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Research paper

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Abstract

Our work develops an archetypical representation of current digital business models of Start-Ups in the logistics sector. In order to achieve our goal, we analyze the business models of 125 Start-Ups. We draw our sample from the Start-Up database AngelList and focus on platform-driven businesses. We chose Start-Ups as they often are at the forefront of innovation and thus have a high likelihood of operating digital business models. Following well-established methodological guidelines, we construct a taxonomy of digital business models in multiple iterations. We employ different algorithms for cluster analysis to find and generate clusters based on commonalities between the business models across the dimensions and characteristics of the taxonomy. Ultimately, we use the dominant features of the emerging patterns within the clusters to derive archetypes.

Keywords: Digital Business Model, Logistics, Archetypes, Taxonomy.

1 Introduction

The importance of logistics for economic value creation is steadily increasing, as is the spectrum of competencies and activities bundled in the logistics domain (Akdoğan and Durak, 2016). The primary function of logistics services lies in the planning, organizing, and conduct of the transportation of goods (Hompel and Heidenblut, 2011). Recent industrial and technological development demand the adaption of logistics processes to new challenges set by digitization and initiatives like Industrie 4.0 (Hermann et al., 2016), and to innovate existing as well as to develop new business models (Kagermann et al., 2013). As of yet, there is no structural analysis explicitly examining the anatomy of such digital business models in the logistics domain. Some studies systemize Start-Up business models in the logistics sector (Göpfert and Seeßle, 2017) and provide taxonomies extending classical business models of logistics by some digital elements (Meyer et al., 2018). To the best of our knowledge, there is no formal taxonomy thematizing the structural analysis of such digital business models in the logistics sector.

Our reasoning for pursuing the creation of a taxonomy for digital business models in logistics Start-Ups is manifold. Even though innovation does not exclusively occur in Start-Ups, we chose Start-Ups as our object of observation because they provide ample opportunity for uncovering a relatively novel phenomenon (Criscuolo et al., 2012). Also, contrary to traditional businesses, which may employ multiple business models, Start-Ups are more likely to pursue a single and clearly distinguishable business model (Sabatier et al., 2010). They are not burdened by legacy systems and are a *tabula rasa* for *"purer business models"* (Hartmann et al., 2014, p. 2). However, as Start-Ups face multiple challenges, e.g., lack of

financing, or lack business knowledge and are thus prone to fail early, we cannot make a statement about the success of the business model (Salamzadeh and Kesim, 2015; Hartmann et al., 2016). Secondly, taxonomies assist researchers in unbundling a complex domain of research and facilitating the classification of a broad spectrum of research objects (Nickerson et al., 2013). Thirdly, many authors stress the importance of taxonomies and the lack thereof in the evolutionary path of research on business models (Groth and Nielsen, 2015), as their development has mainly occurred in the offset of business model research (Kamprath and Halecker, 2012). In general, Lambert (2006, p. 2) points to the importance of adequate classification schemes in business model research as *"Business models are abstract, complex concepts of which understanding can be enhanced through the development of a general classification scheme"*. Thus, considering these aspects and the use of taxonomies for business models, we regard the development of a branch-specific taxonomy for logistics as a highly relevant contribution to the emerging and developing field of research of digital business models (Kamprath and Halecker, 2012; Lambert, 2015). Finally, classifying objects and making them distinguishable from one another is foundational in theorizing an emerging and dynamic field like digital business models (Williams et al., 2008). For the reasons above, our first research question reads as follows:

Research Question 1 (RQ1): What are the key dimensions and characteristics of digital business models of Start-Ups in the logistics domain?

Based on a taxonomic analysis of a domain of interest one can derive archetypes. The Oxford dictionary defines an archetype as *"a very typical example of a certain person or thing"* (Oxford Dictionaries). There are various applications of archetypical representation, e.g., in analytical psychology by Jungian archetypes of the collective unconscious (Jung et al., 1981). However, authors in the domain of economics and Information Systems research have adopted the concept and applied it to their respective fields. For example, Remane et al. (2016) derive archetypes of car sharing business models and Schilling et al. (2017) explicitly call for integrating archetype theory in the domain of Information Systems research. Weking et al. (2018) derive archetypes of Industrie 4.0 business models. These archetypes provide basic conceptual representations, from which manifestations derive. Johnson illuminates archetypes as an *"original pattern from which copies are made"* (Johnson, 1994, p. 289). Visualizing the taxonomy in the form of a morphological box produces patterns, of which the central ones build the foundation for archetypes. We consider the derivation of archetypes from taxonomy to be purposeful, as that archetypes *"are a basic human mechanism for organizing, summarizing, and generalizing information about the world"* (Souza et al., 2007, p. 2). Hence, our second research question is the following:

Research Question 2 (RQ2): What are the archetypes of digital business models of Start-Ups in the logistics domain?

The paper is structured as follows. After the hitherto conducted introduction, we will proceed to outline the theoretical background on business model theory and systemizations. Additionally, we investigate the literature for pre-existing important systemizations adjacent to our topic of interest. Section 3 explicates the research design, followed by section 4, which presents the taxonomy. Lastly, we present archetypes derived from statistical analysis and provide conclusions for our work.

2   Theoretical Background

2.1   (Digital) Business Model Theory

The business model terminology emerged in the 1990s parallel to the rise of the internet hype and aimed to explicate a firm's core business logic, i.e., how it creates value for customers and stakeholders while generating revenue (Casadesus-Masanell and Ricart, 2010; Teece, 2010; Zott et al., 2011). As a strategic management tool, the business model fulfills several functions, such as assisting innovation and evaluation of the business logic in Start-Ups as well as long-established organizations (Veit et al., 2014). The heterogeneous application of the concept in diverging domains caused the emergence of a multitude of different definitions in silos (Teece, 2018; DaSilva and Trkman, 2014; Morris et al., 2005). However, Groth and Nielsen (2015) note that reaching a unifying definition, in contrast, to merely accepting multiple definitions might pose a trade-off between effort and benefit. Thus, we act on the premise that the

business model represents the *"blueprint how a company does business"* (Osterwalder et al., 2005, p. 2), i.e., how the business generates, delivers, and captures value (Amit and Zott, 2001). Despite this definitional ambiguity, there is a certain degree of agreement regarding the placement of the business model as a conceptual interface between the high-level business strategy and the operationalized business process model (Al-Debei et al., 2008; Osterwalder, 2004).

Various authors produce conceptual tools for assisting users in designing business models. Examples for this are the Business Model Canvas (Osterwalder, 2004), the Business Model Navigator (Gassmann et al., 2017), or the V^4- Framework (Al-Debei et al., 2008). Some approaches aimed towards designing digital business models, e.g., exist in the literature in the form of methods (Möller et al., 2018; Otto et al., 2015) or tools for innovation (Sathananthan et al., 2017; El Sawy and Pereira, 2013).

The V^4-framework provides a high-level ontological structure consisting of a four-part subdivision of the business model concept, which is as follows (Al-Debei et al., 2008):

- **Value Proposition:** The design or innovation of a business model is impossible *"without first identifying a clear customer value proposition"* (Johnson et al., 2008, p. 61). The value proposition consists of a bundle of products and services which provide value to a customer segment (Chesbrough, 2010).

- **Value Architecture:** The value architecture is the technological and organizational infrastructure used to deliver products and services to customers (Al-Debei and Avison, 2010).

- **Value Network:** The value network includes the totality of actors related to the creation of the value proposition (Hamel, 2002). Also, channels for value mediation as well as roles and network modalities are taken into account (Al-Debei and Avison, 2010).

- **Value Finance:** Value finance provides a dimension considering both stream of revenues as well as the cost structure (Al-Debei et al., 2008).

Table 1 gives an overview of exemplary definitions of digital business models from the literature, which influence our understanding of the terminology. Digital business models are on the one hand new, e.g., in Start-Ups, or emerge from traditional companies within the framework of digital transformation projects (Kutzner et al., 2018). Commonly, the difference between traditional and digital business models is explained as the shift from non-digital value delivery mechanisms to digital ones through ICT-enabled means (Bärenfänger and Otto, 2015; Bock and Wiener, 2017; Haftor, 2015; El Sawy and Pereira, 2013; Veit et al., 2014). Typically, characteristics of digital business models focus on providing digital value offerings, such as digital products (e.g., digital music, applications, software, i.e., everything that can be digitized and reproduced at low marginal cost (Shapiro et al., 1999; Veit et al., 2014)), digital services (e.g., streaming, software services (Bock and Wiener, 2017)), hybrid offerings (Veit et al., 2014) through digital platforms (Bharadwaj et al., 2013; Yoo et al., 2010; Bock and Wiener, 2017; Weill and Woerner, 2013; El Sawy and Pereira, 2013).

Exemplary Definition	Source
"[...] digital business models rely on digital platforms to balance benefits among an ecosystem with multiple organizations and individuals involved (Iansiti and Levien, 2004)"	(Remane et al., 2017, p. 42) based on Iansiti and Levien (2004)
"Digital businesses are those which carry out transactions that are digitally mediated or involve products or services that are experienced digitally (Weill & Woerner, 2013). It is the digitized, non-material nature of such goods and services that gives them the potential for high scalability."	(Zhang et al., 2015, p. 245) extended from Weill and Woerner (2013, p. 71)
"A digital business model has three components: content, customer experience and platform."	(Weill and Woerner, 2013, p. 73)
"A business models is digital if changes in digital technologies trigger fundamental changes in the way business is carried out and revenues are generated."	(Veit et al., 2014, p. 48)

Table 1.   Exemplary definitions of digital business models from the literature.

2.2 Systemizations

Taxonomies enable detailed analysis of a complex phenomenon and give means to create a classification of objects according to *"mutually exclusive and collectively exhaustive characteristics"* (Nickerson et al., 2013, p. 340), which make objects comparable and distinguishable (Bailey, 1994; Gregor, 2006). Classifications are essential to structure, organize and understand a research field (Lambert, 2015). Thus, taxonomies *"structure or organize the body of knowledge that constitutes a field"* (Glass and Vessey, 1995, p. 65). Still, there is ambiguity regarding the definitory demarcation of the termini *typology* and *taxonomy* (Doty and Glick, 1994). The taxonomy refers to imposing characteristics, which both are mutually exclusive and occupied by at least one object (Doty and Glick, 1994; Eickhoff et al., 2017). One of the most famous examples of the taxonomic representation of reality is found in biology, which classifies species according to their characteristic properties (McKelvey, 1978). Even though the terminology is often used synonymously in the scientific literature, one can broadly distinguish between conceptual classification (typologies) and empirical classification (taxonomies). The preparatory work of Lambert (2006) illuminates differences between typologies and taxonomies and lets us classify our work as the latter.

Table 2 gives an overview of existing taxonomies and general systemizations in the literature adjacent to the topic at hand. Göpfert and Seeßle (2017) provide a detailed analysis of Start-Ups in the logistics sector and derive a general alignment of their business models. Their work produced six main categories of Start-Ups in logistics, namely *Storage, Software-provider, Technology, online-platforms, infrastructure provider,* and *cep-service providers*.

Source	Type	Description
(Meyer et al., 2018)	Industry-specific Taxonomy	Taxonomy for business model innovation in the rail freight sector (Logistics/Digital Business Models)
(Remane et al., 2016)	Industry-specific Taxonomy	Taxonomy of Carsharing Business Models (Digital Business Models)
(Remane et al., 2017)	Industry-specific Taxonomy	Taxonomy of mobility sector business models (Digital Business Models)
(Eickhoff et al., 2017)	Industry-specific Taxonomy	Taxonomy of FinTech enterprises (Digital Business Models)
(Bock and Wiener, 2017)	General Taxonomy	Taxonomy of digital business models (Digital Business Models)
(Göpfert and Seeßle, 2017)	Systemization	Summary of systemizations of Start-Ups in the logistics domain and development of novel systematization

Table 2.   Examples of topic-related taxonomies and systemizations.

3   Research Design

3.1   Data Collection

Our means of data collection follows the approach applied by Täuscher and Laudien (2018), who base their method for data collection on Hartmann et al. (2016). We use the Start-Up database *AngelList* to draw a sample of logistics enterprises. *AngelList* is a database for Start-Ups (at the time of this paper: 4,409,254 companies) addressing mainly business angels and job-seekers. Companies can be filtered according to different criteria, e.g., *location, market,* or their *investment stage*. We see using this database as purposeful, as there is a high likelihood for Start-Up business models to be digital and subsequently fit the scope of our study. As per the high number of search results (for "logistics": 2.167, for "Supply Chain Management": 824), we follow the recommendations by Nickerson et al. (2013) and use a randomized subset of logistics enterprises in multiple iterations to generate the taxonomy. In random sampling one proceeds to select each specimen n from a larger body of samples N while securing equal

probability to be drawn (Cochran, 2007). In our case, we used the randomization functionality of *Microsoft Excel* and then proceeded to go through the objects one at a time. The iterative increase of samples ultimately leads to an increase in the reliability of the findings (Lee and Baskerville, 2003). Table 3 gives an overview of the samples used in each iteration of the taxonomy development process.

	N	Source	Sample	Approach
1st iteration	-	(Al-Debei et al., 2008)	-	Conceptual-to-Empirical
2nd iteration	50	AngelList	Random	Empirical-to-Conceptual
3rd iteration	50	AngelList	Random	Empirical-to-Conceptual
4th iteration	25	AngelList	Random	Empirical-to-Conceptual

Table 3.   Overview of iterations, sampling techniques, and the taxonomy building approach.

The selection process of suitable business models is subject to constraints. There needs to be enough available information provided by the enterprise to derive meaningful information (Täuscher and Laudien, 2018). Our sources for information gathering are primary sources, e.g., the website of the firm and secondary sources, e.g., articles. We regard this way of data acquisition as a target-oriented one, as core elements of business models are often communicated transparently by the companies, in that *"gross elements of business models are often quite transparent"* (Teece, 2010, p. 173; Hartmann et al., 2016). Secondly, enterprises need to be active. Our search indicates that there are some enterprises listed that have since gone out of business. Furthermore, the business needs to have the properties of digital business models. We follow Remane et al. (2017) and draw on frameworks that explicitly refer to digital business models and identify digital platforms as a central element of them. For example, the VISOR-framework identifies five central elements, namely the *value proposition, organizing model, interface, service platform,* and *revenue model* (El Sawy and Pereira, 2013). The framework of Weill and Woerner (2013) identifies *content, experience,* and *platform* as central elements to digital business models. Lastly, Bock and Wiener (2017) developed a general and literature-based taxonomy of digital business models and identified digital platforms to be a central dimension. Thus, in our study, we focus on digital business models that employ digital platforms and digitized value offerings, such as digital services (Bock and Wiener, 2017; Weill and Woerner, 2013; El Sawy and Pereira, 2013; Bharadwaj et al., 2013; Venkatraman et al., 2014). Lastly, to ensure relevance for the field of logistics, we only consider business models to be suitable if they are labeled as either *"logistics"* or *"supply chain management"* through *AngelList*. Including both search terms is necessary as there is no clear distinction, especially in the English-speaking world, between logistics (management) and supply chain management (Cooper et al., 1997).

3.2   Taxonomy Development

To generate the taxonomy for digital business models in logistics we follow the well-established guidelines by Nickerson et al. (2013), which have been widely disseminated in high-ranking conference proceedings (Remane et al., 2016; Bock and Wiener, 2017; Hanelt et al., 2015) and journal articles (Oberländer et al., 2018; Tan et al., 2016). The method provides a procedural model (see Figure 1) outlining distinct steps to taxonomy development. Firstly, one is to determine a *meta-characteristic,* which specifies the goal that the taxonomy strives to achieve. Subsequently, all dimensions resulting from either *conceptual-to-empirical* or *empirical-to-conceptual* design need to address the *meta-characteristic*. The first approach focuses on the deduction of dimensions and characteristics while the latter uses induction to derive dimensions and characteristics from empiricism. The next step prescribes the definition of the ending conditions, i.e., the point in time when the taxonomy building process is completed. Nickerson proposes a set of eight objective ending conditions and five subjective ending conditions (see Table 4), which we adopt. Step three marks the defining choice of taxonomy development, as it is either possible to opt for an *empirical-to-conceptual* or vice versa approach. As it is our goal to entangle concepts prevalent in the scientific literature with empirical data our approach starts with *conceptual-to-empirical*

and subsequently continues with *empirical-to-conceptual* for as many iterations as required. As taxonomy design is diachronic, over the time of its development, dimensions, as well as characteristics, may vary before reaching their final state, which fulfills all subjective and objective ending conditions (Bailey, 1994).
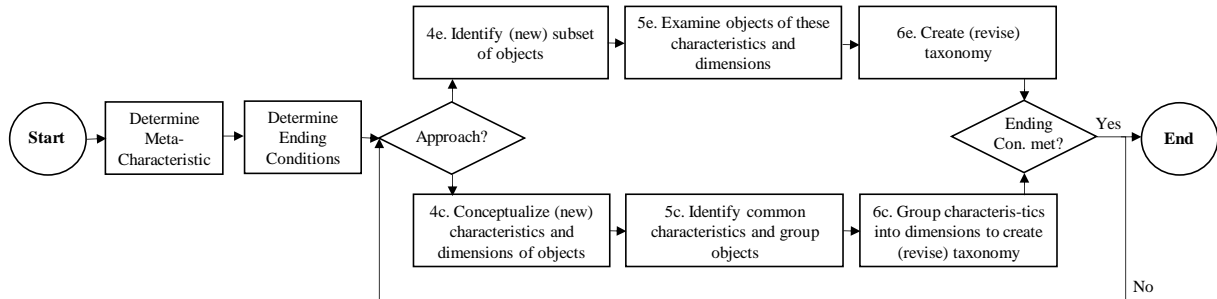

Figure 1.   The procedural model for taxonomy development as proposed by Nickerson et al. (2013).

3.3   Cluster Analysis

We see using cluster analysis to derive archetypes as sensible, as archetypes represent basic patterns, from which copies derive (Johnson, 1994). Correspondingly, *"Cluster analysis is the organization of a collection of patterns (usually represented as a vector of measurements, or a point in a multidimensional space) into clusters based on similarity."* (Jain et al., 1999, p. 265). Therefore, conducting cluster analysis enables us to group business models according to their similarities along the dimensions and the characteristics of the taxonomy. To conduct the cluster analysis, we use the statistical programming language *R*. The functionalities of *R* are fed by developers all over the world contributing software *"packages"* (Gardener, 2012). In particular, we use the package *"cluster"*, which consists of tools and functions for analyzing, clustering, and visualizing data. The *daisy* function (Dissimilarity Matrix Calculation) enables the identification of dissimilarities between datasets in which non-numerical values occur by Gowers coefficient (Maechler et al., 2018; Gower, 1971).

Following prior publications Remane et al. (2016) and Kutzner et al. (2018) we apply the two-step procedure of Punj and Stewart (1983) for performing cluster analyses to the taxonomy. The first step is to conduct agglomerative hierarchical clustering using Ward's method (Ward, 1963). Agglomerative clustering aims to sort objects into clusters based on their similarity. The approach is iterative, as the method analyses each object individually and proceeds to gradually cluster all elements according to their similarities (Domokos and Bálint, 2017). Secondly, we employ the K-means partitioning method, which is popular due to its ease of implementation as well as performance. The K-means method clusters objects based on an *a priori* defined number of partitions (Jain, 2010). Using the elbow method assists in choosing the optimal number of clusters. The elbow method acts under the assumption that above a certain number of clusters there is no more added value created for the data modeling (Bholowalia and Kumar, 2014). Comparing the clustering results enhances the robustness of the clustering solution (Fred and Jain, 2003; Wagner and Wagner, 2007).

4   Taxonomy Design

4.1   Meta-Characteristic

The *meta-characteristic* defines the goal and the purpose of the taxonomy and, in our case, reads as follows: *"Key distinguishing features of digital business models in logistics"*. We chose this citation as it is our goal to inquire into the general mode of conduct of enterprises with prenominally digital business models. However, as per the comprehensive nature of some businesses, we delimit our search to key elements of business models. Additionally, looking for essential business model characteristics not

only enables us to uncover the core business logic but also pays tribute to the establishment of distinctness between the individual objects of observation.

4.2 Meta-Dimensions

As our taxonomy is intended to include as heterogeneous digital business models as freight markets and data platforms, it needs to be general by design to cover the span of the observation frame (Hanelt et al., 2015; Glass and Vessey, 1995). Therefore, we chose to pursue a general approach rather than a specific one. As per the general nature of the framework, we see the V^4- Framework (see Section 2.1) as suitable for acting as meta-dimensions for our study. Additionally, the V^4- Framework has already been employed in the taxonomic analysis of digital business models (Bock and Wiener, 2017). Secondly, other frameworks such as El Sawy and Pereira (2013)'s VISOR-framework seem to be much better suited for specific taxonomies as shown in publications such as a Remane et al. (2017) and Remane et al. (2016).

4.3 Dimensions

We analyzed the sub-sample according to branch-specific characteristics of digital business models. Meaning, that we analyze and code the characteristics from the viewpoint of digital business models in logistics (Kamprath and Halecker, 2012). Figure 2 depicts the evolution of the dimensions employed in our study. The taxonomy took four iterations to reach its final dimensions. As explained above, the first iteration provides a general frame of reference to act as a conceptual starting point for our study. Thus, the first iteration provides conceptual meta-dimensions stemming from the literature (deduction). Subsequent iterations follow the *empirical-to-conceptual* approach (induction) (Nickerson et al., 2013). Each iteration produced some change to the existing make-up of the dimensions, thus failing to fulfill the ending conditions and justifying a subsequent iteration.
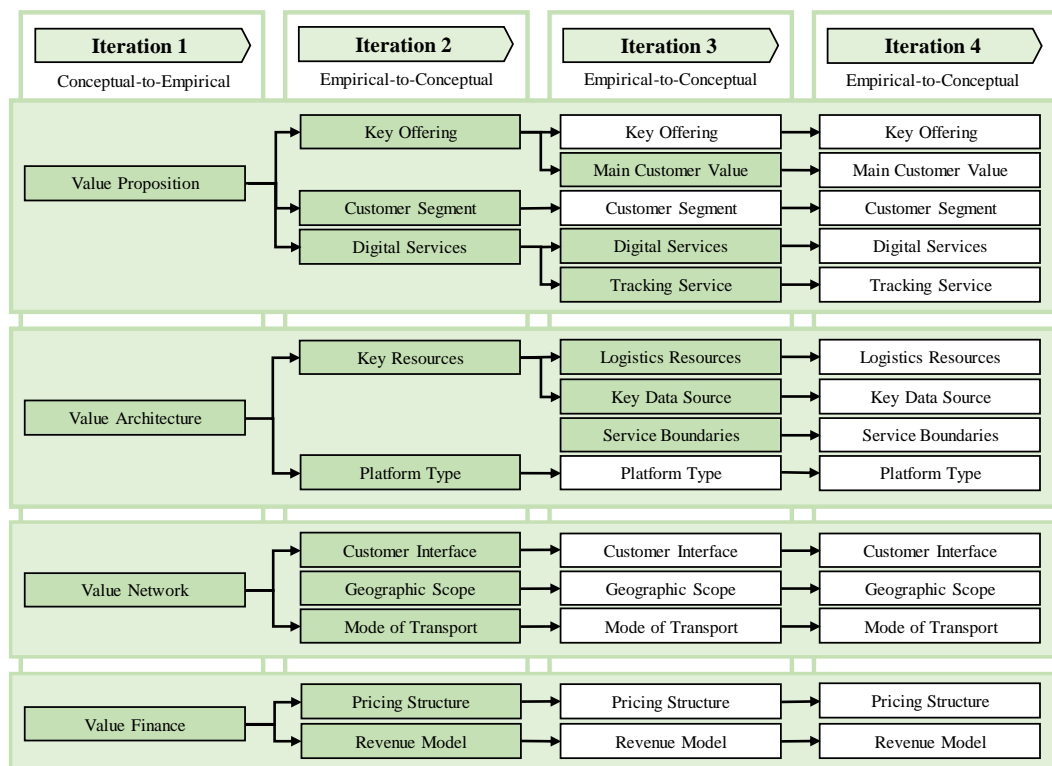

Figure 2.   Overview of the four iterations required to design the dimensions of the taxonomy.

Table 4 depicts the ending conditions consisting of eight objective and five subjective ending conditions. During the development cycle, we undertook several decompositions of dimensions. For example, it

became clear that offering tracking services are fundamental across all samples. Thus, we split the dimension of *digital services* into *tracking services* and *digital services* to account for different characteristics of tracking services. *Digital services* subsume all other digitally provided services, such as descriptive or predictive analytics.

	Ending Conditions	#1	#2	#3	#4
Objective	All objects or a representative amount of objects have been examined	-	-	√	√
	No object was merged with a similar object or split into multiple objects in the last iteration	-	-	-	√
	At least one object is classified under every characteristic of every dimension	-	√	√	√
	No new dimensions or characteristics were added in the last iteration	-	-	-	√
	No dimensions or characteristics were merged or split in the last iteration	-	-	-	√
	Every dimension is unique and not repeated	-	-	√	√
	Every characteristic is unique within its dimension	-	-	√	√
	Each cell (combination of characteristics) is unique and is not repeated	-	-	√	√
Subjective	**Concise:** Is the taxonomy meaningful without being overwhelming?	-	-	√	√
	Robust: Do the dimensions/characteristics provide for differentiation?	-	-	√	√
	Comprehensive: Can all objects or a random sample be classified?	-	-	-	√
	Extendible: Can a new dimension/characteristic simply be added?	-	-	√	√
	Explanatory: What do the dimensions/characteristics explain?	-	-	√	√

Table 4.   The ending conditions for each development iteration (Nickerson et al., 2013).

4.4 Final Taxonomy

In this section, we present the final taxonomy consisting of fourteen dimensions and corresponding characteristics (see Table 5) structured according to the corresponding meta-dimensions. We chose to visualize the taxonomy as a morphological box as it grants intuitive insight into the structure, i.e., the shape of the exemplified objects (Ritchey, 2006). We have removed the categories *"unknown"* and *"unspecified"*, as these are relevant methodologically but hinder clarity and usability of the taxonomy.

4.4.1 Value Proposition

What type of **(1) Key Offering** does the business offer? Our findings indicate a focus on either *transportation services, warehousing services, data services*, *management software,* or *technology*.

What is the **(2) Main Customer Value** that the customer receives from the product or service (Woodruff, 1997)? Due to their similarity, we adopt the characteristics *matching/intermediation* and *unification/convenience* from Eickhoff et al. (2017). *Matching/intermediation* refers to the act of bringing two parties together, either through providing the necessary infrastructure in the form of marketplaces or direct intermediation. *Unification/convenience* provides a significant reduction of complexity for customers and allows them to focus on their core activities. *Optimization* refers to customers receiving, e.g., reduction of cost, savings of time or resources. Lastly, visibility gives customers knowledge of logistics and SCM processes (Zrenner et al., 2017). Some enterprises focus on giving customers the means to *compare & book* services based on a multitude of offers.

As per the heterogeneous nature of targeted **(3) Customer Segments**, sensible inclusion into the taxonomy requires abstraction. Therefore, we propose a threefold classification explicating the nature of a business's customer segments based on platform-literature. In that, scholars distinguish *single-sided* (Yablonsky, 2018), *two-sided* (King, 2013; Rochet and Tirole, 2003), and *multi-sided* customer structures in platforms (Staykova and Damsgaard, 2015).

Partly following the taxonomy of (Bock and Wiener, 2017) we make the threefold distinction between business providing **(4) Digital Services** *focally*, *complementary,* or in combination with a *physical component*. Enterprises focussing on digital services do not offer a physical product (Williams et al., 2008).

Each business, at least, provides *complementary* digital services, e.g., analytic dashboards, predictive analytics, management functionalities. Lastly, some digital services, such as the aggregation temperature data require a physical component equipped with sensors.

(5) Tracking Services: Our sample reveals that offering tracking services of transports or inventory is a dominant characteristic spread across most enterprises. We undertake the distinction between *real-time*, *event-based, none,* and *unspecified.* The last characteristic emerged, as it was not possible to explicitly make the distinction between *real-time* and *event-based* for all specimen of the sample.

4.4.2   Value Architecture

(1) Logistics Resources refer to resources required to provide logistics services. Under this category fall, e.g., transport vehicles, warehouses, or storage units. We distinguish four characteristics, namely *None, Exclusive Orchestration, Network,* and *Control. None* includes business models in which the business does not directly interact with any logistics resource. For example, most data services fall under that characteristic. *Exclusive orchestration* subsumes most digital marketplaces, which provide brokerage for logistics services between suppliers and demanders (Van Alstyne et al., 2016), but do not own any transport vehicles themselves. *Resource control* refers to the partial or total possession of the required logistics resources (Wang, 2015).

To conceptualize the **(2) Service Boundaries,** we draw from logistics theory. Firstly, we take the intra-logistic view on internal processes of logistic processes happening in-house (Burduk et al., 2018). Secondly, we consider the interlogistics point of view is covering logistics processes between companies, i.e., *intercompany* logistics processes.

(3) Key Data Source stems from the taxonomy of Hartmann et al. (2016) and differentiates into the characteristics *tracked & generated*, *customer*, and *free/external* for possible critical sources of data.

Incumbent to all analyzed samples is the utilization of some **(4) Platform Type**. We draw the concept *transaction platform* from Evans and Gawer (2016), which describes platforms mediating transaction between one or more parties. We divide the *transaction platform* into the *digital marketplace* and the *booking platform*. The *digital marketplace* provides infrastructure for the supply-side of service and the corresponding demand-side (Buyya et al., 2009), e.g., to counteract capacity bottlenecks (Bierwirth et al., 2002). The booking platform gives customers the means to choose from a variety of offers and book the service in-platform (Bierwirth et al., 2002). Software-as-a-Service (SaaS) means the provision of software products via the internet in return for a user fee defined regarding time and money (Buxmann et al., 2008). As SaaS applications run in private or public cloud infrastructures we, in line with the dimension, use the terminology *SaaS Platform* (Di Martino et al., 2014; Cusumano, 2010). Lastly, to conceptualize platform providing digital services, i.e., analytics, we adopt the terminology *Digital Service Platform* as an intermediary and modular component composed of resources, capabilities, and digital services (Göbel and Cronholm, 2016). A more detailed conceptualization of the digital service platform requires a too broad and specific granularity, which in the context of the development of a general taxonomy is contrary to the condition of conciseness.

4.4.3   Value Network

(1) Customer Interfaces describe the mode of interaction the customer uses to interface with the service or product. We distinguish between distinctively web-based solutions, including those business models, which contain pure web-based services without particular references to a mobile application. Secondly, we subsume all enterprises providing software or mobile applications as *App-based* (Täuscher and Laudien, 2018).

The **(2) Mode of Transport** refers to the specific vehicle, such as *trucks* or *ships. Multimodal* logistics services use two or more transport modes (International Transport Forum, 2009). Some enterprises, which provide purely digital services are independent of the specific transport mode. Thus, we adapted the characteristic *multimodal* to *multimodal/independent*. Vehicles which only occur in a little sample, or are specific, such as mini-vans, arrange themselves under the characteristic *other*.

The **Geographic Scope (3)** restricts the service geographically. We adopt the threefold classification of *regional, local,* and *global,* also used in other taxonomies, e.g., from Täuscher and Laudien (2018). We adapt the characteristic *global* to *global/independent* to include enterprises independent of specific geographic boundaries.

4.4.4   Value Finance

The **(1) Pricing Mechanism** determines how the final price paid by the customer comes together. Our sample reveals that three pricing mechanisms are dominant, i.e., *demand-based*, *feature-based*, and *price-based*. The price depends on the demand, e.g., determined by the frequency of use, the achieved price and a percentage commission to be paid on it or the selected features.

The **(2) Revenue Model** refers to the specific pattern of revenue generation, i.e., it explains how the business makes money. Commonly, marketplaces charge a commission for each mediation. Other revenue models include *subscription plans, service fees, freemium,* or *pay-per-use.*

Dimension		Characteristics				
Value Proposition	Key Offering	Transport	Data Services	Warehousing	Management Software	Technology
	Main Customer Value	Optimization	Visibility	Unification/Convenience	Matching/Intermediation	Comparison/Booking
	Tracking Services*	Event-Based		Real-Time		None
	Customer Segments	Single-Sided		Two-Sided		Multi-Sided
	Digital Services	Focus		Complementary		With physical component
Value Architecture	Logistics Resources	None	Orchestration		Control	Network
	Platform Type	Digital Service Platform	Digital Marketplace		SaaS-Platform	Booking Platform
	Service Boundaries	Intracompany		Intercompany		Overarching
	Key Data Source	Tracked & Generated		Customer	External	Multiple
Value Network	Customer Interface	Web-Based		App-Based		Both
	Mode of Transport	Truck	Ship	Multimodal/Independent	None	Other
	Geographic Scope	Local		Regional		Global/Independent
Value Finance	Pricing Mechanism*	Price-Based		Demand-Based		Feature-Based
	Key Revenue Model*	Commission	Subscription Plans	Customized	Fees	Freemium	Pay-per-Use

*Table 5.   Final taxonomy visualized as a morphological box with the three examples Import-Genius (Blue), Cargomatic (Red), and OnFleet (Green). *For a better presentation we have removed the characteristics "unknown" and "unspecified".*

5 Archetypes

As per the high amount of unknown revenue models (50.4%) and pricing structures (56%), we decided to leave these dimensions out of the cluster analysis. Their influences too actively tarnish the clustering results by a seemingly not useful characteristic *unknown*. Therefore, the data basis of all clusters is based on the similarities of the remaining features of each object.

In line with our research design, we use cluster analysis (see Section 3) as the foundation for archetypes. Firstly, using the elbow method suggests that the optimal number of clusters is between five and seven. We proceed to both apply hierarchical clustering using Ward's method, as well as the K-means algorithm in *R*. To identify the partitioning results with the most comprehensive insight, we vary the parameters between five to seven partitions and compare the results based on similarities between the patterns of individual objects across the dimensions and characteristics of the taxonomy. We chose the following methods to adequately asses the validity of the clustering result:

- Manual check for meaningfulness and subsequent coding of the clusters (Rousseeuw, 1987)

- Compare clustering results using different algorithms (Fred and Jain, 2003; Wagner and Wagner, 2007). In our case, hierarchical clustering and K-means results (Remane et al., 2016; Punj and Stewart, 1983) Also, identify and remove outliers (Punj and Stewart, 1983). The result of the cluster comparison is documented in Table 5 under the label *consistency*. The measure describes the congruence of both clusters with the value of K-means as the underlying base value.

- Using the average silhouette width to establish cluster validity for K-means. This procedure calculates the average silhouette width length and produces a measure for evaluating cluster validity. Strong cluster structures have high average silhouette widths, with the maximum numerical value being 1.00 (proper clustering) and the lowest -1.00 (incorrect clustering) (Rousseeuw, 1987).

We compared each clustering outcome with the dataset and found consensus for maximal explanatory insight into possible archetypes for k = 5 clusters. The results between hierarchical clustering and K-means proved to be comparable, indicating five potential archetypes.
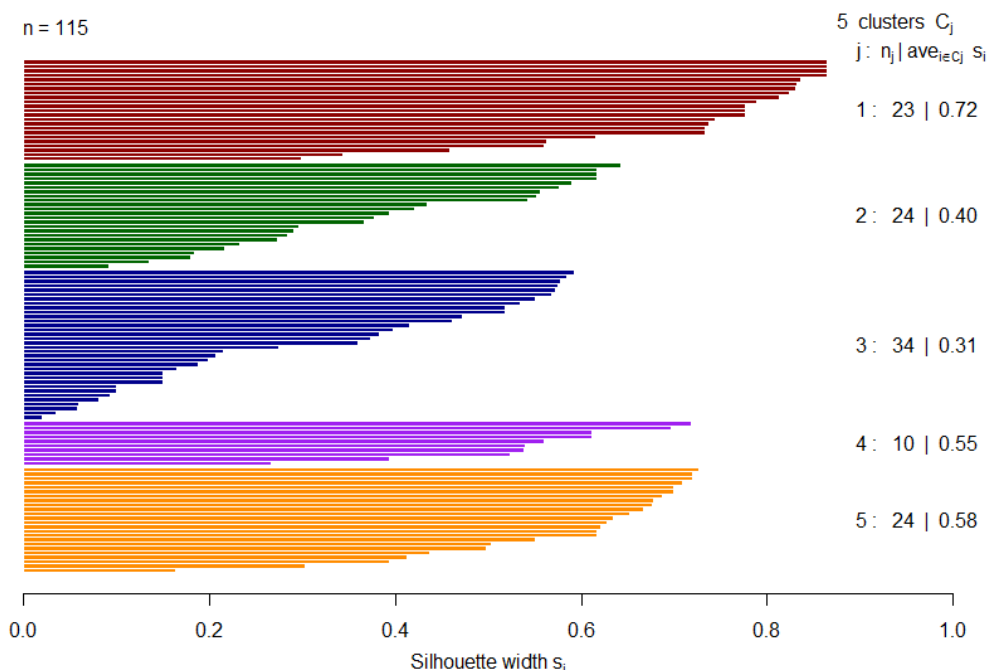

Figure 3.   Silhouette plot of K-means partitioning for k=5. Average silhouette width = 0.49. The red, purple, and orange average silhouette value indicate a very strong cluster structure. Green and blue indicate a strong cluster structure. Through iterative analysis of the clustering results, we removed ten outliers from the initial sample.

To evaluate the structural strength of each cluster, we investigated the silhouette width. Our first iteration of a sample of n = 125 produced ten distinct outliers with negative silhouette width values. Through analysis of the data set, we identified the outliers as exotic, comparable to the complete dataset. For example, outliers include providers of blockchain infrastructure, i.e., technology providers. However, as their number was so small and their particular composition so unique compared to the others, they are marked as outliers. As it is our goal to find archetypes as basic and representational patterns, we excluded these outliers in our further analysis. We argue, that while relevant, to be suitable for archetype derivation, there also needs to be enough quantitative representation to constitute a measurable statistical cluster. Figure 3 shows the silhouette plot without the ten outliers for the remaining sample of n = 115. We interpret the average silhouette width for clusters one, five, and four as reliable indicators for valid clusters, as per their high positive value. Clusters 2 and 3, while lower in value, still are positive and thus classifiable as valid. Table 6 gives a summary of the archetypes developed, a brief description and the degree of congruence of the underlying clusters.

#	Archetype	Description	Examples	Consistency
1	Digital Transport Marketplace for regional trucking services	Provider of digital marketplaces as infrastructure for mediating suppliers and demanders of transportation services. Using customer provided data to mediate jobs. Provide real-time tracking of delivery and complementary digital services in the shape of analytics, ratings, and dashboards. Mainly brokerage of intercompany regional truck transport services.	GoLorry, Cargonexx, Cargomatic, CargoBr, Convoy	91%
2	Digitally supported global and regional fulfillment and forwarding services	Provision of unifying, mostly globally and multi-modal acting transportation services using either own resources or access to a logistics network. Interaction with the customer through the web or app-based booking platforms or Digital Service Platforms. Complimentary digital services based on customer provided data.	Boxton, Coureon, Flexport, Parcelbright, AirLift, Shadowfax	87%
3	Optimization and Visibility Data Services	Provider of data services focusing on establishing supply chain visibility and route optimization and additional complementary digital services. Based on tracked & generated data processed and offered through Digital Service Platforms or SaaS Platforms. Independent of transport modality and geographic scope.	TruckMap, ClearMetal, CigoTracker, LogiNext	91%
4	Digitally supported warehouse service providers	Provider of warehousing services through either web-based mediation via digital marketplaces or booking platforms. Predominantly orchestration of external resources. Complimentary digital services, i.e., analytics, dashboards or inventory tracking services based on customer provided data.	AiHello, Flexe, Spacer, Stord, StowGa, Ware2Go	90%
5	Software-as-a-Service providers for the management of logistics processes	Provider of fleet and inventory management software via SaaS-platforms for process optimization and tracking. Using multiple data sources, e.g., customer data or tracked & generated data. Independent of the global scope and transportation mode.	OnFleet, QuikMile, Convey, GoComet, Transcount	96%

Table 6.   Summary of the developed archetypes of digital business models in logistics based on cluster analysis and manual coding. The consistency represents the congruence between clusters generated with k-means and hierarchical clustering using k-means as the base value.

6 Discussion

Our research produced archetypes for digital business models derived from a taxonomic analysis of a sample of Start-Ups drawn from *AngelList*. The design of the taxonomy in Section 4 addresses **RQ1** and the derivation archetypes in Section 5 addresses **RQ2**.

Our taxonomy is subject to **limitations**. First and foremost, each taxonomy building process requires the subjective definition of a meta-characteristic. Other researchers might find a different meta-characteristic more suitable for their respective needs. Also, regarding choosing dimensions, one may vary the scope of observation drastically, e.g., going into more detail or abstracting even further. Secondly, as per the nature of generating characteristics and dimensions through coding, the results are naturally prone to personal influences and preferences. Third, our data collection focuses on Start-Ups. We argue that these companies prove to have a high probability of being digital businesses even though we acknowledge that this particular approach excludes traditional enterprises setting up digital business models. Thus, our contribution requires, at some point, extension into additional databases to get a holistic understanding of digital business models of companies across the entire spectrum of organization types. Innovative technologies such as drones or blockchain infrastructures were represented, but could not be taken into account due to, for example, too little available information on the specific business models. That can be explained by the lack of quantitative availability of such providers and the maturity of the technologies.

Our research provides several contributions. The **scientific contribution** lies in the structural analysis of patterns of digital business models in logistics through the derivation of archetypes. We argue that due to the abstract and generalized nature of archetypes we provide ample contribution to the scientific body of knowledge on digital business models. We can track this contribution by viewing the evolutionary path of business model research and the importance of taxonomy building within (Osterwalder et al., 2005). Our archetypes partly correspond with the systemization provided by Göpfert and Seeßle (2017), yet provide more in-depth insight into the structural composition, i.e., dimensions and characteristics, of each business model. Our findings give fertile soil for further research. As already mentioned in the limitations section, there is room for additional research covering broader databases, as the work predominantly focuses on Start-Up enterprises. Furthermore, as our taxonomy is general by design, one can use the findings to investigate each archetype further. It provides an umbrella of archetypes for our sample, which, naturally, means that it only scratches the surface. In that, our work greatly contributes to develop the field of digital business models in logistics and acts as a starting point for several future research opportunities. One can argue that each archetypical business model merits the creation of a respective specific taxonomic analysis and the derivation of lower-threshold archetypes. Furthermore, as our work is restricted to providing a snapshot of the archetypes in time, continuing this work in the framework of longitudinal study would be viable to gain knowledge on the success and failure of the business models. Lastly, gathering input from practitioners through case studies or surveys support the validation of our findings.

Regarding **managerial implications**, we argue that conceptual contributions such as taxonomies may assist practitioners, at the very least, to gain awareness and insights about the emerging field of digital business models in general. More specifically for the logistics domain, it enables practitioners in the crystallization of logistic-specific digital business models for which archetypes may act as guides. From that, practitioners may derive where to position themselves in the ever more digitally driven logistics domain. Our work provides practitioners from traditional enterprises with an up-to-date snapshot of innovative developments from Start-Ups at a glance. In addition to reflecting one's business model, the taxonomy and the archetypes assist the design of such digital business models, detached from the respective company situation.

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