

Comparing Digital Platform Types in the Platform Economy

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Abstract. In the domain of the platform economy we identified two gaps in the current literature. First the lack of a shared conceptualization of digital platform types. We solve this issue with a taxonomy giving an overview of digital platform attributes, with attribute values expressing the possible variations between platforms depending on their type. These attributes and attribute values are then used in the typology giving a clear overview of all the digital platform types and how they are related to each other. The second gap is the lack of knowledge concerning the software functionalities of digital platforms. We contribute to this with a proposal of a reference ontology allowing for a better communication between developers and other stakeholders. Our envisioned ontology can be used as a common language that all platform stakeholders can understand to facilitate future research and support ontology-driven development of digital platforms.

Keywords: Digital Platform, Ontology Model, UFO, Taxonomy

1 Introduction

The platform economy is a broad term that encompasses a growing number of digitally enabled activities in business, politics, and social interaction facilitated by digital platforms [1]. This platform economy, including platforms like Airbnb, eBay, Etsy, Ticketswap, Tinder, Dropbox and Uber, is defined very broadly and overlaps with other phenomena; ‘sharing economy’, ‘collaborative economy’, ‘gig economy’, ‘on-demand economy’, ‘collaborative commons’, ‘peer-to peer economy’, ‘access economy’, ‘the mesh’, ... [2]. On these markets a wide range of services are exchanged by both human and organizational actors, in sectors such as travel, car rental, finance, staffing, information, music and video streaming, that were previously provided uniquely by firms [3, 4]. Problematic for academic studies is that the types of digital platform used in these markets, including ‘sharing economy platform’, ‘digital marketplace’, ‘on-demand platform’ and ‘multi-sided platform’, are umbrella concepts or ‘buzz words’ getting a lot of attention in both academic and professional communities but without consensus on what they comprise [3, 5–10]. These platform types have a lot in common,

but also have substantial differences in functionalities offered and the type of business model that is supported, resulting in different information system structures.

This lack of agreement has made it difficult for scholars to determine the impact that the digital platforms have for the economy as well as for society at large. It remains difficult to compare different studies and their results since each of them conceptualizes the markets and their platforms differently [11]. Clearer definitions of the used digital platform types can improve communication, guide future research and produce useful contributions and recommendations for practitioners who are keen on learning more about the opportunities that digitalization brings for fostering the sharing economy [11, 12].

Furthermore, the literature of these digital platform types offers a very partial view with a relatively small number of papers focusing on the functionality of the software enabling digital platforms of different types. It is observed “that perspectives on technology are currently lacking in the research on the sharing economy” [7] as “few research works have been done from the perspective of information technologies” [13]. Although there has been some interest in the discipline of Information Systems to create a knowledge base for developing platforms that realize goods and service access for sharing [13], there is a lack of knowledge regarding the requirements and design of the different types of digital platforms. Providing an overview of the various distinctions in the digital platform types is not only important from an academic perspective but also for regulation and policy, as a 'one size fits all' policy and regulatory approach is inappropriate [14].

This paper contributes to filling both gaps regarding the state-of-the-art in the research on digital platforms. We do so by creating two artefacts and proposing a third one. First, we contribute to the lack of shared conceptualization by creating a taxonomy and a typology for digital platforms. The taxonomy gives an overview of digital platform attributes, with attribute values expressing the possible variations between digital platforms depending on their type. These attributes and attribute values are then used in the typology giving a clear overview of all the digital platform types and how these types are related. Second, the lack of knowledge concerning the software functionalities of each type is tackled with both the taxonomy and a first module of a reference ontology. The envisioned reference ontology describes the general functionality of any digital platform and the more specific functionality of each digital platform type in relation to its attribute values as defined in the taxonomy. The reference ontology thus describes the functionality of the distinct digital platform types by referring to typical digital platform concepts including ‘listing’, ‘transaction’, ‘subscription’, ‘peer’, ‘matching’ and ‘access-based’, allowing for a better communication between developers and other stakeholders. Further, a digital platform reference ontology can support ontology-driven development of platforms, hence capitalizing on a design knowledge base of the software functionalities for different types of platforms. Summarizing, the reference ontology is envisioned as a common language that all platform stakeholders (including software engineers, entrepreneurs, managers, economists, governments and social scientists) can use to facilitate future research and development of digital platforms.

This paper is structured as follows; In section 2 we explain our methodology. In section 3 we present our taxonomy. In section 4 we propose the typology. In section 5

we discuss the first module of the ontology and provide a link to the other modules which are work in progress. In section 6 we discuss these artifacts and in section 7 we present our conclusion.

2 Methodology

We develop three related artefacts that contribute to addressing the previously observed gaps in digital platform research:

1. A taxonomy including a set of digital platform attributes and their possible values to differentiate between the main digital platform types;
2. A typology to have a complete overview of the digital platform types and how they are related to each other depending on their attribute values;
3. A reference ontology describing the required software functionality of the digital platform types in relation to their attribute values defined in the taxonomy.

Our research methodology for building and evaluating these artefacts is shown in Figure 1 and explained below.

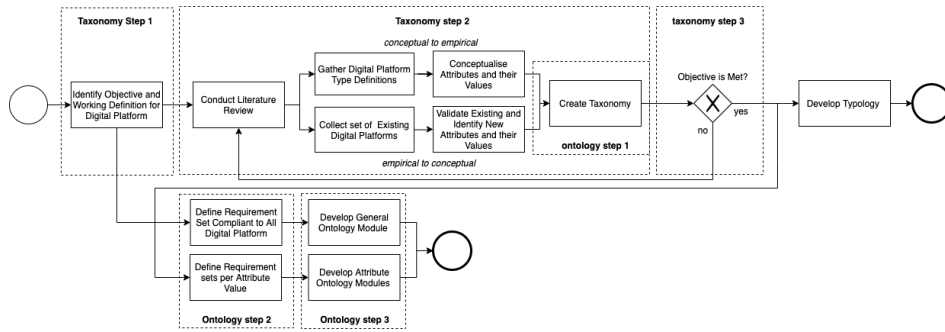


Fig. 1. Methodology

First, to create the digital platform taxonomy, we use the method for taxonomy development and its application in Information Systems research of [15]. This method was used by [16] to create a taxonomy for P2P sharing and collaborative consumption and by [17] to create a Crowdfunding taxonomy. Compared to these taxonomies, our taxonomy has a broader scope by including a wider range of digital platform types. The method of [15] includes three steps:

1. Identify the objective: As stated in the introduction, our digital platform taxonomy should be able to differentiate between the main digital platform types in our scope. To define the scope of our research we construct a working definition for digital platform.
2. Taxonomy development: The taxonomy development step is done in an iterative manner for which we alternately use the ‘conceptual to empirical’ and ‘empirical to conceptual’ approach, starting in the first iteration with the former.

- a. For the ‘conceptual to empirical’ approach, we gather digital platform types in line with our working definition. This is done by a literature search of secondary sources (literature reviews) on digital platform type. As these literature reviews include a lot of contradictive definitions for these types, we use convenience sampling to gather platform types and their definitions that are most used and widely accepted by the academic community, but are still easy to understand and compare. When the digital platform types are gathered, we compare their definitions to conceptualize the attributes and their values that enables us to differentiate between them.
 - b. For the ‘empirical to conceptual’ approach, we collect a set of existing digital platforms used in the primary sources of the literature reviews found using the previous approach. This way the objects of this set can be directly linked to their digital platform types. As these primary sources mention and use a very large number of objects, we compose the set using a purposive sampling method called Maximum Variation Sampling [18] to eventually collect a rather small but diverse enough sample that covers all types discussed in the selected literature reviews. The attributes and attribute values that were conceptualized in the ‘conceptual to empirical’ approach, are then validated using the composed set of existing digital platforms. Doing so, the emergent taxonomy is compared systematically with evidence from each object, following [5]. If needed, a new iteration is started to add new attributes and their values (i.e., when we find in our sample existing digital platforms that cannot be characterised by the currently conceptualized attributes and attribute values).
3. Evaluation: Only when the taxonomy satisfies our objective, the taxonomy development is terminated. To reach our objective, we verify that every digital platform type collected in step two had a unique combination of empirically validated attribute values (i.e., at least one existing digital platform with those attribute values is found), implying that the taxonomy allows to define a set of unique and inter-related digital platform types that all have real-life instances.

A second artefact is the typology. A typology is an organized system of types that can be used for forming concepts and sorting cases [14]. To create the typology we follow the multi-level modelling theory of [19] and use UML as a notation to describe the types as super and subclasses of each other. Every digital platform type captures the common features of existing digital platforms that are instances of the type. For example, both Airbnb and Uber intermediate P2P services between their users. The attributes and attribute values are then used to highlight the differences between the types. As each type has a unique combination of attribute values, we can differentiate between each type in our typology. To conclude, the typology provides a complete overview of how the digital platform types, including sharing economy platform, digital marketplace and on-demand platform, are related to each other in relation to their attribute values.

The third artefact is the creation of a digital platform reference ontology. Ontology modelling is a special type of conceptual modelling [20] that is used as a basis for the engineering and evaluation of information systems [19]. Ontology modelling also helps

in the common understanding of a domain by making the domain assumptions explicit [21] and by providing a clear account of domain concepts to foster communication, consensus and alignment [22]. Our approach to ontology modelling follows the patterns of the Unified Foundational Ontology (UFO), a high-level ontology that provides us with basic concepts for objects, events, social elements and relations [20]. We create the digital platform reference ontology by combining the reference ontology engineering approaches proposed by [23] and [24] consisting of three steps. In step one, we split the digital platform domain into modules. This step is already accomplished during the taxonomy creation, when we conceptualized distinctive digital platform attributes and attribute values. In step two, we define the requirements for the platform software to provide the features that are expressed by the attribute values that are conceptualized in the taxonomy. We also define a set of general requirements relevant to all digital platforms, based on the working definition of a digital platform that is developed in the first step of the taxonomy development. These general requirements are independent of the type of digital platform. A digital platform that is an instance of a certain digital platform type, has to fulfill the set of general requirements and the sets of specific requirements for the attribute values that define the type. Elaborating on the design of the requirements per attribute value doesn't fit the scope of this paper, hence we provide a link towards work in progress on these requirements, and focus instead in this paper on the general requirements. Finally, in a third step, the ontology is described using OntoUML [25], a UFO-based ontology-driven conceptual modelling language capable of representing objects, events and social entities. In this paper, given the focus on the general requirements, one general ontology module is presented that holds for all digital platforms, regardless their type. The link also guides the reader to work in progress where ontology modules are defined for the specific requirements that cover the unique attribute values. The ontology of a certain digital platform is thus composed of the general ontology module and of all ontology modules for the attribute values that characterize the type of the digital platform.

3 Taxonomy

Due to the dispersal of digital platform research across a number of fields, there is a miscellany of perspectives concerning a digital platform. To reach our objective, a clear working definition of a digital platform independent of their type is needed. For example the term 'sharing economy platform' or 'digital marketplace' is used alternately as the algorithm, the abstract term 'platform', the technology [7], the company owning the algorithm [26], a business model [27] or (part of) an intermediary service [28, 29]. This conceptual confusion makes academic decision-making difficult, and makes decisions difficult to communicate [12]. As we wish to cover a wide range of digital platform types, we relate a platform to the broader concept of service economy, and therefore follow [1, 10, 28, 29] in defining a digital platform as 'a service offering by the digital platform management to the users. The primary action offered are interactions between users and these interactions are enabled by a software'. This definition is very broad, as these interactions can consist solely of information transfer (e.g. WhatsApp, Tinder)

but can also include offerings of products (e.g. eBay) and/or services (e.g. Airbnb). It is required that the interactions are the primary actions offered by the platform, and not secondary actions such as product reviews on regular B2C e-commerce sites and apps.

Now that the working definition is formulated, we start the digital platform taxonomy development. After numerous runs of the ‘conceptual to empirical’ approach, we ended up with six literature reviews [2, 3, 7, 8, 14, 30]. Out of these literature reviews and their primary sources, eventually nine digital platform types were collected: Multi-Sided (including two-sided) platform by Hagiu and Wright [6]; transaction platform by Acquier et al. [9]; investment platform by Evans and Gawer [10]; crowdfunding platform by Haas et al. [17]; digital marketplace by Täuscher and Laudien [27]; Peer-to-Peer (P2P) sharing and collaborative consumption platform by Chasin et al. [16]; sharing economy platform by Frenken and Schor [31]; on-demand platform by Mamonova [32]; and second-hand P2P platform by Acquier et al. [9]. The definitions of these nine types were compared to each other and their differences were conceptualized by defining digital platform attributes and their values.

During the ‘empirical to conceptual’ approach iterations, we collected information on existing digital platforms for the types identified by the previous ‘conceptual to empirical’ approach iterations. For each digital platform that was selected, we collected data based on sources such as the official website, blogs and industry magazines, following the approach of [5]. The attributes and their values for the types that were identified, were validated and if needed adjusted based on the information of the real instances selected for these types. The total sample of digital platforms investigated is given in following link¹.

The taxonomy itself is given in table 1. Market sides [6] indicates the number of different groups of platform users in the market that are connected. Although it is not allowed by the method of [15], for practical reasons and in alignment with our sample we decided to make the following three attributes inclusiveⁱ, meaning a platform can have more than one attribute value for the same attribute; Affiliation [8] refers to different ways that users (per group) can be connected to the platform. Because this attribute is inclusive, our taxonomy allows users to be connected to the platform by multiple affiliation options. Centralization [7, 33] depends on the way the users can connect to each other. This can be via a decentralized search by the users of one side, or a centralized, automated matching by the platform software. The following two attributes are only applicable if the platform has multiple sides^{ms}; Participation [27, 34] indicates if the market that is intermediated by the platform is Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Consumer (C2C) or Peer-to-Peer (P2P); the latter case holds when platform participants are considered as ‘equals’, where C2C is a specialization of P2P when users of at least two sides are only allowed to be private persons. The offering orientation [35] differentiates between product selling, result-oriented services or user-oriented when it’s a combination of the previous two. The last two attributes are only relevant for user-oriented offerings^{uo}. A digital platform offers immediate access [36, 37] if access to the product is possible when the customer needs it. Under-utilized [31] indicates that the product is offered because of excess capacity.

¹ <http://model-a-platform.com/sample-of-existing-digital-platforms/>

Table 1. Digital Platform Taxonomy

Attribute	Values			
<i>Market sides</i>	One-sided		Multi-sided	
<i>Affiliationⁱ</i>	Registration	Subscription	Transaction	Investment
<i>Centralizationⁱ</i>	Decentralized		Centralized	
<i>Participation^{i,ms}</i>	B2C	B2B	P2P	C2C
<i>Offering orientation^{ms}</i>	Product	Result		User
<i>Immediate access^{uo}</i>	True		False	
<i>Under-utilized^{uo}</i>	True		False	

The reason why only these attributes are included in the taxonomy is simply because these attributes are necessary to classify the existing digital platforms (of our sample) to the right type(s) (collected by the literature review). For example, without checking the under-utilization of the product it is not possible to know if rentmydress.com is a sharing economy platform by [31] and/or a digital marketplace by [27]. These attributes and attribute values are further explained in relation to the digital platform types in next section. Notice that as future types arise, or new platforms are added to the sample the taxonomy can (and needs to) be modified.

4 Typology

In this section, we provide an overview of the digital platform types that can be distinguished based on the attributes and their values as defined in the taxonomy (table 2). The typology shows the instantiations of digital platform type as super- and subclasses of each other. This means that every digital platform type captures the common features of the digital platforms that are instances of the type. Our typology, shown in figure 2, confirms to the suggestions of [14] as it (i) has descriptive power and is empirically grounded, (ii) reduces complexity, and (iii) identifies similarities and differences between the types. Further on, we explain how the attribute values of our taxonomy are related to the nine types of digital platform that we identified before.

On the top of our typology we have the root superclass ‘digital platform’, meaning that all instances of our 9 digital platform types are considered digital platforms following our working definition. For all nine digital platform types we found real-life instances, but notice that, in theory, every unique combination of attribute values can be defined as a distinct type. If needed, new types can be included in the typology if instances of such types would appear.

The most popular definition of a Multi-Sided (MS) platform is by [38] ; “Including at least two distinct but interdependent sides to have direct and clearly identified interactions with each other with direct and indirect network externalities that they internalize”. Because of the complexity of this definition, we used the more convenient and also popular definition of [6]: “A MS market enables direct interactions between multiple sides with each side affiliated with the market”.

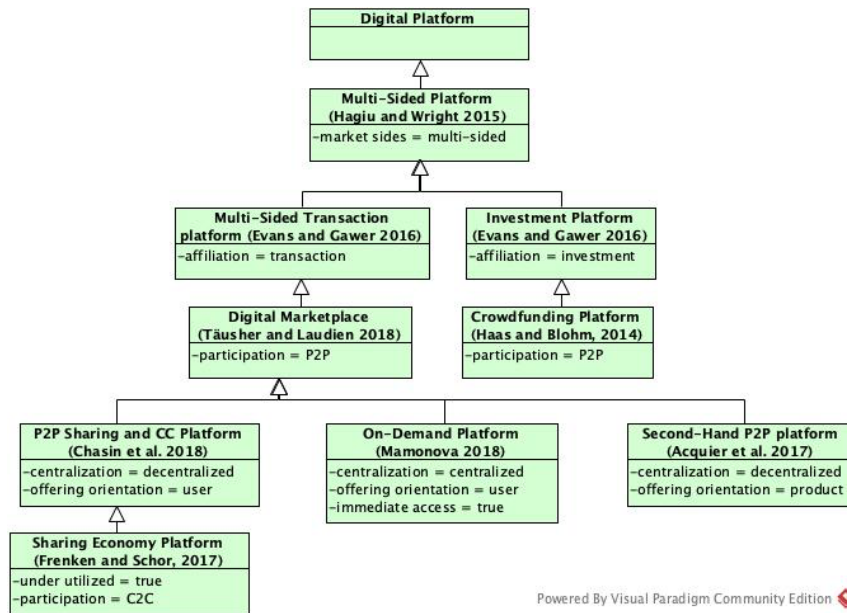


Fig. 2. Digital platform typology

In case the platform allows users to make transactions, the digital platform is a MS transaction platform as defined by [10]. These transactions can be facilitated by the platform in multiple ways, what is referred to in many papers as part of the ‘intermediation’ by the platform software. This intermediation can be all kinds of software supported functionality including the exchange of the product, service and the transfer of payments between the users [39]. The transactions can involve tangible products (e.g., bags on O My Bag), intangible products (e.g., games on Xbox), services (e.g., teaching on Preply) or a combination of these (e.g., meal delivery on Uber Eats).

In case users of one market side make an investment of financial resources that benefits users of another market side, the platform is an investment platform, as defined by [10]. This type includes online stockbrokers (e.g., Degiro, Keytrade) that intermediate financial instruments between stock exchanges and investors.

When the users of the different market sides are considered as peers, meaning equal participants, also called prosumers alternating in their role as producer (or creator, capital seeker, provider) and consumer [35], the platform operates in a Peer-to-Peer (P2P) market. How to define and agree on what this equality means is one of the reasons why an ontology is needed as it helps to find and communicate a generally accepted definition. When an investment platform has P2P participants, it is a crowdfunding platform, as defined by [17] based on the P2P lending principles of [40]. An example is Kickstarter, helping projects to life by connecting creative people with their community [41].

For a digital platform to be a digital marketplace, four conditions need to be fulfilled [27]. The first condition, ‘connects independent actors from a demand and supply side and these individual actors can participate on both sides’, implies that a digital marketplace needs to be a P2P multi-sided platform, which is confirmed by our sample. The

second, third and fourth condition, respectively ‘these actors enter direct interactions with each other to initiate and realize commercial transactions’, ‘the marketplace platform provides an institutional and regulatory frame for transactions’ and ‘the marketplace does not substantially produce or trade products or services itself’, indicates a digital marketplace is a transaction platform. Hence, multi-sided platforms without clear transactions between the users (e.g., YouTube) or intermediating non-P2P markets (e.g., Amazon) are not considered digital marketplaces.

The definition of P2P sharing and collaborative consumption platform by [16] also has four conditions. The first condition ‘individuals can assume the role of a peer-provider on the platform’ translates to the P2P value for the participation attribute. For the second and third condition, respectively ‘peer-providers can offer physical resources on the platform’ and ‘access to a resource is granted temporarily’, we rely on [35] stating that an offering can be placed on a continuous scale between product-oriented and result-oriented. Product-oriented offerings are geared towards sales of products, while in result-oriented offerings the provider is selling a result or competence, by offering a mix of services. In the middle of this continuum are the user-oriented offerings consisting of product leasing, renting, sharing and pooling [42], which is the case for the definition P2P sharing and collaborative consumption platforms by [16]. The last condition, ‘Peer-consumers can search for resources offered by peer-providers’, means a decentralized market following the frameworks of [7, 33]. In a decentralized market, the platform exercises little control for exchanges beyond matchmaking. The provider sets the price and the customer can search for the right provider. In a centralized market, on the other hand, the platform provides access to a centralized resource pool and has a strong influence on the interactions between users by assigning matches and setting dynamic and time-related prices. To conclude, the P2P sharing and collaborative consumption platform type includes platforms where customers can search and rent physical resources (in combination with other services) from their peers. This type includes platforms such as Airbnb for home renting, BlaBlaCar for carpooling, and Sharedesk to book a working spot.

The basic concept of an on-demand platform, as defined by [32], is ‘immediately and effectively access to a product and service’ with Uber as main example. Uber is clearly operating in a centralized market, also known as a matchmaker [43], where the platform management acts as a brokering service offering and facilitating transactions between providers and customers [43]. Secondly, an on-demand platform is part of the (immediate) access economy described by [37] as ‘offering customers access to a product and service where and when the customer needs it, and this can be straight away’.

A second-hand P2P platform as mentioned by [9] is a decentralized, product-oriented digital marketplace, as it facilitates the searching and sales of used products between peers. An example is Carousell, a platform to resell used goods.

The definition most used for ‘sharing economy’ is the one by [31]: “Consumers granting each other temporary access to under-utilized physical assets (idle capacity), possibly for money.” A typical example of a platform operating in the sharing economy is Couchsurfing, where private persons rent out temporarily vacant accommodation (under-utilized physical good) to other private persons (C2C) for an agreed upon number of days (temporary access). It includes the six affordances of sharing economy by

[7] (generating flexibility, matchmaking, extending reach, transaction management, trust, and facilitating collectivity). In this paper we consider a sharing economy platform by [31] as a platform where all transactions operate in the sharing economy. This is equal to the already discussed P2P sharing and collaborative consumption platform of [16], but with under-utilized products offered and consumed by private persons (i.e., C2C specialization of P2P).

5 Reference Ontology

In this paper we only discuss the first module of our ontology. The reference ontology describes the functionality of a general digital platform and of each digital platform type in relation to their attribute values defined in the taxonomy. The entities of our ontology modelled in OntoUML can come from three UFO sub-ontologies: UFO-A, an ontology of objects (indicated in red in figure 3), UFO-B, an ontology of events (in yellow) and UFO-C, an ontology of social entities with the power to connect entities built on top of UFO-A and UFO-B (in green). A ‘type’ entity (indicated in purple) is used to categorize user roles [44], like Airbnb homeseeker, Airbnb homeowner, and Uber Eats rider.

Based on the working definition in section 3, we define general digital platform requirements as a basis for the general ontology module. We recall that a service offering has to implement these requirements in order to be qualified as a digital platform. The general digital platform requirements are partly derived from UFO-S [22], a core ontology grounded in UFO that provides a clear account of services and service-related concepts. Because a digital platform is a service offering to its users, and users can also offer services (and products) through the digital platform, it is convenient to reuse UFO-S concepts and relations to model the ontology patterns of a digital platform. Also, reuse is pointed out as a promising approach for ontology engineering, since it enables speeding up the ontology development process [45]. In UFO-S, a service offer event results in the establishment of a service offering between a service provider and a target customer community [22], from which we derive the following two requirements for a digital platform:

1. A digital platform is a service offering [22]
2. This service offering is offered by a digital platform management towards a certain ‘target platform user community’ consisting of ‘target platform users’.

The following requirements come from the literature and are confirmed by the instances of our sample:

3. This service offering is enabled by software [10]
4. This service offering includes platform supported interaction between the users [1]

Figure 3 shows the general ontology module for our digital platform reference ontology. The detailed rationale for the design of this ontology module out of (specialized) UFO-S ontology patterns, cannot be explained within the scope of this paper. Instead,

we provide a general account of how this ontology model can be read, followed by an example of how it can be used to describe existing digital platforms.

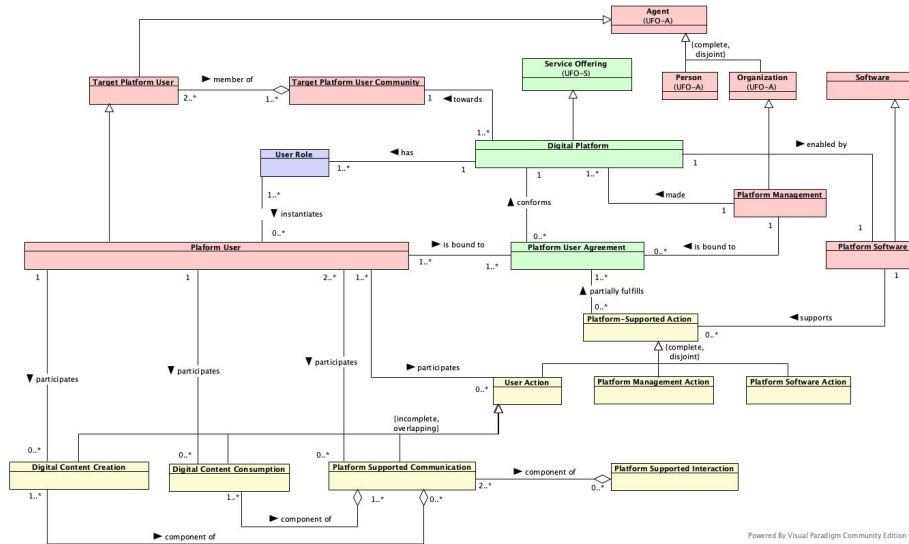


Fig. 3. General digital platform ontology module

The green part of figure 3 shows that a digital platform is a service offering. Moving to the red part, we see that this service offering is made by the company managing the platform (i.e., ‘platform management’) to a target platform user community. These targeted users can be organisations or private persons. The digital platform is enabled by running platform software that supports different kinds of actions. Moving to the yellow part of figure 3, we see that these platform-supported actions are divided into user actions, platform management actions, and platform software actions. In this general digital platform ontology module, the focus is on the user actions as they clarify the functionality that a digital platform offers to platform users. The most basic user actions are digital content creation (e.g., sending a message) and consumption (e.g., receiving a message). When both creation and consumption take place, we talk about a communication action. To fulfil the fourth requirement of a digital platform, the platform software must allow interactions, which is communication of two (or more) users in at least two directions (e.g., sending, receiving, replying, receiving).

A digital platform can have different user roles (in purple) that allow defining distinct user groups, with distinct user actions, but in the most general sense of digital platform, all users have equal participation rights (e.g., WhatsApp). Notice however, that depending on the type and related attribute values of our taxonomy, a digital platform can distinguish between actions allowed for different user groups. For example, depending on the affiliation, a user of a certain type is able to register, subscribe, make transactions and/or invest using the software. The moment a user is affiliated with the digital platform, a platform user agreement that defines the allowed actions (in green, middle of figure 3) comes into existence (even if this agreement may be tacit).

The requirements per attribute value and their related ontology modules are work in progress and can be found under following link². The reference ontology has to conceptualize a common understanding of the digital platform domain. As this domain and common understanding evolves, so will the ontology.

6 Discussion

Our typology, based on a taxonomy of attributes and attribute values that characterise digital platforms, distinguishes nine types of digital platform, which contributes towards a better understanding of the platform domain. We acknowledge that this typology is a simplification (or stated more positively, a research abstraction), that does not take into account the full complexity of the digital platform domain. Further, the typology only includes types for which instances exist given the current state of the domain. As this domain is in constant state of change, the typology needs to be corrected and enlarged accordingly. This is exactly why the typology is based on a taxonomy, which provides a more robust structure for defining digital platform types.

Another complexity in the digital platform domain is that different digital platform types are starting to merge, combining providers of different sorts on one platform for a single offering. An example is meal delivery platforms such as Deliveroo and Uber Eats, which include a combination of two digital platform types. First, the meals are offered by the restaurants who can set the price themselves and offer them compliant with a decentralized digital marketplace. Afterwards, a customer orders the meal using the platform, an on-demand platform mechanism comes into place and the meal is delivered by (bike) deliverers at a price/cost set by the platform. Another example is a travel platform as described in [46], where multiple assets, goods and services (including accommodation, car, activities, guide and driver) by different providers can be combined as one offering on the platform. These combinations of platforms are also called hybrid platforms [33] or integrated platforms [10], allowing more than one provider and different platform types for one offering. As shown by these examples, the typology can help to analyse such evolutions by classifying digital platforms according to the distinctive features of the platform types that are included.

Our reference ontology on the other hand can help comprehend the complexity and functionality of each digital platform type (or combination), and support ontology-driven development of platforms. A better understanding of the functionality can help to create such platforms in a fast and efficient way, with clear terminology to improve the communication and decision-making between the stakeholders.

7 Conclusion

In this paper, we contribute to addressing two research gaps in the digital platform domain. The first gap is the lack of shared conceptualization of digital platform types. Many platform types, including sharing economy platform, on-demand platform and

² <http://model-a-platform.com/digital-platform-ontology-2/>

multi-sided platform, are buzz words, used a lot in both academic and professional communities but without consensus on what they comprise. To solve this issue, we created a taxonomy and typology for digital platforms based on both existing literature and an empirical sample. The taxonomy gives an overview of digital platform attributes, with attribute values expressing the possible variations between digital platforms depending on their type. These attributes and attribute values are then used in the typology giving a clear overview of all the digital platform types and how these types are related. With the help of these artefacts, researchers and practitioners can improve their communication and improve the comparability of future studies. This includes the comparability of research using the same digital platform type name but with a different meaning (e.g., sharing economy by [31] and [13]). We also discussed our method based on [15] on how to improve these artefacts when new types arise to keep a good overview in this fast-changing and complex domain of digital platforms.

The second gap this paper tackles is the lack of knowledge concerning the software functionalities of digital platforms. The reference ontology proposed in this paper can help with this issue as it describes the general functionality of any digital platform. This reference ontology is based on UFO [20], a high-level ontology that provides us with basic concepts for objects, events, social elements and relations and modelled in OntoUML [25], an ontology-driven conceptual modelling language capable of representing these concepts. At this point the more specific functionality of each digital platform type in relation to its attribute values as defined in the taxonomy is under construction. In future research we plan to fully develop an ontology module for each attribute value in our taxonomy. First, we will verify the syntactic correctness of the ontology representation using the OntoUML plugin for Visual Paradigm³. Second, these modules will be validated by ontology experts to make sure our ontology is correctly modelled. And third, we plan to validate the platform domain knowledge in our ontology (modules) by applying the ontology to a selection of existing digital platforms in our sample by combining the modules as building blocks. Eventually, the envisioned reference ontology can improve the common language that all sharing economy stakeholders can use to facilitate future research and development of digital platforms.

References

1. Kenney, M., Zysman, J.: The rise of the platform economy. *Issues Sci. Technol.* 32, 61–69 (2016).
2. Ranjbari, M., Morales-Alonso, G., Carrasco-Gallego, R.: Conceptualizing the Sharing Economy through Presenting a Comprehensive Framework. (2018).
3. Görög, G.: The Definitions of Sharing Economy: A Systematic Literature Review. *Management.* 13, 175–189 (2018).
4. Puschmann, T., Alt, R.: Sharing economy. *Bus. Inf. Syst. Eng.* 58, 93–99 (2016).
5. Trabucchi, D., Buganza, T.: Fostering digital platform innovation: From two to multi-sided platforms. *Creat. Innov. Manag.* 1–14 (2019).
6. Hagi, A., Wright, J.: Multi-Sided Platforms. *Int. J. Ind. Organ.* 43, 1–32 (2015).

³ <https://github.com/OntoUML/ontouml-vp-plugin>

7. Sutherland, W., Jarrahi, M.H.: The sharing economy and digital platforms: A review and research agenda. *Int. J. Inf. Manage.* 43, 328–341 (2018).
8. Sanchez-Cartas, J.M., Leon, G.: Multi-sided Platforms and Markets: A Literature Review. *SSRN Electron. J.* 1–62 (2019).
9. Acquier, A., Daudigeos, T., Pinkse, J.: Promises and paradoxes of the sharing economy: An organizing framework. *Technol. Forecast. Soc. Change.* 125, 1–10 (2017).
10. Evans, P.C., Gawer, A.: The Rise of the Platform Enterprise: A Global Survey. (2016).
11. Ertz, M., Durif, F., Arcand, M.: Collaborative consumption: Conceptual snapshot at a buzzword. *J. Entrep. Educ.* 19, 1–23 (2016).
12. Wieringa, R.: What is a platform, <https://www.thevalueengineers.nl/what-is-a-platform/>.
13. Yin, C., Wang, X., Rong, W., Wang, T., David, B.: A System Framework for Sharing Economy. *Proc. 2018 IEEE 22nd Int. Conf. Comput. Support. Coop. Work Des. CSCWD 2018.* 779–784 (2018).
14. Codagnone, C., Biagi, F., Abadie, F.: The Passions and the Interests: Unpacking the “Sharing Economy.” (2016).
15. Nickerson, R.C., Varshney, U., Muntermann, J.: A method for taxonomy development and its application in information systems. *Eur. J. Inf. Syst.* 22, 336–359 (2013).
16. Chasin, F., von Hoffen, M., Cramer, M., Matzner, M.: Peer-to-peer sharing and collaborative consumption platforms: a taxonomy and a reproducible analysis. Springer Berlin Heidelberg (2018).
17. Haas, P., Blohm, I., Leimeister, J.M.: An empirical taxonomy of crowdfunding intermediaries. *35th Int. Conf. Inf. Syst. "Building a Better World Through Inf. Syst. ICIS 2014.* 1–18 (2014).
18. Etikan, I.: Comparison of Convenience Sampling and Purposive Sampling. *Am. J. Theor. Appl. Stat.* 5, 1 (2016).
19. Carvalho, V.A., Almeida, J.P.A.: Toward a well-founded theory for multi-level conceptual modeling. *Softw. Syst. Model.* 17, 205–231 (2018).
20. Guizzardi, G.: *Ontological Foundations for Structural Conceptual Models.* (2005).
21. OntoText: What are Ontologies?, <https://www.ontotext.com/knowledgehub/fundamentals/what-are-ontologies/>.
22. Nardi, J.C., Falbo, R. de A., Almeida, J.P.A., Guizzardi, G., Ferreira, L., Sinderen, M.J. Van, Guarino, N., Morais, C.: A commitment-based reference ontology for services. *Inf. Syst.* 54, 263–288 (2015).
23. Ruy, F.B., Guizzardi, G., Falbo, R.A., Reginato, C.C., Santos, V.A.: From reference ontologies to ontology patterns and back. *Data Knowl. Eng.* 109, 41–69 (2017).
24. Falbo, R. de A.: SABiO: Systematic approach for building ontologies. *CEUR Workshop Proc.* 1301, (2014).
25. Guizzardi, G., Fonseca, C.M., Benevides, A.B., Almeida, J.P.A., Porello, D., Sales, T.P.: Endurant types in ontology-driven conceptual modeling: Towards ontoUML 2.0. *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics).* 11157 LNCS, 136–150 (2018).
26. Oh, S., Moon, J.Y.: Calling for a shared understanding of the “sharing economy.” 1–5 (2016).
27. Täuscher, K., Laudien, S.M.: Understanding platform business models: A mixed

- methods study of marketplaces. *Eur. Manag. J.* 36, (2018).
28. Wu, L.: Understanding Collaborative Consumption Business Model: Case of Car Sharing Systems. *DEStech Trans. Mater. Sci. Eng.* 403–409 (2017).
 29. Apte, U.M., Davis, M.M.: Sharing economy services: Business model generation. *Calif. Manage. Rev.* 61, 104–131 (2019).
 30. Nguyen, S., Llosa, S.: On the difficulty to define the sharing economy and collaborative consumption – Literature review and proposing a different approach with the introduction of “collaborative services.” *Journée la Relat. à la Marque dans un Monde Connect.* 19–25 (2018).
 31. Frenken, K., Schor, J.: Putting the sharing economy into perspective. *Environ. Innov. Soc. Transitions.* 23, 3–10 (2017).
 32. Mamonova, Y.: Sharing Economy vs. On-Demand Economy: The Major Differences, <https://ikajo.com/blog/sharing-economy-on-demand-economy-differences>.
 33. Acquier, A., Carbone, V., Massé, D.: How to Create Value (s) in the Sharing Economy : Business Models , Scalability , and Sustainability. 9, 5–25 (2019).
 34. Ehikioya, S.A.: A formal model of peer-to-peer digital product marketplace. *Int. J. Networked Distrib. Comput.* 6, 143–154 (2018).
 35. Ritter, M., Schanz, H.: The sharing economy: A comprehensive business model framework. *J. Clean. Prod.* 213, 320–331 (2019).
 36. Andersson, M., Hjalmarsson, A., Avital, M.: Peer-to-peer service sharing platforms: Driving share and share alike on a mass-scale. *Proc. 34th Int. Conf. Inf. Syst.* 4, 2964–2978 (2013).
 37. Gobble, M.A.M.: Defining the sharing economy. *Res. Technol. Manag.* 60, 59–61 (2017).
 38. Rochet, J., Tirole, J.: Platform Competition in Two-Sided Markets. 5–6 (2001).
 39. Hepp, M.: GoodRelations: An ontology for describing products and services offers on the web. *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*. 5268 LNAI, 329–346 (2008).
 40. Burtch, G., Ghose, A., Wattal, S.: An empirical examination of the antecedents and consequences of attitudes tow. *Inf. Syst. Res.* 24, 499–519 (2013).
 41. Kickstarter: Our mission is to help bring creative projects to life., <https://www.kickstarter.com/about?ref=global-footer>.
 42. Tukker, A.: Eight types of product-service system: Eight ways to sustainability? Experiences from suspronet. *Bus. Strateg. Environ.* 13, 246–260 (2004).
 43. Hafermalz, E., Boell, S.K., Elliot, S., Hovorka, D., Marjanovic, O.: Exploring Dimensions of Sharing Economy Business Models Enabled by IS: An Australian Study. *Australas. Conf. Inf. Syst.* 1–11 (2016).
 44. Carvalho, V., Giancarlo, G., ...: Extending the Foundations of Ontology-based Conceptual Modeling with a Multi-Level Theory. In: *International Conference on Conceptual Modeling* (2015).
 45. Ruy, F.B., Reginato, C.C., Santos, V.A., Falbo, R.A., Guizzardi, G.: Ontology engineering by combining ontology patterns. *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*. 9381, 173–186 (2015).
 46. Derave, T.: A Reference Architecture For Customizable Marketplaces. In: *ER 2019 Doctoral Consortium* (2019).