

Understanding Digital Marketplace Business Models: An Ontology Approach

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Abstract. Digital marketplaces, including sharing economy platforms, are digital platforms that may operate under a large variety of business models. Business model variations are typically conceptualized in taxonomies, but these fall short in describing platform user roles and role-specific digital platform functionality. Reference ontologies offer more potential for capturing this information and thus provide a conceptual basis for model-driven development of platform software. This paper presents an extension of the Digital Platform Ontology (DPO) of Derave, Sales, Gailly and Poels (2020) that is agnostic to business model choices. We extend the DPO with digital platform business model ontology modules, based on an analysis of digital marketplace business models, that was informed by a literature review and a sample of existing digital marketplaces. The new ontology modules can be used as building blocks to model a digital marketplace operating under a chosen business model.

Keywords: Digital marketplace, Sharing economy platform, Business model, Digital Platform Ontology, UFO

1 Introduction

Digital marketplaces and its subtype sharing economy platforms are operating in the platform economy and have been in the focus of attention for a number of years [1]. Their idea and economic advantages are not a recent phenomenon but due to the Internet, users can easily communicate, find an agreement, and make a transaction with strangers, enormously decreasing the transaction costs between unknown others [2]. Due to this technological evolution, digital marketplaces including eBay, Craigslist, Etsy, Airbnb and Couchsurfing, have recently emerged as a viable alternative to fulfilling a variety of consumer needs, ranging from prepared meals to cars to overnight accommodations, that were previously provided by firms [3]. An important problem for academia and practitioners alike is the conceptual confusion in different types of digital platforms, with important ramifications for their expected functionality. To

tackle this problem, we developed a Digital Platform Ontology (DPO) in [4]. The DPO visualizes digital platform types as subtypes from each other and consists of different modules which allows the conceptualisation and improves the communication of platform type differences. By organizing the ontology into modules, it is possible to select and combine modules to create an applied ontology for each platform type. Therefore, it is possible to compare studies of different types, and makes it easier to set the scope of a certain platform study domain.

But besides the conceptual confusion in platform types, there is also a lack of knowledge concerning the user roles and the role-specific implications on the functionality of digital platforms deploying different business models [5, 6]. This confusion is partly due to the complex mechanism of value co-creation between providers and consumers based on interactions and the possible overlap between these roles. Therefore, we continue on the work of [4], and use their original ontology to set the scope of this paper. We extend the DPO for only one specific platform type named ‘digital marketplace’ because previous literature on the matter had a strong focus on business model variations. Taxonomies of digital marketplace business models as the one developed by Täuscher and Laudien [7] provide a holistic perspective of a marketplace and a focus on the core logic of creating and capturing value [8]. But these taxonomies are not capable of explaining how each business model specification choice works, and whether and how these business model specifications can be combined. Such taxonomies also don’t help in understanding the functional aspects of the development, implementation and operation of the platform software, and are therefore not capable in improving the software development process.

In this paper we address this issue by extending the Digital Platform Ontology (DPO) with modules capturing business model choices for digital marketplaces. We do so by applying the ontology engineering method proposed in [9]. Whereas the DPO was originally created to understand and classify digital platforms of the platform domain into different platform types (including digital marketplace and its subtype sharing economy platform), the additional ontology modules proposed in this paper are meant to cover a wide variety of digital marketplace functionality applying different business models.

In the complex and diverse domain of digital marketplaces, an ontology can be a vital tool as it improves the understanding and communication of a certain domain and eventually drives ontology/model-driven software development [10]. Marketplace domain knowledge including the terminology, relationships, user roles and constraints, is captured in the DPO as it is conceptually grounded on a focused literature review and empirically validated with a diverse sample of existing digital marketplaces operating different business models. As the DPO is modularized, the proposed ontology modules in this paper allow adjusting to a range of marketplace business model variations and make it easier for developers to analyse the influence of business model decisions on expected platform functionality. While it is already understood that ontologies can improve software engineering in general [11], our DPO extended with digital marketplace business model ontology modules does so specifically for digital marketplace development.

Besides the advantages for digital marketplace development, this paper contributes to the ontology domain as well. It validates the ability of the ontology engineering

method of [9] to capture business model variations in a given digital platform type, and it digs deeper into the required functionalities of a specific platform type (digital marketplaces), eventually paving the road to ontology-based software development of other platform types.

In this paper, due to page limits, we present one digital marketplace business model ontology module, and provide a link to the other modules that are currently work in progress. We also present a proof of concept by modelling accommodation rentals on Airbnb.

Section 2 provides background on the original DPO and applies it to the digital marketplace type of digital platforms. Section 3 presents our research methodology. In Section 4 we present a digital marketplace business model taxonomy that was adapted from Täuscher and Laudien [7] as a stepping stone to ontology development. In Section 5 we exemplify our extension of the DPO with the ‘offline service’ ontology module. We also demonstrate the use of the extended DPO in modelling Airbnb. Section 6 concludes the paper and outlines limitations and future research.

2 Background: Digital Marketplace and DPO

A digital marketplace intermediates in the transactions between customers and providers that are considered equal participants (i.e., ‘peers’) as they can switch roles [7]. A digital marketplace can be positioned in the broader domain of the platform economy by defining it as a type of digital platform [4]. In turn, a sharing economy platform as defined by Frenken and Schor [2] is a type of digital marketplace mediating and simplifying the temporary access of an under-utilized physical asset between individuals.

The original DPO [9] is based on UFO, a foundational ontology that defines basic concepts such as objects, events, social elements and their types, relations and properties [12]. The DPO is represented in OntoUML [13], a conceptual modelling language that is capable of representing the objects, events and social entities of UFO. By combining the DPO modules that are relevant to a specific digital platform type, an ontology for that type can be constructed. Figure 1 shows the OntoUML ontology model for digital marketplaces that can currently be constructed using DPO modules. Classes are color-coded. Objects are coloured red (e.g., the platform software, the company owning and managing the platform software, different types of users). Events, representing different types of action, are coloured yellow. A user action can be seen as an offered functionality enabled by the platform software (e.g., registration action, listing creation, listing search). Relators are coloured green. Relators are social constructs that have the ability to connect two or more objects. The DPO module name of a class is given between brackets (e.g. Transaction).

The model shows that platform visitors get to the marketplace website or mobile app and must perform a registration action before they can use the platform services. A registered user can create listings (for which this user becomes the offering creator). A platform visitor can perform listing searches (the user then becomes a target platform customer), after which a transaction can be created. The target platform customer that initiates the transaction then becomes a(n) (effective) platform customer, whereas the

offering creator of the target listing becomes a platform provider. This transaction can then be fulfilled by a delivery to the platform customer.

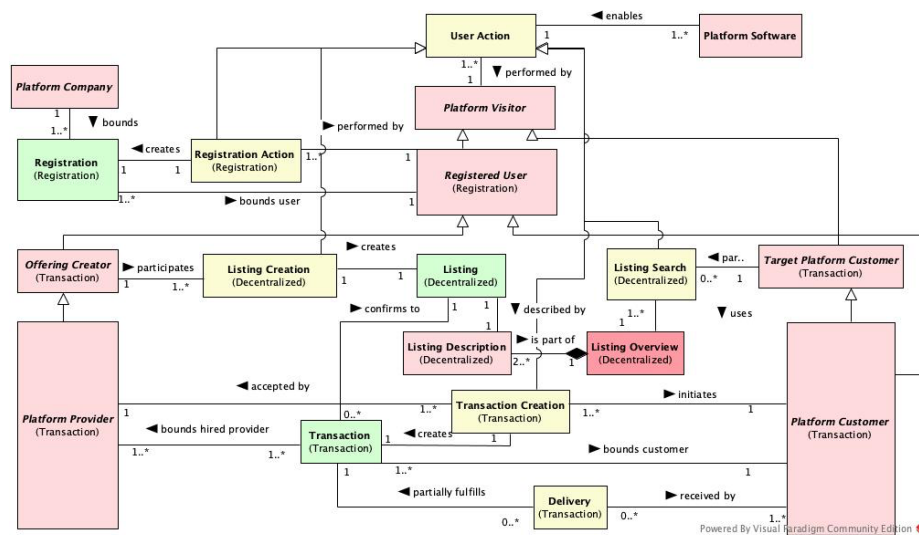


Fig. 1. General Digital Marketplace Ontology Based on DPO

3 Methodology

Our objective is to extend the DPO following the method of [9] and make it accountable for a diverse set of digital marketplaces that differ in offered functionality depending on their business model. This method is summarized in figure 2.

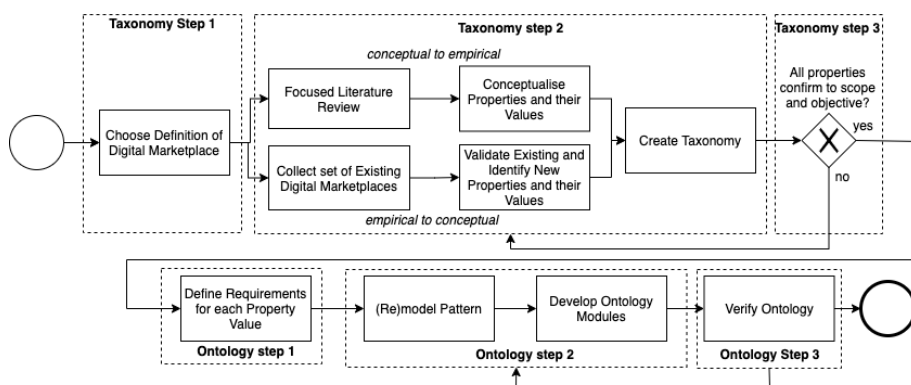


Fig. 2. Method of [9]

Taxonomy development: In a first step we define the scope of our research by choosing a definition of digital marketplace. The taxonomy development activity is done in an iterative manner for which we alternately use the ‘conceptual to empirical’ and ‘empirical to conceptual’ approaches, starting in the first iteration with the former. For the ‘conceptual to empirical’ approach we conduct a focused literature review to understand the required functionality of platform software depending on the digital marketplace business model. The search queries were a combination of digital marketplace types (including sharing economy platform) and search terms such as taxonomy, classification, model, category, and framework. We searched in two digital databases (Google Scholar and Web of Science). In further iterations we used snowballing and inclusion and exclusion criteria to reach a final set of papers. Based on these papers we capture the variation in the different business models through conceptualizing properties (to be understood as types) and property values (i.e., instances of properties) that allow distinguishing between digital marketplaces that operate different business models. For the ‘empirical to conceptual’ approach, we collect a set of existing digital marketplaces. The properties and property values that were conceptualized in the ‘conceptual to empirical’ approach, are now validated using the composed sample of existing digital marketplaces and if needed new values are added (i.e., when we find in our sample existing digital marketplaces operating different business models, but that cannot be distinguished from one another by the currently conceptualized properties and property values). In a third step, each property and property value is confirmed with respect to the scope and objective of our research. Properties and property values that are not applicable to digital marketplaces or have a low impact on the platform required functionalities (not mechanism focused following [14]) are excluded.

Ontology development: We extend the DPO to also include the business model variations for digital marketplaces. Based on our taxonomy of properties and property values, we develop an ontology module for each property value. To develop these ontology modules, we use the patterns of UFO [12]. First, for each property value we define a set of requirements for platform functionality based on both the literature and our sample used in the taxonomy development. These requirements define the functionality of a digital marketplace that deploys a chosen business model. Secondly, we develop each ontology module by modelling the requirements defined in the previous step, using ontology patterns. In a third step we verify each ontology module on syntactic correctness of the ontology representation using the OntoUML plugin for Visual Paradigm¹. We also test the descriptive power of the ontology by applying it to model the digital marketplaces in our sample. We thus verify that our ontology can capture the complex variety of digital marketplace business models. As an example, we show the application of our ontology to the marketplace ‘Airbnb’ in Section 5. When during the verification step changes are required, the process returns to ontology step two, the pattern in question is remodelled and the process continues from there.

¹ <https://github.com/OntoUML/ontouml-vp-plugin>

4 Taxonomy

To define the scope of our research, we use the digital marketplace definition of Täuscher and Laudien [7]. The objective of the taxonomy development is creating a structured overview of all variations in digital marketplace business models portrayed by properties and values. We started our taxonomy development by including the 14 business model properties proposed by Täuscher and Laudien [7]. In total 31 papers that were found using the search strategy described in Section 3, were used to further develop our taxonomy². The properties were verified with a sample of 47 existing digital marketplaces³, distributed over 25 business models, as defined by unique combinations of property values. Our sample is a combination of existing marketplaces found online (e.g., on blogs) and in papers with a large diversity in industry sector, geographic scope, and functionality. The modifications to the original properties of [7] are summarized in table 1.

Table 1. Proposed modifications to the properties of [7]

Property	Modification
Platform Type	Omitted, the difference between web-based and mobile app has a low impact on the required user functionality
Industry	Omitted, vertical or horizontal focus has a low impact on the required user functionality
Geographic scope	Omitted, because of economies of scale the location of users has a low impact on the required user functionality
Key activity	Omitted, the motive of the user has a low impact on the required user functionality
key value proposition	Omitted, the motive of the user has a low impact on the required user functionality
Listing type	Aggregation of transaction content and transaction type: Due to the high fluidity of the concepts 'product' and 'service' [15] and their dependencies, the property values are combined and inclusive.
Payment system	Included with values of the different ways payment transfers between the customers, providers and the marketplaces owning company take place [16].
Revenue stream	Third-party, advertising and service sales revenue streams are combined to 'other' to reduce complexity and focus on the role-specific implications on the functionality
Price discovery	Expanded with a 'free' option and 'set by the market', to collect all entities who can determine the price. Price set by marketplace is excluded as this is only used for on-demand platforms.
Price calculation	Merger of the price mechanism, price discrimination and part of the price discovery to five property values including free', 'quantity-based', 'feature-based' and 'by auction'. The last property value named 'price negotiation' was changed to 'quote', as this is the more general term used in practice for formal negotiations concerning the price. Location-based is excluded as this is only used for on-demand platforms.

² An overview of the literature review can be found on <http://model-a-platform.com/marketplace-business-model-sources/>

³ An overview of the sample can be found on <http://model-a-platform.com/marketplace-business-model-sources/>

Conversation System	Two different values are included as a user conversation can be initiated before the transaction concerning the listing (listing conversation), after the transaction (transaction conversation) or both.
Marketplace participants	Split into customer and provider type, to include all possible combinations (e.g., C2B&C, B&C2B&C, B&C2C)
Review system	User reviews split into reviews by customer and reviews by provider. Review by marketplace is excluded as this is only used for on-demand platforms.

Our final taxonomy is given in tables 2 and 3, respectively showing listing-dependent properties and marketplace-dependent properties. A listing is an offering of a good or service on the marketplace and includes the price and a description of what the customer can expect. Listing-dependent properties describe listings, while marketplace-dependent properties describe properties of the digital marketplace itself.

All properties are mandatory, meaning that at least one property value must be selected. Property values are exclusive when if such value holds for the property, no other values are allowed (indicated with a superscript ‘e’ in tables 2 and 3). All other property values are inclusive and allow to be combined with other inclusive property values. We also differentiate between listing-dependent exclusivity (table 2) and marketplace-dependent exclusivity (table 3). Listing-dependent exclusivity means that if an exclusive property value is chosen for a particular listing, other values are still possible for the other listings offered on the marketplace. The property values for Price Discovery (table 2) are examples of listing-dependent exclusivity. Take for instance Artsy, a marketplace for buying and selling art. For Artsy, the price of a single listing cannot be set simultaneously by the provider and by the market (e.g., using an auction). But Artsy allows both types of listings.

We also specify *dependencies* for modelling situations where the choice of property values is restrained by the choice of values for other properties. Such dependencies are indicated by the thick boxes in table 2 and 3. In our taxonomy, a listing with price discovery set by provider (table 2) can only have a quantity-based or feature-based (or both combined) price calculation. A revenue for the marketplace company in the form of a listing fee (cost for the registration of a new listing) (table 3) always comes from the provider side. And the ‘other’ revenue stream and source groups all third parties, with advertising and service sales revenue streams.

Table 2. Taxonomy with listing-dependent properties

Property	Values				
<i>Listing Type</i>	Physical Good Transfer	Digital Good Transfer	Offline Service	Digital Service	
<i>Price Discovery</i>	None ^e	Set by Provider ^e	Set by Customer ^e	Set by Market ^e	
<i>Price Calculation</i>	None ^e	By Quantity	By Feature	Auction ^e	Quote ^e

Table 3. Taxonomy with marketplace-dependent properties

Property	Values
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<i>Customer Type</i>	Person			Organization	
<i>Provider Type</i>	Person			Organization	
<i>Payment System</i>	None ^e	Offline	In-house		External
<i>Revenue Stream</i>	Other	Subscription	Commission	Fixed Fee	Listing Fee
<i>Revenue Source</i>	Other	Customer		Provider	
<i>Conversation System</i>	Listing Conversation			Transaction Conversation	
<i>Review System</i>	None ^e	By Customer		By Provider	

A famous example of an existing marketplace is Airbnb that intermediates between a houseowner (provider) and a renter (customer) for an offline service (renting the accommodation). The price is set by the provider based on quantity (number of nights) and features (e.g., high or low season prices). The customer type is person, and the provider type can be person or organization. The payments are transferred by an in-house payment system and the revenue stream is a commission of the transaction price paid by the customer. The conversation system allows both conversation systems with messages before (listing conversation) and after the transaction (transaction conversation) and after the delivery of the service both a review by the provider and by the customer towards each other are allowed.

5 Ontology Modules and Airbnb Proof of Concept Modelling

In our current research, we are developing ontology modules for each property value in our taxonomy. In this workshop paper, we present in figure 3 the ontology module for the value ‘offline service’ of the listing-dependent property ‘listing type’ (table 2). In figure 3, the ontology module name (= property value) of each class is given between brackets. The ontology classes with ‘(Offline service)’ are thus newly defined in this ontology module.

A service involves an activity of performing work for others to provide satisfaction [17]. Based on our sample, we captured the following requirements for offline services (i.e., service that are not provided via the platform). First, a listing can have several available timeslots (req 1). A timeslot is an intrinsic quality which has a structured value and has multiple phases it can go through. The colour coding of qualities is blue following the usual conventions of OntoUML models [18]. When a customer creates a transaction called a booking for services, the period of the booking is captured in a booked time slot (req 2). Eventually, the service will be delivered by the service provider according to the previously created booking (req 3). We match the ontology patterns to the requirements using blue dotted rectangular shapes.

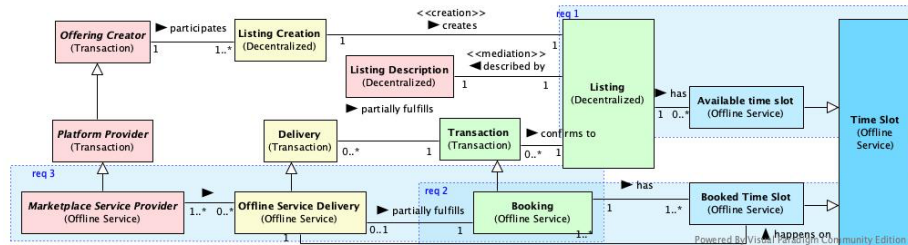


Fig. 3. Offline service ontology module

The offline service ontology module can be further improved with for example other timeslot phases (e.g., cancelled, delivered). For a complete modelling of digital marketplaces operating under a certain business model described by the properties and property values of our taxonomy, other ontology modules are needed. To demonstrate how the DPO extended with digital marketplace business model ontology modules can be used to model digital marketplace business models, we apply the latest version of our DPO extension to Airbnb in figure 4 by combining the general digital marketplace ontology (figure 1) with the required business model ontology modules⁴. In future iterations of our ontology development process, we plan to validate the ontology modules on a large number of existing marketplaces in our sample as explained in step 3.2 of the ontology engineering process.

The ontology in figure 4 can be read as follows: A platform visitor can perform a registration action and become a registered user. This user can perform both a listing creation event (as a homeowner), and a listing search event (as a home seeker). During the listing creation, the price is set (by the provider) and captured as offering price in the listing description, for which each timeslot can have a different offering price. During the listing search, a home seeker can initiate a conversation concerning the listing with the homeowner. After, the home seeker can create a booking (becoming a home renter) of which the booked price is calculated based on the offering price. Part of the booking price, called the commission, is collected by the marketplace company. The other part is transferred via an in-house payment from the home seeker to the homeowner. The booking includes the chosen time slot. After the booking, the home seeker and homeowner can participate in a conversation concerning the booking. During the period specified by the booked time slot, the homeowner rents out the property to the home seeker and after the service, both users can create a review towards one another.

⁴ Other modules are in development. The latest version of the digital marketplace business model ontology modules can be found on <http://model-a-platform.com/business-model-modules/>

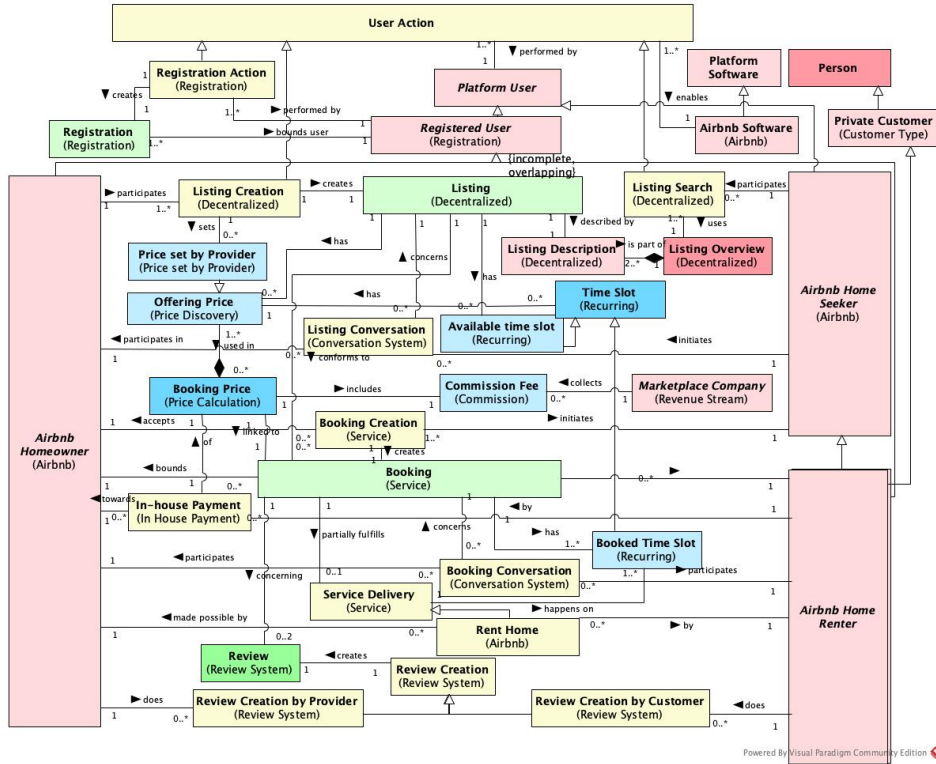


Fig. 4. Ontology applied on Airbnb accommodation rental

6 Conclusion and future work

In this paper, we address the knowledge gap concerning the functional aspects and required user functionality of digital marketplaces deploying different business models by using the method of [9] and extending the earlier developed Digital Platform Ontology (DPO). The extended ontology is modularized using a taxonomy of digital marketplace business model properties and property values based on a literature review of 31 papers and a sample of 47 existing digital marketplaces. In this paper we only presented one ontology module, with a link to the other modules that are currently work in progress. As demonstrated in this paper, it is possible to combine the ontology modules as building blocks and model a digital marketplace operating under a chosen business model. These ontology-based models can help in the understanding of and communication about the required functionality of digital marketplaces operating under a chosen business model.

We believe the extended DPO can be used for model-driven development of digital marketplaces. In this ontology, objects and relators portray the required data structure for the marketplace software, while events portray the required functionality. Pergl, Sales and Rybola [11] already describe the transformation of an ontological model into

an implementation model. Other literature focusses on ontology-driven relational database development [11, 19–21]. However, what lacks is a method for prototype design that includes User Interface (UI) design, which is a necessity to launch a Minimum Viable Product (MVP) [22]. We plan to investigate how the extended DPO can support the development of a diverse set of marketplace prototypes operating different business models. A test case will be set up with aspiring entrepreneurs who plan to develop a prototype of their marketplace idea.

Lowering the barrier of platform development is vital, as many marketplaces have the tendency to apply a ‘winner-takes-all’ strategy to create a monopoly. An essential element that creates incentives to enter and isolate the influence of competitors is increasing the differentiation of digital marketplaces. This way, network effects are mitigated, and divide-and-conquer strategies are less effective, which reduces the monopolization problem at the same time [23]. Due to the high complexity of the software design, in combination with high costs and time needed to develop digital platform software [24], competitors with less diversification but a superior technology are still capable to monopolize a market [23]. We believe that our digital marketplace ontology can accelerate the development of smaller, more alternative, and socially responsible marketplaces and can thus contribute to the creation of a more socially responsible sharing economy. Besides this, also regulators can make use of our marketplace ontology to improve the decision-making transparency.

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