolute or %)			

The **revenue model** consists of the **revenue streams** and **revenue sharing model (3rd party)** as key dimensions. The revenue streams describe how ecosystem operators generate revenue. It can be from *ecosystem access (membership), data listing, sponsored search, brokerage fee, trading fee, data asset sales, service fee, and advertisement.* The revenue sharing model (3rd party) describes how revenue generated is shared with actors, e.g., data marketplace operators. This can range from *fixed (absolute or %)* and *sliding scale (absolute or %)*. Fixed means a fixed percentage of apportioned to an ecosystem irrespective of the amount generated from the revenue streams. For example, Apple gets about 70% revenue while developers associated with its ecosystems get about 30% from every sale. *Sliding scale* (absolute or %) describes revenue based on the proportion of revenue made. For example, a revenue below 10000 Euros would mean a 60%-40% split between an ecosystem operator and a data marketplace operator. In comparison, revenues of about 10000 Euros would mean a 70%-30% split. Both revenue sharing models have both upsides and downsides which must be considered. For example, a high revenue split favoring stakeholders in the ecosystem might encourage and incentivize actors to participate in an ecosystem.

3.3.5.2 Pricing Model

<table>
<tr><th>Dimension</th><th colspan="4">Characteristics</th></tr>
<tr><td>Operator pricing model</td><td>Transactional</td><td>Subscription</td><td>Licensing</td><td>Freemium</td></tr>
<tr><td>Payment currency</td><td colspan="2">Fiat</td><td colspan="2">Cryptocurrency</td></tr>
</table>

The pricing model describes specifications regarding the calculation of prices related to services provided by an ecosystem. The operator pricing model refers to how the operator seeks to generate revenue from the services provided. It can be classified into *transactional, subscription, licensing, and freemium.* **The payment currency** describes what currency is used for payments, which can be *fiat* (e.g., US dollar, EU) or *cryptocurrency*.

4 Emerging viable positioning options of TRUSTS within The Unified Taxonomy

This section describes the potential positioning of TRUSTS within the unified taxonomy (refer to Table 11). The positioning is analyzed based on congruency with the original TRUSTS project proposal, the current project vision and condition, and continuous alignment efforts between TRUSTS project partners from the business domain and technical domains.

Table 11 TRUSTS Positioning within the Unified Taxonomy

Meta		Dimension	Characteristics					
Value creation	Federation focus	**Sector**	Government	Scientific communities	SMEs	Enterprises	Civic society	
		Industry	Focus	Multiple industries				
		User groups	Data sellers	Data buyers	3rd party data service providers	Data brokers	3rd party data marketplaces	Open data providers
		Geographic	Global	Regional	Local			
	Value proposition	**Value discipline**	Operational excellence	Product or service leadership	Customer intimacy	Value chain coordination		
		Completeness of vision	Data exchange	Data trading	Collaboration	Ecosystem access		
		USP	Privacy	Security	Sovereignty	GDPR compliant	Inter-operability	Unique or high quality data
		Sovereignty features	Anonymization	Encryption	Smart Contracts			
	Data assets	**Data source**	Self-generated	Customer-Provided	Acquired			
		Types of data assets	Datasets	Services	Applications			
		Supply-demand side-bias	Supply sided (Domain-focused)	Demand sided (Solution-based)				
		Data time frame	Static datasets (fire and forget)	Up-to-date	Near real time (latency >3sec)	Real time (latency <3sec)		
		Data enhancement	Raw	Standardized data	Aggregated			
		Data asset discovery	Meta-search engine	Brokerage services				

<table>
<tr><th colspan="2">Meta</th><th>Dimension</th><th colspan="12">Characteristics</th></tr>
<tr><td rowspan="14">Value creation</td><td rowspan="11">Ecosystem operator services</td><td>Onboarding mechanisms</td><td colspan="4">Framework-based</td><td colspan="4">Algorithmic support</td><td colspan="4">Consulting service</td></tr>
<tr><td>Data pricing mechanisms</td><td colspan="3">Set by data provider</td><td colspan="3">Set by data buyer</td><td colspan="3">Negotiated</td><td colspan="3">Indicative Pricing Benchmarking</td></tr>
<tr><td>Contracting support</td><td colspan="4">DIY</td><td colspan="4">Contract-based support</td><td colspan="4">Smart contract engine</td></tr>
<tr><td>Data quality measures</td><td colspan="6">Self-declared</td><td colspan="6">User reviews</td></tr>
<tr><td>Metadata quality</td><td colspan="4">Self-declared</td><td colspan="4">Quality check by an ecosystem operator</td><td colspan="4">Quality check by a third party</td></tr>
<tr><td>Data service enabler</td><td colspan="4">None</td><td colspan="4">A proprietary stack of an ecosystem</td><td colspan="4">An app store</td></tr>
<tr><td>Computing and storage infrastructure</td><td colspan="6">Infrastructure provision</td><td colspan="6">Infrastructure Brokerage</td></tr>
<tr><td>On-ecosystem analytics</td><td colspan="4">None</td><td colspan="4">Basic analytics</td><td colspan="4">Sandbox environments</td></tr>
<tr><td>Data service validation</td><td colspan="4">None</td><td colspan="4">human-based</td><td colspan="4">machine-based</td></tr>
<tr><td>Review system</td><td colspan="3">Ecosystem operators</td><td colspan="3">Data marketplace operators</td><td colspan="3">End-users (e.g., data buyers)</td><td colspan="3">Third parties (e.g., data brokers)</td></tr>
<tr><td>Promotion (on the website)</td><td colspan="6">Vendor profiles</td><td colspan="6">Dataset showcases</td></tr>
<tr><td rowspan="3">Transaction processing</td><td>Contract</td><td colspan="6">Standardized</td><td colspan="6">Negotiated</td></tr>
<tr><td>Transaction execution</td><td colspan="4">On-ecosystem (centralized)</td><td colspan="4">On-ecosystem (decentralized)</td><td colspan="4">Referred</td></tr>
<tr><td>Interfaces</td><td colspan="4">Web-based interface</td><td colspan="4">Standardized connector</td><td colspan="4">Application Programming Interfaces (APIs)</td></tr>
<tr><td rowspan="5">Value delivery</td><td>Delivery channel</td><td>Ecosystem access</td><td colspan="4">Open</td><td colspan="4">Close</td><td colspan="4">By proxy (federation)</td></tr>
<tr><td rowspan="4">Key resources</td><td>Platform infrastructure</td><td colspan="6">Centralized</td><td colspan="6">Decentralized</td></tr>
<tr><td>Record keeping</td><td colspan="6">Traditional database</td><td colspan="6">Blockchain record</td></tr>
<tr><td>Data exchange standards and frameworks</td><td colspan="3">GAIA-X</td><td colspan="3">IDSA</td><td colspan="3">CKAN</td><td colspan="3">Industry-specific standards</td></tr>
<tr><td>Cross-data marketplaces transfer</td><td colspan="4">Decentralized point-to-point</td><td colspan="4">Proxy node</td><td colspan="4">Central</td></tr>
</table>

Meta		Dimension	Characteristics							
Value delivery	Coordination and governance	Decision-making	Centralized	Decentralized	Semi-centralized (union)					
		Authentication	Centralized ("ecosystem DAPS")	Decentralized						
		Federation object	Commercial data marketplaces	Public / open data clouds						
		Ecosystem owner	Private	Consortium	Public	PPP	Independent (NPO)			
		Ecosystem operator	Private	Consortium	Public	PPP	Independent (NPO)			
	Key activities	Value chain positioning	Data asset orchestration	Data asset exchange	Data asset trading	Data processing	Consultation			
		Type of trading	Pure data asset brokerage (link demand and supply)	Hybrid: brokerage and proprietary trading (e.g., harvested data)						
		Data processing activities	Data collection	Data cleansing	Data storage	Data analysis	Data distribution			
Value capture	Revenue model	Revenue streams	Ecosystem access (membership)	Data listing	Sponsored search	Brokerage fee	Trading (transaction fee)	Data asset sales	Service fee	Advertisement
		3rd party revenue sharing model	Fixed (absolute or %)	Sliding scale (absolute or %)						
	Pricing model	Operator pricing model	Transactional	Subscription	Licensing	Freemium				
		Payment currency	Fiat	Cryptocurrency						

TRUSTS can broadly target the *customer segments* for data sharing in all sectors ranging from government, scientific, Small and Medium-sized Enterprises (SMEs), large enterprises, and civic society. The positioning of TRUSTS in this regard informed by the broad role TRUSTS is expected, i.e., as stated in the proposal, *"to analyze the EU & worldwide challenges and trends for data-sharing and define the requirements for the provision of a multi, concurrent and cross-domain, secure and scalable end-to-end (E2E) data marketplace service."*

TRUSTS can also cover multiple industries within the EU region and incorporate all user group needs in data marketplaces, including but not limited to data providers, data buyers, data brokers, third-party providers, and existing data marketplace as well as open data operators. The positioning of TRUSTS within this broad market segment ties with the initial analysis of TRUSTS as described in T7.2 and T7.5. TRUSTS *value proposition* relies on value chain coordination, focusing on aligning data sharing, data trading, collaboration, and ecosystem access to its ecosystem members. Specifically, TRUSTS Unique Selling Propositions (USPs) provide security, privacy protection, and sovereignty for data trading while ensuring compliance to GDPR and interoperability between all involved actors. Sovereignty features provided by TRUSTS include anonymization, encryption, and smart contracts.

TRUSTS will focus on data as a traded commodity. This data is primarily provided by data providers for facilitated trading. In addition, proprietary trade of acquired data should not be readily discarded, such as trading harvested open data. The type of data traded within TRUSTS is raw, standardized data or aggregated data. TRUSTS infrastructure will allow static, up-to-date, and near real-time (latency >3sec) datasets to trade. Data assets can be discovered via the meta-search engine and brokerage services. TRUSTS can focus not only on the supply side, e.g., by allowing data providers to offer their data, but also the demand side, e.g., by allowing data buyers to request data based on their needs. In addition, to focus on *data assets*, TRUSTS can also potentially provide services, e.g., shared services for its federation members.

TRUSTS provides many services. To onboard in TRUSTS platform, standard requirements based on the framework-based need to be fulfilled by applicants. TRUSTS provides computing and storage infrastructure provision and brokerage to support data trading processes. At the moment, TRUSTS will provide on-ecosystem analytics by allowing third-party providers to provide services via the TRUSTS app store. The validation of data services will be based on human justification. User reviews will assess data quality, whereas TRUSTS will assess the quality control of metadata. Considering data pricing mechanisms, data can be priced by data providers or data buyers. Moreover, the negotiation of price is also possible. TRUSTS provides smart contract engines to support the transaction. Lastly, TRUSTS can also promote specific data marketplace operators, brokers, or data providers on the TRUSTS website by showing the vendor profile and showcasing the dataset or services.

TRUSTS, in general, provides standardized contracts that will be embedded via smart contracts. Nevertheless, this contract is negotiable and can be adjusted. The transaction execution occurs on the TRUSTS ecosystem using a decentralized approach. TRUSTS will provide a web-based interface to access basic functionalities. Standardize connector and Application Programming Interfaces (APIs) are available to access advanced functionalities. TRUSTS ecosystem can only be accessed when relevant actors have passed the onboarding process mechanisms. Data exchange standards and frameworks will primarily be based on IDSA. TRUSTS will use decentralized architecture and utilize blockchain for keeping the record and data assets. Regarding cross-data marketplaces transfer, decentralized point-to-point mode or proxy node is possible if data marketplace participants are willing to utilize the TRUSTS connector.

TRUSTS could consider semi-centralized (union) decision-making. TRUSTS members may delegate the decision-making process to ecosystem operators while still having spaces to voice their opinions. The federation object of TRUSTS will be both commercial data marketplaces and public open data clouds. The ecosystem owner of TRUSTS is a consortium consisting of seventeen partners. Establishing an ecosystem operator will depend on negotiations during, and possibly extending beyond the project end. In this case, by considering taking a startup phase, the possibility for a private company to operate TRUSTS is more prominent, as compared to others. A key activity within the TRUSTS ecosystem is to link demand and supply, therefore, to purely brokerage for data asset trading. Nevertheless, property trading by harvesting data is still under consideration as a viable, possibly prerequisite option for business sustainability. The TRUSTS ecosystem will consider the entire cycle of data processing activities, ranging from data collection to data distribution.

Lastly, considering value capture, eight options presented in the taxonomy are possible to be implemented in TRUSTS. Revenue sharing models between TRUSTS and its ecosystem 3rd party are to be explored further, to create incentives ecosystem members. A detailed discussion related to this dimension is required to determine the appropriate model. Moving to the operator pricing model, to calculate the price related to services provided by TRUSTS, four options provided by taxonomy are deemed possible for adoption. In either case, fiat wull be used for transactions on TRUSTS.

5 Challenges, Opportunities, and Recommendations

This section describes the challenges, opportunities, and recommendations for TRUSTS. It considers option along the discussed three roles of the platform –Data marketplace, Federator, and Ecosystem facilitator – highlights business requirements for each option, and concludes with a recommendation.

5.1 TRUSTS as a Data Marketplace

Referring to the D2.1 report, “Definition and analysis of the EU and worldwide data market,” key marketplace challenges can be summarized as follow (categorized using the STOF model):

1. *Service:* data ownership definition, ensuring data integrity, assessing data quality, ensuring contractual compliances, losing of control over data, lack of transparency,
2. *Technology:* privacy protection, security, technical efficiencies & scalabilities, data placement cost, and user-friendly applications & interfaces,
3. *Organization:* the absences of legal frameworks, lack of resources and technical knowledge, unclear organizational structure, ethical concern,
4. *Finance:* pricing mechanism, data valuation, and profit maximization.

While in general, the challenges mentioned above have been primarily covered by respective Work Packages (WP) (e.g., the absences of legal frameworks in WP6, privacy protection and security in the WP3), these specific opportunities, based on the insights from the developed taxonomies, can also be considered in developing viable business models for TRUSTS:

1. **Value propositions that offer a solution instead of raw data trading.** As elaborated in Section 3.1.2.4 (the taxonomy takeaways for TRUSTS), data marketplaces that offer the performance of value-adding services like
   a. clean data to ensure data quality,
   b. analyze data to create aggregated datasets,
   c. offer personal assistance in data sale and acquisition appears to be commercially viable in practice.
2. **The need for strong customer relationships to attract customers.** Based on the taxonomy insight, data marketplaces that offer personal assistance to their customers regarding data sale and purchase tend to viable and commercially exploited in practice compared to data marketplaces that merely offer data trading.
3. **The emergence of novel technological applications** in the industry that enhance trust among data marketplace participants, such as data-exchange solutions, decentralized platform architectures, smart contracts, and cryptocurrencies as a payment method, are emerging. These opportunities align very well with current TRUSTS visions.
4. The study exposes the existence of services that aggregate personal data for commercial purposes, i.e., **B2C harvesting by data marketplaces / aggregators**. This type of data marketplace is emerging and enables individuals to monetize their data. As per the vision of TRUSTS, this may not be an valid business option for TRUSTS itself, but TRUSTS could become a focal platform for aggregators as data asset sellers.

5. Possibility to **harvest open data sets** (or metadata thereof) to complement the data catalog with domain- or solution-specific curated data. This enables value creation by providing more prosperous, more readily accessible datasets for data buyers seeking solutions to their (business) problems. In turn, this enables value capture through increased sales of both 3rd party and open-turned-proprietary data.
6. **Focus on a limited number of key industries as a starting point.** To incentivize participation to enroll on the platform, TRUSTS could initially focus on key industries such as the automotive, banking, or telecommunication industry where a mass amount of the data is available. TRUSTS could then leverage the value of the platform to other users who could then enroll on the platform.
7. Using **a seeding strategy** to attract data providers and data buyers. For example, TRUSTS can start by intensively providing data assets from its consortium members to attract data buyers. As the number of buyers grows, data providers could subsequently be attracted to use TRUSTS to expose their data. The provided data should comply with best practices of data trading, e.g., anonymizing datasets.
8. **Technical sales support** can be one business opportunity since one of the target groups of TRUSTS are MSMBs. Many of them are in the early stages of their digital transformation, creating additional barriers to bringing them onto TRUSTS. Whereas standardized connectors will ease integration, the need for awareness creation & education, internal data management, and set up – to name but a few – may require additional support.

<u>**Business Requirements**</u>

TRUSTS will ensure trust in the concept of data markets as a whole via its focus on developing a platform based on the experience of two large national projects, while allowing the integration and adoption of future platforms. Beyond the sound technical services that hide any complexity for the users, TRUSTS aims at analysing the state of the art business processes and models. The aim is to assess pros and cons and define the best business model strategy to safeguard sustainability.

In detail the requirements for the TRUSTS business operation are:

DMR1 TRUSTS business requirements
TRUSTS has to fulfill a sustainable role in the data marketplace ecosystem. The aim is to define a multidisciplinary business offering which is able to address current and emerging needs of commercial enterprises, governmental agencies, academia and individuals while respecting regulations for data privacy, sovereignty and free flow. Analysis of the current status resulted in the conclusion that though a great number of data marketplaces exist, none achieved a dominant position in the market while many remain in a conceptual stage. This constitutes an opportunity for TRUSTS which aims at setting up robust commercial operations targeting from the outset:

- large enterprises and organisations requiring a consistent and trustworthy environment that will assist them to more fully explore and coopetitively exploit opportunities to innovate and exand business in the digital era
- SMEs as data providers and data application providers seeking to broaden market reach towards trading their data assets through data marketplaces rather than having to create their clientele ecosystem on their one.
- Individuals aiming at accessing datasets and applications via a one stop shop easy to use trusted environment

It is required that TRUSTS develops a concrete business model aiming at providing targeted solution for industries, SMEs, professionals and individuals with respect to their data exchange, analysis and trading needs.

Such a business model will be based on the taxonomy presented in this report. In parallel, a set of consistent business processes of the platform should be designed aiming at ensuring quality operation, undisputable transactions, IPRs respect and adherence to regulations e.g. GDPR.

Last but not least, the business model should be supported by a remuneration model aiming at providing fair remuneration of all actors in the value chain. The pricing model should reflect the unique position we envisage for TRUSTS in the data marketplace ecosystem while ensuring clientele loyalty.

5.2 TRUSTS as a Federated Data Marketplace

In the TRUSTS-internal stakeholder workshops "Positioning of TRUSTS in the European data economy" and "TRUSTS WP BusTech Alignment," a separate discussion regarding the (generic) potential adoption barriers of a federator of data marketplaces were collaboratively explored. Barries can be distinguished into two main categories: 1) *perceived insufficient value creation* and 2) *perceived risk and cost.*

Perceived insufficient value creation:

1 **Unclear and unproven general value propositions.** In general, value propositions in adopting a federator for data marketplaces related to actors in data marketplaces, e.g.,

a. **For data buyers**, for instance, a federated data marketplace will help them to ease data discovery processes, avoid high switching costs, and demonstrate legal compliance;

b. **For data marketplace operators,** for instance, the value-added hypotheses regarding network effects scaling power have not been proven yet practically and scientifically.

2 Unexplored economics of various data marketplace setups with a federation (e.g., revenue sharing mechanisms).

3 **The boundary of the 'federation' is still unclear.** More clarification about what will (not) be incorporated in the federation, e.g., money flow mechanisms, need to be further studied.

Perceive risk and cost:

1. **Increased complexity and cost for technology integration.** For example, each data marketplaces already deploys their own (proprietary) technology mechanisms to enforce control over data to achieve data sovereignty. Therefore, alignment of these technological stacks is required and highly likely to create complexities.
2. Data marketplace operators onboarding to the federation may fear losing part of data marketplaces’ Unique Selling Propositions (USPs)
3. **Potential membership issues.** While data marketplaces have vastly different mechanisms to onboard their data providers and data buyers, integrating these membership schemas into an umbrella will cause confusion.

Irrespective of these challenges, a federated data marketplace opens various opportunities as such:

1. **Providing a *one-stop shop* via a standardized portal** can ease data discovery and transaction processes of data buyers and providers from multiple data marketplaces. Federation in its most bascic form coule direct and forward traffic from the federation portal to appropriate focal data marketplaces. In doing so, both transaction and search cost can be reduced.
2. **Providing commissioned brokerage** for data buyers who look for solution-based data assets.
3. **Establishing shared services for non-differentiating capabilities (e.g., billing)** for data marketplace operators. Therefore, they could reduce cost and risk, enabling stronger focus on and refinement of their respective Unique Selling Propositions (USPs).
4. Increasing quality and quantity of overally accessible datasets and solutions, including disseminating its meta-data throughout datasets combination from all onboarded data marketplaces.
5. Arranging gradual harmonization of the technology stack through coordination and common standards.
6. **Ensuring legal compliance** such as GDPR in data trading processes in this federated environment.
7. **Providing a central register for data providers and** buyers to track and sanction violations of data trading code of conduct.

<u>Business Requirements</u>

TRUSTS aims at laying the groundwork for an ecosystem that will enable federation of independent data marketplaces. Federation is very important in order to capitalize on various initiatives (e.g. vertical data marketplaces, territorial data marketplaces, etc.) and build a global ecosystem that will assist data economy growth. TRUSTS aims at playing a key role in the process providing comprehensive tools and processes to enable federation of data marketplaces in a consistent and unified manner.

The requirements resulting from the aforementioned analysis are:

FR1	TRUSTS Business federation requirements
	TRUSTS will ensure trust in the concept of data markets as a whole via its focus on developing a platform allowing the integration and adoption of future platforms. The TRUSTS platform will act independently and as a platform federator, while investigating the legal and ethical aspects that apply on the entire data valorification chain, from data providers to consumers. TRUSTS should both provide technological means and business incentive to achieve sustainable business and technology federation with third party marketplaces. On a business level, TRUSTS should create a business model that defines a distinct value proposition in order to be considered a prefered business federator. Federation between data marketplaces is pursued in order to: ● Achieve an inorganic expansion of market reach. In this way a data marketplace is able to reach larger clientele market through through external data marketplaces. ● Augment assets repository. Through federation with third party marketplaces, the data assets repository is accordingly enlarged as well. In order to achieve federation a data marketplace should: ● initially have an adequate market position in order to create the interest to third parties to federate with the aforementioned data marketplace. ● provide business incentives in order for both data marketplaces to achieve mutual benefits. It is required that the TRUSTS business model and commercialisation roadmap define: ● the federation model that clearly provides transparency and mutual business benefits while ensuring quality of operation. ● a roadmap in order for TRUSTS to achieve an adequate market position so as to be considered by the data marketplace ecosystem a ‘prefered federator’.

5.3 TRUSTS as an Ecosystem Facilitator

As an ecosystem facilitator, TRUSTS stands to create value for participants through facilitating interaction among participants. This focus implies that TRUSTS could act as a community and a knowledge pool across different data domains, data providers, data services, and end-users of data. In doing so, TRUSTS stands to create a more significant impact across the EU data economy. TRUSTS should not be solely conceived as an infrastructure provider by assuming such a role but play a brokerage role that helps facilitate cross interaction across industry boundaries. The role of TRUSTS as a central node in creating an impact for a broader ecosystem is to ensure that TRUSTS could play an essential role in enabling efficient interactions. This could be enabled through the development of standardized interfaces. This involves the need to ensure knowledge translation in the different communities.

Challenges related to an ecosystem facilitator encompass:

1. **Lack of shared visions across the ecosystem members.** Because of the likely distribution of actors within different communities and data domains, the challenge for TRUSTS would be ensuring that different actors participating in the ecosystems have a shared vision of the goals of TRUSTS.
2. **Low level of goal congruence among actors in the ecosystem**. TRUSTS could suffer from a low level of goal congruence among actors in the ecosystem.
3. **High transaction costs** associated with monitoring and enforcing contracts in the ecosystems since distributed actors operate with no central authority to determine or assertively determine the rules. Such can be challenging in an ecosystem where different actors and stakeholders have distinct interests.
4. Closely related to point (3), **the initial cost** of running the ecosystem can be high, especially in the beginning when there are no clearly defined value propositions in the ecosystem. This can result in situations where participating actors in the ecosystem question the legitimacy of TRUSTS as a critical facilitator in the ecosystem.
5. **Growing complexity** could also be a challenge as new actors enroll in the ecosystem with different technologies and more complex interactions and relations between entities.

This complexity can create chaos if not properly orchestrated.

6. **Competing goals among actors.** Providing a value proposition relevant to all actors in the ecosystem might be challenging given the diversity of interest among actors.
7. **Imbalances in the competitive landscape.** The involvement of big players and asymmetric power relations in the ecosystem might also help tilt the balance of power towards data suppliers or buyers with the most data.
8. The necessary incentive for TRUSTS to entice participation in the ecosystem would lie in TRUSTS's ability to ensure that distributed actors in the ecosystems could be matched using some special form of boundary resources that are considered compatible across different communities.

Some opportunities related to an ecosystem facilitator can be described as follows.

1. TRUSTS brings together **a broader audience** to participate in the ecosystem by facilitation and brokerage roles as an ecosystem facilitator.
2. **Cross-fertilization across different industry domains**. Because of interactions across the ecosystem, stakeholders have more possibilities to share knowledge across various industries. Furthermore, because their very survival would depend on the overall health of the ecosystem, different stakeholders will participate in ensuring the success of the ecosystem. Moreover, because of the close interaction of different companies in the ecosystems, solutions for problems can be generated from different actors in the ecosystem, which can benefit different industry domains.
3. As an ecosystem facilitator, TRUSTS has the privilege of shaping the trajectory of the ecosystem through **checks and presiding over critical issues** that may affect the ecosystem, such as checking the powers or undesired behaviors of certain partners.
4. Participation of more actors and the generation of a more significant impact than the impact a single industry domain could generate.

Business Requirements

TRUSTS is expected to become a data marketplace ecosystem facilitator, contributing to realization of the expected impact of the HORIZON 2020 ICT-13 Work Programme.

The requirements resulting from the analysis above are:

EFR1 TRUSTS Ecosystem Facilitator Requirements
Data-driven technologies and their applications produce and process data at a pace unimaginable a few years ago. Companies have started to leverage data technologies to innovate by inventing new products and services. Data has become a product on its own and can be transferred and traded in newly emerged “data marketplaces.” Data platforms are virtual environments facilitating the exchange and connection of data between different organizations. They are key facilitators in this emerging data marketplace. For TRUSTS to become an ecosystem facilitator, it is required to analyse the needs and constraints of the market stakeholders, industries, and individuals. TRUSTS focus should create a business and commercial plan on defining a series of actions that enable data governance models and other framework conditions facilitating the emergence of an ecosystem around the TRUSTS platform, to allow companies and individuals to avoid the negative externalities of proprietary industrial platforms (supply-driven approach, lower level of control on proprietary data, centralized data governance and technical architecture). In particular, attracting an ever-increasing number of companies and achieving critical mass would be fundamental for TRUSTS to become recognized and successful and a wide range of domain actors (including third-party developers, suppliers and users) should be encouraged to join the platforms and build applications and services that run on them. To this aim, legal aspects related to data transfer and data use, as well as implications emerging from data ownership and control and close cooperation with international standardization bodies, should be duly considered to reduce barriers and risks and encourage more users to embrace the data platform model.

5.4 Business Model Recommendations for TRUSTS

TRUSTS core business model is that of a platform-as-a-service (PAAS). Combining both big data and small data processing approaches focuses on the transformation function of data goods and data services, that is, standardizing the data provided by data holders and then making it available to data users (Spiekermann, 2019). To support the wider EU data economy, TRUSTS as a platform is well advised to ultimately offer a wider variety and quantity of data assets, as compared to other (focal) platforms. Thus, access to more data holders is required, which may be addressed through federation. For data holders whose data contains more or less confidential business data, there is no incentive to provide data to TRUSTS if they cannot expect business benefits or other forms of compensation from TRUSTS (Azkan et al., 2020). Data users want a variety of data from multiple sources on the platform.

Also, the platform should be easy to use. Simplified operation and real-time access can reduce the barriers to use and enable customers to create and extract value by utilizing the platform. Data privacy and security are also value propositions that TRUSTS should pay closase attention to. For both data holders and data users, transactions are valuable only when data privacy is guaranteed. TRUSTS can improve upon preceeding and current data markets, addressing identified flaws and loopholes to enhance trust and security in data trading.

Data quality is another key factor that TRUSTS needs to ensure. If the data quality is poor or inconsistent, customers may lose faith in TRUSTS and choose to switch to other platforms. Data transactions in TRUSTS need to be more transparent. For that, TRUSTS needs to connect Clouds and create the infrastructure that allows for open but managed access to distributed resources with both public and private data (Azkan et al., 2020). Data is effectively processed on the TRUSTS platform and shared with multiple companies, thus avoiding repeat data processing for individual companies. For companies, data sharing reinforces open inquiry, encourages the development of various perspectives (Estabrooks & Romyn, 1995). This helps improve their efficiency and, therefore, the digital level of enterprises and their decision-making abilities, especially for start-ups.

There are some important value propositions TRUSTS can offer. For organizations that already have data and the ability to process it, they will obtain the following added value. First, companies can get a more reliable and stable data stream from TRUSTS. Currently, static data no longer meet the growing business expansion needs of digital companies. TRUSTS can provide them with a standardized, long-term data stream (dynamic dataset) to serve as an emergency backup if their data sources become unavailable. Second, they can enrich their data with TRUSTS. Stahl et al. point out that *“When data is merged, matched, or compared to other data, it is enriched, and its value increases.”* (Stahl et al.2015, n.d.). These companies can merge data availed through platforms with their data to expand the dataset or match and validate the two.

Data marketplaces’ emergence is related to the growth of Big Data. Organizations start to acknowledge data as an asset. Businesses are generating more data either internally or collect external data through web scraping and other initiatives. Some of this data is valuable for other companies, too. Data marketplaces enable organizations to monetize the data, as secondary business or possibly to create innovation and new business opportunities.

When offering data to other entities on a data marketplaces, monetization can be in the form of:

- Selling the data or products derived from the data
- Using external data internally to generate value: Adding another dataset to your own business data to create better insights or new workstream

TRUSTS’ business model should incentivize the actors in the data and applications trade value chain in order to subscribe and transact with the platform.

Individuals will monetize their own data by selling it on the platforms. Individuals either set the price for their data and wait for a buyer or accept incentives such as sign-up cash, etc., by TRUSTS. TRUSTS is fully GDPR-compliant, and individuals are sharing their data purposely.

On a B2B level, TRUSTS will collect enterprise meta-data from a multitude of data providers onto the platform. TRUSTS will enable data consumers (other organizations) to access data (e.g., an aggregate of pre-curated information from multiple sources that can be used for marketing, sales, and BI purposes). Larger amounts of datasets are shared, as compared to personal data marketplaces.

It is recommended that the TRUSTS business model reveals the value that a data marketplace could provide to all actors and define the respective business and process environment, thus creating trust. A proficiently concrete commercial approach is required to reassure (potential) users that TRUSTS aims to establish a sustainable business. This will constitute a major advantage over several concurrent datamarket-related projects which mainly explore aspects of the data marketplace concept.

6. Conclusion and Next Actions

6.1 Conclusions

The objective of deliverable D7.1, "Sustainable Business Model for TRUSTS Data Marketplace I," were to:

a. contextualize and position TRUSTS within the unified taxonomy and
b. explore potential TRUSTS, business models.

This deliverable developed four business model taxonomies to achieve this objective, considering TRUSTS' roles as a) a data marketplace, b) a federator, and c) an ecosystem facilitator of data marketplaces. The final and unified taxonomy consists of 11 meta-characteristics, 46 dimensions, and 160 characteristics. The result of the potential TRUSTS positioning is presented in Section **Error! Reference source not found.**. The development of the unified taxonomy has led to the discussion of potential TRUSTS business models in the future. Section 4 presents challenges and opportunities for TRUSTS. The discussion is also structured considering the three roles of TRUSTS.

TRUSTS as a data marketplace needs to deal with challenges clustered in the Service, Technological, Organizational, and Financial (STOF) domains. It can also consider eight business model opportunities presented in Section 4.1, ranging from value propositions that offer a solution focus instead of raw data trading, the needs of strong customer relationships, and the *seeding strategy* for attracting new end users. Considering TRUSTS' role as a federator of data marketplaces, the main challenges related to perceived insufficient value creation and perceived risk & cost should be considered in future business model development efforts. Nevertheless, this role opens seven new business model opportunities to be considered, such as providing a one-stop-shop via a standardized portal, providing commissioned brokerage for data buyers who look for solution-based data assets, and establishing shared services for non-differentiating capabilities (e.g., billing) and others. As an ecosystem facilitator of data marketplaces, TRUSTS needs to reflect on the mentioned challenges, such as lack of shared visions across the ecosystem members, low level of goal congruence among actors in the ecosystem, growing complexities, and others. Nonetheless, these roles open business model opportunities for TRUSTS. In addition to this, business requirements that considering each role are also explicitly mentioned.

6.2 Outlook on the Second Half of the Project

Task 7.1 "Sustainable business models" will continue to work towards the second half of the project phase to develop a business model for TRUSTS. The focus will be on selecting business models based on the insight extracted from this deliverable. The business model will be developed by applying tools for business model innovation as developed in TUD's award-winning platform businessmakeover.eu. The tools will be applied in workshops with project participants and, later on with outside stakeholders to validate hypothesis and to stress test the business models options.

After developing the business models, the evaluation will be done in three ways:

1. by conducting a summative evaluation on the implications of business model choices on critical success factors that measure the viability of the business model;
2. by informing T7.5 on concrete actions and activities needed to realize the business model and testing the feasibility of these actions based on T7.5 findings;
3. by applying TUD’s method business model stress-testing to evaluate the sustainability of the business models in different future scenarios (e.g., different levels of citizen trust in data economy or different levels of regulatory regimes).

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