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Common typology of virtual communities and multi-sided platforms. Analysis of business models using qualitative system dynamics

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Working paper

This paper presents a common typology of virtual communities and multi-sided platforms. The analyzed entities comprise 69 of Poland's most prominent websites, representing one of two business models. Based on three dimensions: collaboration among users, reputation-based user competition, and user multi-sidedness, we identified four business models. These are problem community, object community, object market, and reputation market. They were depicted in qualitative system dynamics diagrams. The typology was verified using the statistical clustering technique, which yielded corresponding results. This paper helps comprehend the diversity of value creation logic in virtual communities and multi-sided platforms.

Keywords: platforms, communities, business models, typology

1. Introduction

A typical online discussion forum differs from an average marketplace. The former can be classified as a community, while the latter is a multi-sided platform. However, many entities evade easy classification. Is Instagram a multi-sided platform or a community? Many teenagers use the site to share content exclusively with their peers. On the other hand, amateur photographers can follow world-class photographers who, in turn, have no interest in the pictures taken by their fans, but desire to maximize the reach of their images. Instagram, therefore, serves a dual function as a community and a multi-sided platform.

Are Couchsurfing, Airbnb, and Booking.com virtual communities or multi-sided platforms? These companies likely do not share a single business model although they belong to a particular continuum of companies that facilitates lodging booking. Couchsurfing connects people who are looking for a place to stay while being interested also in hosting guests, Booking.com is an intermediary between tourists and hotels, and Airbnb combines features of both services.

A community is a voluntary association of actors, typically lacking in a priori common organizational affiliation but united by a shared instrumental goal (West, Lakhani, 2008). A multi-sided platform is an intermediary enabling direct interactions between two or more distinct sides, each affiliated with the platform (Hagiu, Wright, 2015). Both entities are described as wielding significant influence over consumer behavior and companies' operations. Prahalad and Ramaswamy argue that *thematic consumer communities (...) are revolutionizing emerging markets and transforming established ones* (2004, p. 3). The platforms' effect on traditional vertically integrated markets is described straightforwardly by van Alstyne et al. *when a platform enters a pipeline firm's market, the platform almost always wins* (2016). Even if these claims seem somewhat hyperbolic, the blurred boundaries separating the two business models and their significant roles in transforming modern economies are reason enough to research their relationship.

As we demonstrate later, despite the extensive classificatory scholarship, multi-sided platforms and virtual communities are classified separately in different research streams. They tend to be confused, and the resulting classes are often excessively heterogeneous and sometimes include other business models. There is a conspicuous gap in the research on typologies encompassing both business models. Hence, the purpose of this research was to identify the most common types of both business models and their logics of value creation. The accompanying research question concerns the differences in the logics of value creation between various types of virtual communities and multi-sided platforms.

The important contribution of the research is the system of four identified business models. It may be treated as a middle-range theory explaining how virtual communities and multi-sided platforms create value. This article helps comprehend the diversity of both business models and explains their value creation logics with system dynamics diagrams. The study introduces new typology dimensions, i.e., collaboration among users, user competition, and user multi-sidedness. It advances thinking, especially about the last one, as user multi-sidedness has probably not been operationalized yet. The research also sheds light on objects as the key elements of platform value propositions that satisfy the needs of users and encourage them to return. Finally, this article contributes to the debate on the role of a business model in market competition.

This article proceeds as follows. We begin by discussing the existing classifications of both business models. Next, we present a detailed methodology for creating the typology. The subsequent section describes the resulting four business models. Afterwards, we discuss their logics of value creation and implications for research on classifications of business models. The article ends with a description of the main conclusions, further research, and limitations. The appendix presents the quantitative verification of the typology.

2. Literature review

Typologies of the business models applied by Internet companies rose in popularity at the turn of the millennium, tracking the growing popularity of Internet companies, whose operations followed a different logic than those of traditional companies. That period saw the emergence of the business model classifications that remain in use today. They include the typologies proposed by Timmers (1998), Weill and Vitale (2001), Rappa (2003), and Canzer (2003). Despite their different areas of analysis (Internet companies, e-business companies) and the varying number of types or taxons they distinguish, most of the classifications designed around 2000 and more recently [blindref] differentiate between multi-sided platforms and virtual communities. Both types of companies have been classified in a number of ways. Tables 1 and 2 present selected typologies and taxonomies of both business models along with the analysis criteria on which they are based.

Table 1. Selected typologies and taxonomies of virtual communities.

Authors	Subject of classification	Dimensions of classification	Resulted classes
Porter (2006)	typology of virtual communities	establishment (member vs. organization) and relationship orientation.	five types: social, professional, commercial, nonprofit, and government communities
Kaplan and Haenlein (2010)	typology of social media	social presence and self-presentation	six types: blogs, social networking sites, virtual social worlds, collaborative projects, and content communities, virtual game worlds.
Sibai et al., 2015	typology of virtual communities	their goals or topics of discussion	communities specialized in commerce, play, support, networking, and information
Sibai et al. (2015, pp. 250–253)	typology of online communities of consumption	social control (mechanisms or processes that adjust individual behaviors to adhere to specific rules in a social group)	three types: market (typical multi-sided platforms with social control exerted through economic mechanisms), hierarchy (users possess a range of abilities depending on their status, e.g., as founders), and clan (self-governance based on traditions, understood as standards that emerge from repetitive behaviors and define group behavior).
Rodríguez-López and Diz-Comesaña (2018)	taxonomy of Facebook-based Lego communities	structure, members' goals, and others related to goal	four types: those managed by the company, those operated by members with an informational/social objective, groups managed by members with a generic objective, and ones managed by members with the intention of buying or selling

Table 2. Selected typologies and taxonomies of multi-sided platforms.

Authors	Subject of classification	Dimensions of classification	Resulted classes
Kaplan and Sawhney (2000)	typology of B2B marketplaces	the purchasing method (systematic sourcing vs. spot sourcing) and the input (industry-specific raw materials and components vs. general maintenance, repair, and operating goods).	four types: MRO hubs, catalog hubs, yield managers, exchanges
Evans (2003)	typology of companies with two distinct groups of customers and at least one-way indirect network effect from the perspective of industrial organization	not expressed explicitly (type of network effect, revenue model)	three types: market-makers (enabling members of distinct groups to transact with each other), audience-makers (matching advertisers to audiences), and demand-coordinators (making goods and services that generate indirect network effects across two or more groups, e.g., software platforms).
Muñoz and Cohen (2017)	business model of sharing economy	platforms for collaboration, under-utilized resources, peer-to-peer interactions, collaborative governance, mission-driven, alternative funding, technology reliance	seven business models: crowd-based tech; collaborative consumption; business to crowd; spaced-based, low-tech sharing; sharing outlier
Reimers et al. (2018)	typology of two-sided markets from the perspective of New Institutional Economics	the body rationing the transaction (public or private) and the type of transaction (bargaining, mutual adjustment transaction, and managerial).	three types: private exchanges, hybrid, hierarchy
Täuscher and Laudien (2018)	taxonomy of marketplaces	Eighty-two binary variables attributed to three categories (value creation, value delivery, and value capture).	six types: efficient product transactions, digital product community, product aficionadas, on-demand offline services, online services, peer-to-peer offline services
Holland and Gutiérrez-Leefmans (2018)	taxonomy of small and medium-sized e-commerce platforms	value proposition, Web 2.0 sophistication, and revenue model	five strategic groups: information laggards, basic networking, advanced networking, advanced networking mature, and social media markets.
Perren and Kozinets (2018)	typology of lateral exchange markets (markets formed through an intermediating technology platform that facilitates exchange activities among a network of equivalently positioned economic actors).	consociality (the co-presence of social actors in a network resulting in opportunities for social interactions) and platform intermediation (the deployment of a software platform and its various digital tools as an intermediary that manages and coordinates the exchange between network actors).	Four types: forums, matchmakers, enablers, and hubs.
Sutherland and Jarrach (2018)	typology of sharing economy platform from the perspective of the mediation type	flexibility, matchmaking, extending reach, transaction management, trust building, collectivity	two types: decentralized and centralized platforms
Cusamano, Gawer, and Yoffie (2019)	typology of platforms	innovations, transactions	transaction platforms (intermediaries for direct exchange or transactions subject effects), innovation platforms (technological foundations upon which other companies develop complementary innovations), and hybrid platforms
Blaschke et al. (2019)	taxonomy of digital platforms from the perspective of platform architecture	perspective of their architecture	three archetypes: orchestration platform (co-opetitive and inclusive), amalgamation platform (monopolistic and assimilative), and innovation platform (hybrid and open).
Pousttchi and Gleiss (2019)	taxonomy of multi-sided platforms in the insurance industry	relation to traditional insurance companies	four types: competition, coordination, cooperation, collaboration

Kim and Min (2019)	typology of platform business models	value stream	three types: supplier, tailor, facilitator
Wirtz et al. (2019)	typology of platforms	transfer of ownership vs. access-based; peer-to-peer provided resources and marketer-provided resources	four types resulting from the binary nature of both dimensions
Perscheid, Ostern and Moormann (2020)	taxonomy of decentralized platforms	platform characteristics, value creation, value delivery, value capture	three types: centralized, semi-centralized, decentralized
Staub et al. (2021)	taxonomy of digital platforms from the perspective of business model	platform structure, platform participants	four archetypes: business/consumer innovation platform, business/consumer exchange platform
Cennamo (2021)	typology of platform markets	The main role played by the platform	three types: multi-sided transaction market, complementary innovation market, information market
Belleflamme and Peitz (2021)	typology of platforms	value creation (within-group and cross-group network effect, capitalization on stand-alone services), value capture (charging users of services, monetization via other users)	five unnamed groups: two communities, two multi-sided platforms, a content provider deriving revenue from advertising

As is apparent from the research cited above, multi-sided platforms and virtual communities have been classified separately according to various criteria. This is both a consequence of their multidimensional nature and a result of the diverse academic disciplines in which the studies were conducted. Multi-sided platforms are typically analyzed in information sciences, management, and economics from the perspective of their architecture, business models, network effects, and market functions. On the other hand, virtual communities are more often studied in psychology, sociology, and marketing. Common perspectives include member engagement, conflicts, and brands. Anchoring the classification in different academic disciplines results in disparate variables, leading to other classes.

Despite a significant number of classifications, few studies combine both types. Muñoz and Cohen (2017) analyzed sharing economy business models, while Perren and Kozinets (2018) researched lateral exchange markets. However, even these studies do not exhaust the combined categories of multi-sided platforms and virtual communities. Due to the research subject, they overlook non-transactional communities and marketplaces that connect buyers and institutional sellers.

In the case of articles presenting typology, there is a tendency to describe the research method only briefly. In particular, many articles do not include the operationalization of the dimensions, description of the research group, or empirical verification. Typologies are often considered to be conceptually derived, resulting from a reflection following the accumulation of the relevant knowledge, thus without

a formalized research process. Additionally, the resulting type system is at times a supplementation rather than the main subject of a study. On the other hand, articles presenting taxonomies usually provide a more in-depth description of the research method, which probably arises from the use of quantitative methods.

As mentioned above, both business models are regarded as separate entities in general typologies of Internet companies. Nevertheless, they tend to be confused with each other in detailed typologies. Täuscher and Laudien treat a digital product community as a marketplace (2018), while others categorize multi-sided platforms as communities (Sibai et al., 2015). The relationship between the two business models is also ambiguous in non-classificatory studies. In Choudary's view, community building is one of the platform's key activities (2015). Wirtz et al. (2019) point out that in studies on platforms in the peer-to-peer sharing economies, the focus has been on transaction entities and community-based online services. These approaches treat the community as an element of the platform's business model. In his discussion of reputation systems, Dellacoras (2010) presents a dissenting view, counting multi-sided platforms such as eBay as communities. Kaplan and Heanline (2010) in a similar way count YouTube as a content community, while the site is typically considered a multi-sided platform.

Furthermore, the classification subject itself is frequently diverse, thus hindering comparisons while illustrating the abundance and ambiguity of concepts. This is particularly apparent in the case of multi-sided platforms, which tend to be given related labels, such as platforms, multi-sided markets, and marketplaces. Sometimes, the boundary between different types of business models is shifted arbitrarily. Platforms may be understood as the technological foundation on which other firms develop complementary innovations (Cusumano et al., 2019) and hence cloud services or even microprocessors fall into this category. In another research stream, a network effect is considered a sufficient condition for being a platform. Therefore, content providers which connect advertisers with users (Evans, 2003), or even Netflix, which uses recommendation systems, are treated as platforms (Belleflamme & Peitz, 2021). The first approach comes from technical sciences; the other one, relating to the network effect, is used in economics. When approaching multi-sided platforms from the perspective of business

models, we decided to limit this category by concentrating on the main purpose of the website. An online store that allows the publication of customer reviews remains an online store even if the very function of customer reviews has some properties typical of platforms.

The heterogeneity of the companies belonging to the resulting classes is a common shortcoming. This may be perceived as contradicting the principle of typology, which is transforming the complexity of apparently eclectic congeries into well-ordered sets of a few rather homogeneous types (Bailey, 1994). In the research by Cusumano et al. (2019), the category of transaction platforms contains heterogeneous entities, such as marketplaces (Amazon Marketplace, Airbnb), dating sites (Match.com), instant messaging (Snapchat), and social media (Twitter, Instagram, LinkedIn). Cennamo treats search engines, along with social media and dating services, as examples of information markets (2021). Even if the above heterogeneous classes are justified as resulting from a broader view, there is a need for more precise classifications with groups of companies operating according to a similar logic of value creation.

The rationale for a common typology of virtual communities and multi-sided platforms are the common features found in both models. User interaction plays a crucial role in virtual communities and multi-sided platforms. Consequently, the network effect occurs in both types of entities. In the case of communities, the direct network effect is predominant, while the indirect one is more pronounced on platform (Belleflamme & Peitz, 2021). Managing the value for users on multi-sided platforms and in virtual communities involves development of a product, just like in the case of one-sided companies, and networks of users (Srinivasan et al., 2004). Examples of the former category comprise creating a user-friendly website and providing assistance. Developing a network of users, on the other hand, is often based on the so-called curation, i.e. filtering and controlling users' access to the platform, the activities in which they participate, and the connections they form with other users (Parker, 2016).

Other shared characteristics appear to differ in terms of intensity. Collaboration between users is noticeable in both models. Barret et al. (2016) state that online communities enable members with common interests or goals to collaborate and interact with one another virtually. While collaboration

among users is an essential feature of communities, it plays a lesser role on multi-sided platforms, where it may occur, for instance, when users review the activities of other users.

A phenomenon present in both business models is competition among users. It is essential on multi-sided platforms, where users from at least one group compete to interact with members of the other participant group. The highly competitive nature of platforms stems from their transparency. This, in turn, is driven partly by user rating systems, seller reputations developed over long periods, and filtering mechanisms. The competition occurs also in communities. Tim O'Reilly, who coined the term "Web 2.0", states that *rival ideas and solutions compete with one another in a free market for ideas* (Muegge, 2013). Community members compete also for status and distinction (Levina & Arriaga, 2014). However, it may be argued that competition among members of a community, unlike among users of multi-sided platforms, is peripheral to collaboration towards a shared goal.

There is a greater diversity of user roles on platforms than in communities. Multi-sided platforms are sometimes described as intermediaries connecting distinct users (Filistrucchi, 2012) or at least users belonging to distinct sides (Täuscher & Laudien, 2018). Communities, by contrast, are often said to connect individuals with similar interests, identities, etc. (Muegge, 2013), who can serve different functions within those communities (Sibai et al., 2015, Levina & Arriaga, 2014). Therefore, a diversity of roles is common to both models although it is more prevalent on multi-sided platforms.

The three characteristics, i.e. collaboration among users, user competition, and user multi-sidedness, are essential to value creation in virtual communities and multi-sided platforms. They also appear to vary in intensity in both types of entities. Hence, they may serve as dimensions of the common typology of virtual communities and multi-sided platforms. These variables have not been used in any of the above-cited classifications.

3. Research methodology

A typology can be understood as an organized system of types (Collier et al., 2013). Types are simplified theoretical entities that combine the characteristics of actual objects. Typologies represent the variety of objects occurring in a particular category. There are several approaches to defining the essence of a typology. Typologies are often described as the result of a grouping process. The analyzed objects are assigned to categories that should be internally homogeneous and externally heterogeneous. According to this perspective, typologies are classification tools comparable to taxonomies (Bailey, 1994). An alternative approach posits that typologies are not the result of classification because typologies aim to create types rather than categorize analyzed objects (Doty & Glick, 1994).

Comparing typologies to taxonomies, the former is more inductive, relies on fewer factors, and is more deeply anchored in theory. Taxonomies typically employ many variables, and grouping is conducted using quantitative methods such as cluster analysis. Taxonomies are more generally used in biology (Bailey, 1994), while typologies are well-established tools in the social sciences (Collier et al., 2013). The typology in question was developed following the four stages of analysis in the process of type construction distinguished by Kluge (2000).

3.1. Development of relevant analyzing dimensions

The first is the development of relevant analyzing dimensions. Based on the analysis of literature and the websites in question, three dimensions have been selected and operationalized into ordinal variables. These are collaboration among users, reputation-based user competition, and user multi-sidedness. They were consulted then with seven experts, including academic researchers and practitioners specializing in the area in question. The respondents were presented with the research agenda and the typology dimensions. Then they were encouraged to make and express appropriate reflections (Eisend & Kuss, 2019). The interviews took place without a standardized scenario and usually lasted 20-45 minutes. These consultations confirmed the general correctness of the dimensions and prompted minor

amendments. The number of grades was reduced in one of the dimensions, and terminology was modified in two others.

To operationalize the analyzing dimensions, we need to introduce the concept of the object. This is a unit of content submitted to a community or multi-sided platform by its users. It typically constitutes the first post in a given thread, thereby enabling other individuals to respond with their statements. Examples of objects include an image, video, or audio file; a description and photograph of a product along with its price; a classified ad for a second-hand item; a recipe; a job ad, and the first post in a thread on a discussion forum (e.g., posing a question or describing a problem). The posting of objects is, on the one hand, an element of collaboration because users strive to achieve a common goal by publishing particular types of content (e.g., images) on a given site; on the other hand, it has features of competition, because users desire to draw other users' attention to their objects. Users of all virtual communities and multi-sided platforms publish objects; therefore, this function cannot serve as a distinguishing feature and has not been included in the dimensions of the typology.

3.1.1 Collaboration among users

The first dimension of the typology is collaboration among users. Collaboration in online communities involves *offering knowledge to others as well as adding to, recombining, modifying, and integrating knowledge that others have contributed* (Faraj et al., 2011). Quantitative rating of objects and posting a comment that does not relate to other comments but the object itself are activities that create the content available to all but do not require adapting the message to comments by other users (Table 3.). The publication of a related comment requires greater alignment between the actions of the individual and the group. Collaborative creation of objects demands synchronization, cooperative decision making, and negotiating the rules of collaboration (Spagnoletti et al., 2015). An example of this type of action is creating an entry on a multifaceted topic by a team of Wikipedians.

Table 3. Typological dimension: Collaboration among users

5. Collaborative creation of objects	Require the coordination and collaboration of many individuals to create or modify an object (e.g., wikis)
4. Mutually connected comments	The dominant form of comments references earlier comments, thereby creating a discussion narrative (we have also included in this category websites on which comments cannot be unambiguously described as connected or unconnected).
3. Mutually unconnected comments below objects	The predominating form of comments expresses an opinion about the object without referencing statements by other users. They can therefore be presented in an arbitrary order.
2. Quantitative rating of objects	Users may rate objects. Their ratings are depicted quantitatively (number of stars, likes, upvotes, downvotes).
1. None	Users may only view posted objects and may not rate, comment, or contribute content.

3.1.2 Reputation-based user competition

In virtual communities and on multi-sided platforms, users compete with one another by posting objects to promote their ideas or to interact with other users. These actions are common to both entities and cannot serve as a distinguishing feature. On some sites, users can pay for a more favorable placement of an object or an advertisement thereof. This competition occurs primarily in marketplaces and is largely absent from virtual communities and non-transactional multi-sided platforms.

Therefore, user competition has been reduced in this study to reputation-based user competition. As Dellacoras notes (2010), reputation is one's past actions within the context of a specific community, presented in a manner that can help other community members make decisions with respect to whether and how to relate to that individual. A central reputation system is almost always essential in large communities where interactions among individual members rarely occur (Dellacoras 2010) and where there are hierarchical inequalities among users (Sibai et al., 2015). Reputation systems may rely on raw activity statistics, user feedback, and synthetic metrics (Dellacoras, 2010; Ziaie & Krcmar, 2012). The proposed dimensions of reputation-based competition correlate with the indications above (cf. tab. 4).

Table 4. Typological dimension: Reputation-based user competition

5. Detailed user information	A minimum of three dimensions describing a given entity based on ratings submitted by other users (e.g., in the case of a hotel: cleanliness, comfort, and location)
4. User feedback	List of comments and ratings left by users (with no detailed dimensions)
3. Activity summary	Statistics about the user's activity on the site (e.g., number of comments or uploaded files) or an overview of the content posted by the user (photos, recipes)
2. Self-presentation	The content of the profile page is self-presentational in character
1. None	No user profile page

Aside from the above levels, there exists also a stage of the reputation-based competition in which users reap tangible benefits from their reputations. These can include more frequent displays of a user's objects to other people, promoting their objects in popular areas of the site, or granting particular distinctions to users or their objects. These may be assigned by algorithmic detection or administrating operators (Ziaie & Krcmar, 2012). However, this is extraordinarily difficult to identify without information sourced from inside the organization in question. Therefore, this level has not been accounted for in the typology.

3.1.2 User multi-sidedness

An analysis of the literature devoted to multi-sided platforms and virtual communities reveals a multitude of approaches to user multi-sidedness. The term reflects the complementarity of functions that members of the participant groups of a given platform can play.

Many studies of communities and C2C platforms emphasize the equal status of users without mentioning their multi-sidedness, for example, in discussions of networks of equivalently positioned economic actors (Perren, Kozinets, 2018), peer-to-peer transactions (Mittendorf, 2018), people who transact directly with one another (Caldieraro et al., 2018), individuals who form special ties with other users and share information, ideas, and interests (Park 2018). Some authors accentuate the multitude of functions available to users, who may perform one or more roles in the systems (Choudary, 2015; Hein et al., 2019), participate in both the supply and demand sides (Täuscher & Laudien, 2018), or both obtain and provide resources or services (Ertz et al., 2016). Other subject discussions simply mention two or more groups of users (Gawer, 2014; Casey & Töyli, 2012; Rochet & Tirole, 2006, Fürstenau et al., 2019). The multi-sidedness of user groups is sometimes explained as the property of the entities they are, e.g., consumers and companies (de Oliveira & Cortimiglia 2017), buyers and sellers (Crittenden et al., 2017), external producers and consumers (Parker et al., 2016), autonomous complementors and consumers (Hein et al., 2019), demand- and supply-side participants (Veisdal 2020; Bazarhanova et al. 2020), independent contractors or professionals and clients (Hagiu & Wright 2015), and suppliers and customers (Alt & Zimmermann 2014).

As is apparent from these lists, various streams of research emphasize either the homogeneity or heterogeneity of a group. Furthermore, users can be assigned to a particular group persistently (based on what a given entity is) or temporarily (depending on the function it currently performs). Table 5 presents the degrees of user multi-sidedness as a dimension of the typology. They have been distinguished based on various criteria, such as the entity's characteristics, the function it performs, and whether the site is open or closed in nature.

Table 5. Typological dimension: User multi-sidedness

5. Two or more permanently different groups	The user base comprises two or more different groups. Membership in a given group is permanent and determined by the characteristics of a given entity (e.g., consumers vs. service providers). Users do not change roles.
4. Group with different transactional roles	A group of users interested in exchanging goods or services of a particular type. Interactions among users are characterized by a high degree of multi-sidedness (buyers vs. sellers), but entities may play different roles in different transactions.
3. Group with different non-transactional roles	A group for users interested in a particular topic. It features a range of functions, e.g., publishing digital objects vs. browsing and commenting. Some functions require users to perform more work or acquire more skills (e.g., creating digital content) than in the case of regular discussion groups. This results in the broader divide between people who post digital objects and those who browse and comment on them.
2. Open discussion group	A discussion group for people sharing specific characteristics, which additionally distinguishes between individuals persistently associated with the community and short-term users of the content posted there.
1. Closed discussion group	A discussion group for people sharing specific characteristics; content is inaccessible to random users. Users (e.g., students in the same class) are persistently associated with the community.

3.2 Grouping the cases and analyzing the empirical regularities.

In this stage, an analysis was conducted of 69 of the most popular Polish virtual communities and multi-sided platforms. These entities were selected based on web traffic rankings compiled in a study by Gemius/PBI, which quantified online traffic (site-centric measurements) and user behavior (user-centric measurements). The study is the standard method of measuring online audiences in Poland, one commonly used in planning advertisement campaigns (PBI, 2022). The analyzed entities were identified from a list of approximately 1,800 websites with the highest number of Polish users in May 2019. The list included websites of different types, including online stores, content providers, brick-and-mortar companies, and public institutions. Therefore, the entities in question are the most popular virtual communities or multi-sided platforms among Polish Internet users. The majority are domestic companies that operate in the consumer market. Companies were determined to serve a large number of users as they have developed the stable functions that were the subject of assessment and classification in this study. This, however, is not without complications. Companies at this stage of development often comprise several business models. In such cases, we attempted to select and rate the dominant functions (e.g., in the case of the auction platform Allegro, we recognized B2C rather than C2C sales as the primary function). If this was not possible, the company was excluded from the studied group (such was the case with Facebook). The analyzed entities also excluded communities and platforms belonging to popular web portals. In Gemius/PBI studies, these sites are listed collectively without providing detailed data on individual entities belonging to a particular group.

Next, the selected entities were rated according to the three dimensions. The subject of coding was the presence of certain website functionalities. An analogical assessment was conducted by a group of three master's students majoring in e-business as part of their term project. The two sets of classifications were essentially congruous. The few differences that mainly occurred involved companies characterized by several functions and pertained to selecting the primary function that was the object of assessment. The majority of these entities were social media.

3.3 Analysis of meaningful relationships and type construction

In theory, three dimensions of five grades each could result in 125 types. However, the analysis of empirical regularities and meaningful relationships (i.e. substantial adequacy of attribution of a website to an empirically founded group) led to distinguishing only four ideal types. This remains in line with Fiss's approach to typology (2011), according to which the complexity of the world should be *pragmatically* reduced to a limited set of ideal types. Each entity was assigned to one of the types, making the assignments mutually exclusive and exhaustive (Bailey, 1994). The distinguished types were then verified empirically, bearing in mind the suggestions made by Kluge (2000) as well as Doty and Glick (1994). The empirical verification is presented in the appendix.

Four distinct types were identified using the three variables among the 69 entities analyzed. They are problem communities, object communities, object markets, and reputation markets. Due to visual constraints, the location of the types in a three-dimensional space is presented in two tables (cf. tab. 6 and 7). In both, four distinct types emerge. One interpretation is that the typology could have been developed in two ways with fewer variables, and the resulting types would have been the same. The first way would be to consider two variables: collaboration among users and reputation-based user competition. The second way would be a typology based on one dimension: user multi-sidedness. This situation can be interpreted as confirming the correctness of the resulting types. It demonstrates that they could be distinguished using different sets of variables derived from the literature on the subject.

Table 6. Number of websites assigned to various levels of collaboration among users and reputation-based user competition as well as location of identified business models

Reputation-based user competition	5. Detailed user information			Reputation market\n\n12		
	4. User feedback	1	1	2		
	3. Activity summary	Object market\n\n10	2	Object community\n\n23	Problem community\n\n9	1
	2. Self-presentation				4	1
	1. None	1		1	1	
		1. None	2. Quantitative rating of objects	3. Mutually unconnected comments below objects	4. Mutually connected comments	5. Collaborative creation of objects
		Collaboration among users				

Table 7. Number of websites assigned to various levels of user multi-sidedness and location of identified business models.

5. Two or more permanently different groups	Reputation market\n18
4. Group with different transactional roles	Object market\n10
3. Group with different non-transactional roles	Object community\n34
2. Open discussion group	Problem community\n5
1. Closed discussion group	\n2

3.4 Characterization of constructed types

The distinguished types were described following the modified Amit and Zott's (2010) concept of the business model, i.e., a system (originally: a bundle) of specific activities that are conducted to satisfy the perceived needs of the market, including the specification of the parties that conduct these activities and how these activities are linked to each other. This understanding of a business model holistically depicts how a company does business, as opposed to what exactly it does or when or where it does it. This perspective emphasizes the process of value creation over value capture (e.g., revenue model, pricing strategy).

The system dynamics methodology was used to create detailed descriptions of the business models. This approach enables the illustration of feedback loops in complex systems. System dynamics analyses are flexible and able to capture various interactions and their characteristics, and—as Morecroft states (2015)—are particularly good for highlighting feedback loops that contribute to the dynamics. This methodology is commonly employed in studies of business models, strategy, or competition (Sterman 2010; Morecraft 2015; Casadesus-Masanell & Ricart, 2011, Gary et al., 2008), including multi-sided platforms (Casey & Töyli, 2012; Ruutu et al., 2017; Wang & Lai 2020; Täuscher & Abdelkafi, 2018) and virtual communities (Mao et al., 2007). As is typical of most articles about business models, we used the feedback system without specifying the power of individual effects in quantitative terms. As a consequence, the method employed in this research aligns with the categories of qualitative system dynamics and feedback loop diagrams. Specifically, it allows us to present generic business models in the form of system archetypes, but precludes us from conducting simulations to ascertain the systems' behaviors over time (Wolstenholme, 1999). The resulting system dynamics models have successfully undergone the validation procedure for boundary adequacy and structure assessment (Sterman, 2010).

Another reason for choosing the system dynamics to describe ideal types was that they serve theory building (Schwaninger & Groesser 2008), just like a typology does. McKinney put it unequivocally *types and typologies function as theory* (1969, p. 10). Both typology and system dynamics models meet

the criteria of being a theory (Doty & Glick 1994): constructs are identified, relationships among these constructs are specified, and these relationships are falsifiable. In the case of typologies, constructs are the analyzed dimensions and the ideal types. In the case of system dynamics, in turn, constructs are their elements. Both ideal types and system dynamics models are treated as middle-range theories (Doty & Glick 1994, Kopainsky & Luna-Reyes 2008), which attempt to generalize beyond a particular case but not beyond one set of circumstances (Woodside, 2003).

4. Description of resulting business models

The following describes identified business models. They serve as ideal types based on median values and contain the typical characteristics of the companies belonging to a given category (McKinney, 1966; Bailey, 1994) For this reason, the description uses the singular form. The qualitative system dynamics method was used to describe the logic of value creation in each of the types. A brief description of examples accompanies each business models. The exemplary websites are located precisely as the identified business models on the three analyzing dimensions.
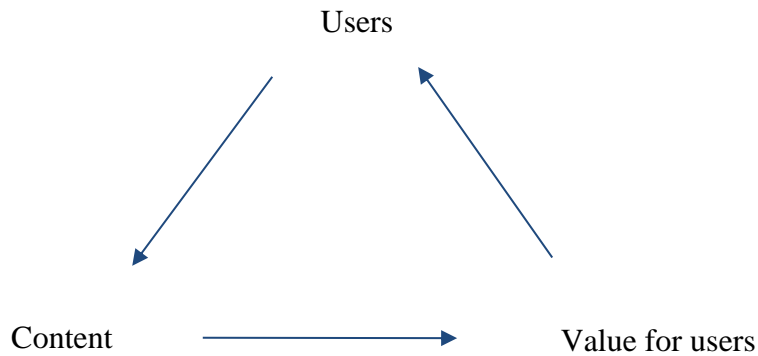
4.1 Problem community

In simple terms, a problem community is a discussion forum or a set of thematically associated discussion threads. One user initiates a thread, and subsequent posts form a discussion. Users collaborate to a large degree by responding to previous posts by other users.

Content is typically displayed in chronological order, beginning with the most recent post. The community moderators block content that does not meet specific standards. However, they do not select content to be displayed in key parts of the site (except for community rules, frequently asked questions, etc.). The user reputation mechanisms rely on quantitative summaries of an individual's activity within a given community (for example, the number of posts). Active users earn badges or status messages indicting their increased involvement. However, a more excellent reputation does not result in any tangible benefits. The problem community has the lowest degree of diversity in the functions performed by users. Starting a new thread or commenting on an existing one does not require access to different site functions or the fulfillment of other requirements (e.g., having a product for sale).

The simplified business model of the problem community can be described as comprising three main elements: users, content, and a value for users (cf. fig. 2). The more users in a given community, the

more content there is. This, in turn, reinforces the value for users. Consequently, new people join the community, raising the number of users and leading to further development.

Figure 2. Simplified business model of the problem community

Examples of a problem community are the websites: dojrzewamy.pl and stackoverflow.com. The first one is a community for teenagers (literally wearematuring.pl) in which they ask questions or describe their problems, which are later answered by their peers. The stackoverflow.com is a popular programmers' community that operates similarly.

4.2 Object community

The next type identified in this research is the object community. In this community, users post objects and comment on them. Objects can include various types of content: memes, recipes, or homework assignments, for example.

In contrast to problem communities, comments are associated with particular objects rather than other comments. As a result, the comments together do not form a linear whole but are instead a set of independent statements about a particular object. There is less synchronization and a lower degree of

collaboration than in the problem community. Users build their reputations with systems presenting their aggregated activity in numerical values, status messages, or ranks.

The multi-sidedness of this community is somewhat higher than that of the problem-based community. Nevertheless, it is still a relatively homogeneous group of people who share an interest in a particular subject, post objects, and comment on them. This model displays greater user multi-sidedness, as creating and publishing an object (e.g., a movie) requires more effort and sometimes more excellent technical skill than simply commenting underneath it. Some less involved users or those with fewer skills perform the roles of commenters only.

The simplified business model of the object community resembles that of the problem community (cf. fig. 3). The more users it has, the more content (objects and comments) it amasses, which in turn increases the value for users. However, this model also presents new factors and their attendant dependencies. In comparison to the previous community type, the role of the moderator also involves selecting objects and displaying them in essential parts of the community, such as the main page or the list of categories. Content curation thus resembles editor's picks in the printed press and similarly increases value for users. Another new feedback loop is the widespread use of mechanisms that facilitate users' sharing of objects on social media. In this manner, informal communication encourages new people to visit the object-based community.

Figure 3. Simplified business model of the object community
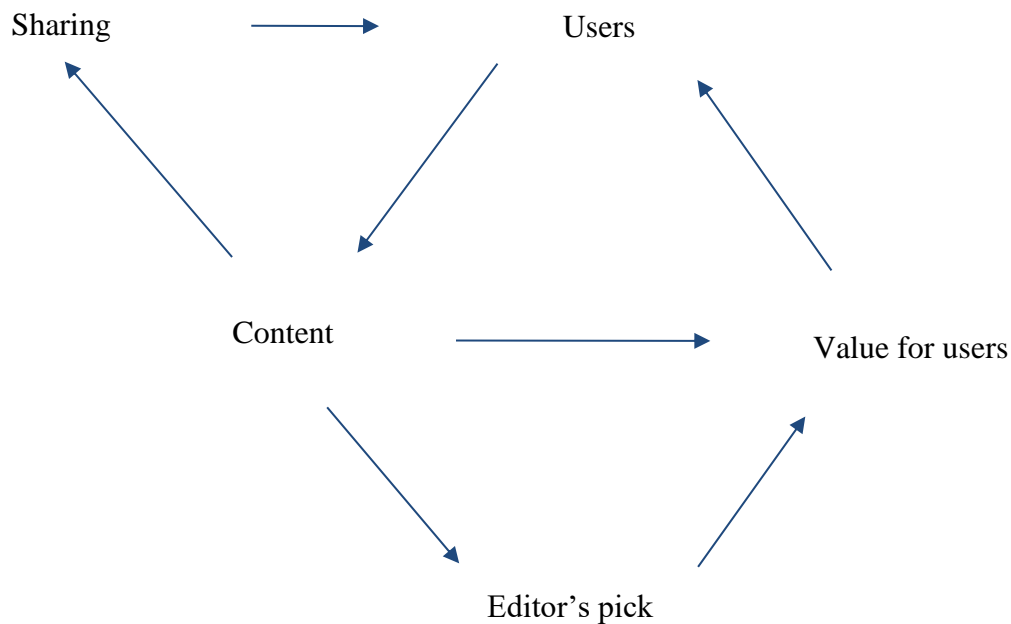
An example of an object community is the website kwejk.pl. This is a typical meme website. Users post their content, often of funny or shocking nature. The website community comments on them and rates them. The administrators pick up the content to be displayed in the major sections of the website (e.g., the homepage). The website gotujmy.pl (letscook.pl) is based on the akin logic. The users post here recipes which are later available to the website community.
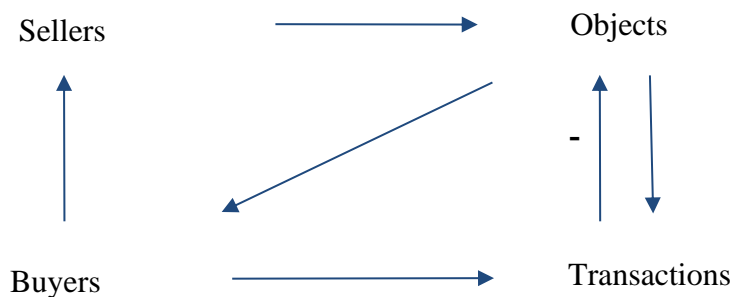
4.3 Object market

The third identified type is the object market. It is a multi-sided platform on which one group of users publishes objects intended for another group. This is how classified ad, job, and dating sites operate.

The lowest level of collaboration among users occurs in this model: users do not rate objects. These services serve as classified ad boards that help connect both sides, rarely offering any additional functions. What is particularly noteworthy in this case is the third criterion, namely the user multi-sidedness. Interactions among users are marked by a contextual two-sidedness. Each entity performs

a specific role in a particular transaction but may perform another function in a different transaction. For example, a user can buy one item on an auction platform and sell another.

In a simplified model of the object market, an increase in the number of sellers (an assumption made for simplicity; users do not always have to be sellers) leads to a larger number of objects (cf. fig. 4). The more objects there are on a site, the more appealing it is and the more traffic it receives from buyers. This results in an increased number of transactions. On this site, transactions reduce the number of available objects as posts are removed. The company must place a greater emphasis on acquiring new objects when the sellers remove existing ones. This relationship is exclusive to this type. In the remaining three types, objects are persistent. An increase in the number of buyers also leads to growth in the number of sellers as they join the site. This ideal type accurately depicts the operations of a classified ad site but provides a less accurate description of job and dating sites. Nevertheless, it remains consistent with the principles of the typology. Individual real types can share the characteristics of the ideal type in varying degrees.

Figure 4. Simplified business model of the object market

The website gratka.pl (bargain.pl) is an example of the object market. Users post classified advertisements here. The website community may access them; however, it cannot comment on them or rate them. The seller profiles predominantly present the list of their offers with scarce information about the seller. The other classified website is sprzedajemy.pl (wesell.pl), which follows the same pattern.
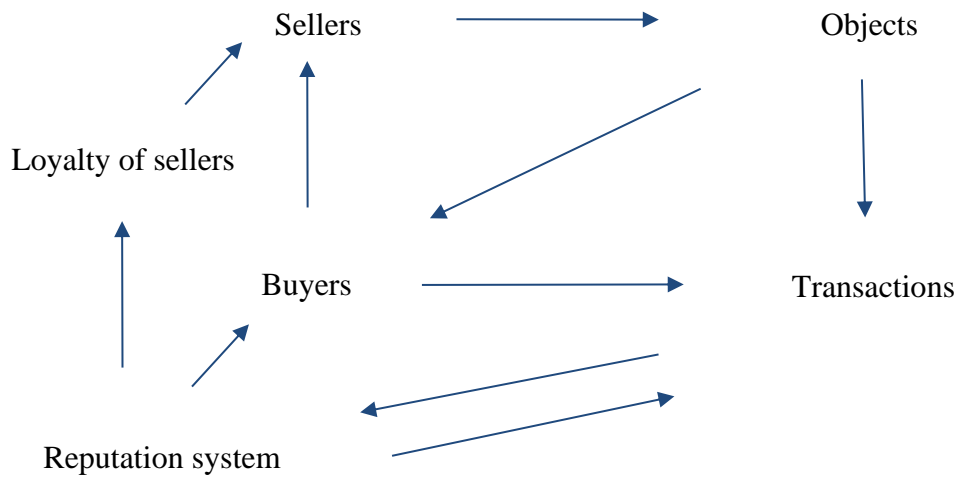
4.4 Reputation market

The final identified type is the reputation market. It is a multi-sided platform that typically connects buyers and sellers; however, unlike in object markets, the users' roles are fixed and do not change across transactions, and the products offered are repeatable. This type of site features elaborate user feedback-based reputation systems. Examples of reputation markets include price comparison sites and aggregators for companies offering various services (tourism, insurance, travel, and online-to-offline services).

Buyers collaborate by reviewing sellers with whom they have completed transactions or interacted in other ways. Out of all the business models distinguished in this research, reputation-based competition is most vital in this type. Sellers and their products are rated across many dimensions. This type also displays the highest level of user multi-sidedness: one group comprises sellers (or service providers), while the other comprises buyers. Notably, these roles are typically asymmetrical: buyers collaborate by rating sellers, while the latter compete based on their reputation.

The simplified business model of the reputation market resembles that of the object market, with two differences (cf. fig. 5). An increase in the number of transactions does not result in a decreased number of objects, as these are being continuously offered (e.g., hotel rooms). There is a reputation system that allows users to rate sellers. This is a crucial element of the business model. The elaborate reputation system facilitates the purchase of products by reducing the risk involved. This increases the number of transactions made by existing users and encourages new buyers to join the platform. The elaborate reputation system also positively affects the loyalty of sellers. A company with a favorable rating based on reviews from thousands of buyers may find its reputation a barrier to exiting a given marketplace.

Figure 5. Simplified business model of the reputation market

The ceneo.pl is the major Polish price comparison website and an example of the reputation market. It enables to find an online store offering a product at a low price and possessing an adequate reputation level. The website community heavily reviews both products and sellers. Similarly, the website niania.pl (nanny.pl) associates parents with babysitters. Its central section presents profiles of the babysitters who are reviewed in four dimensions, i.e.,—the quality of care, honesty, responsibility, and contact with children. Interestingly, niania.pl also utilizes the business model of the object market. Parents may post an ad about hiring a babysitter, which is not ranked or reviewed. This section is, however, less popular. Table 8 presents profiles of the identified business models.

Table 8. Diversity of distinguished business models

	Problem community	Object community	Object market	Reputation market
Overarching business model	Virtual community	Virtual community	Multi-sided platform	Multi-sided platform
Examples	Discussion forums, social media sites	Memes, recipes, homework, wikis	Classified-ad sites, dating sites	Price comparison sites, delivery aggregators (e.g., restaurants), hotel and air travel booking sites
Collaboration among users	Majority of comments are mutually associated	Majority of comments below objects are not mutually associated	None	Majority of comments below objects are not mutually associated
Reputation-based user competition	Activity summary	Activity summary	Activity summary	Detailed user information
User multi-sidedness	Open discussion group	Group with different non-transactional roles	Group with different transactional roles	Two or more permanently different groups
Object type	Post beginning a new thread	Text, image file, video, audio	Classified ad for a second-hand item, a user profile	Description of a continuously available product
Primary method of object curation	Discussion moderation	Editor's pick (selection and prominent display of a small number of objects)	Sourcing new objects to replace removed objects	Providing an exhaustive reputation system
Number of entities in the analyzed set	10	32	14	13

5. Discussion

5.1 Logics of value creation in identified business models

There are four business models identified in the proposed typology, i.e., problem community, object community, object market, and reputation market. Their common feature is the centrality of objects to their business models. Objects are crucial elements of their value propositions because they satisfy the user needs and encourage them to return to the website. Objects also contribute to acquiring new users as they appear in search results or are shared on social media. Among the companies analyzed in this research, almost no entities displayed high user engagement in collaboration within the scope of a single object (the exceptions being Wikipedia and its economics-oriented clone, mfiles.pl). This means that virtual communities and multi-sided platforms operate at large scales by publishing objects created by individual users rather than relying on intense collaboration among many people on one object.

One may find a similarity between user acquisition strategy observed in the identified business models. First, we acquire object creators and then the users who view or purchase the objects. In the absence of the former, a website is simply an information system with no desirable content. However, there are differences in the methods of object curation across identified business models. Object curation in an object community relies on the selection and prominent display of a few objects, which may be conducted by an administrator (i.e., editor's pick) or by the algorithm. Interesting differences in object curation emerge between the object and reputation markets. In the latter, objects are constant because they depict goods or services offered on an ongoing basis. User feedback plays a crucial role in the reputation-based market model, where it forms the basis of reputation systems. Systems of this type typically display quantitative scores and written reviews. This helps shield the buyer from the risk of choosing an unreliable seller while also contributing to the endurance of the reputation market itself. A hard-earned reputation, often based on tens of thousands of reviews, poses a severe barrier to exit for a seller on a particular platform. In other words: building a reputation helps sellers contact potential buyers, but because this reputation is frequently nontransferable to different market contexts, it also constitutes a high switching cost for the seller. Established seller reputations can potentially lead to

another phenomenon, namely, limiting the inflow of new sellers. The existence of this barrier to entry for new sellers may be a subject of future research.

The same cannot be said of object markets such as classified ad sites, dating systems, etc. Objects in this type are not typically associated with comments and can be described as bare or isolated. In contrast to the three remaining types, these objects are not persistent. An object such as a used car ad disappears after the transaction is finalized. Therefore, managing objects in an object market involves more than just accumulating objects and extracting permanent income from them, as is the case with an object community featuring book reviews or recipes. Managing objects in an object market necessitates the continuous acquisition of new objects not just for growth but also to compensate for lost objects. Here, sellers also operate under different circumstances. They often lack established reputations, the loss of which could constitute switching costs, and therefore find it simpler to leave the object market. Based on this reasoning, one could posit the hypothesis that the business model of the object market is less enduring than that of the reputation market, mainly when the latter achieves a critical mass by acquiring the necessary number of sellers and buyers, which translates into objects and their reviews.

Regardless of the objects they acquire, virtual communities and multi-sided platforms also compete based on the comments posted beneath these objects. This is particularly apparent in problem communities and some object communities (such as those in which the object is a question or a homework assignment, and the answers are submitted in the comments). In reputation markets as well, value is created for the buyer not merely by the availability of numerous desirable objects but also by the comments accompanying them, as these reviews are fed into reputation systems that facilitate transactions. The marketplace uses customer opinions to control the quality of its objects, for instance, by providing better exposure to ones with higher ratings. The reviews can themselves be rated by the marketplace's users and sorted in order of helpfulness. This conclusion contradicts Choudary's (2015) observation that platforms, unlike pipes, do not control core value units' quality and quantity.

5.2 Implications for classifications of business models

Our research demonstrates the existence of a continuum encompassing virtual communities and multi-sided platforms. The continuum is to be noticed on two dimensions (reputation-based competition and user collaboration) and on a one-dimensional view (user multi-sidedness). The four identified types form a continuum in that the analyzed entities display a gradation of selected features, accompanied by a similarity between neighboring types and significant differences between extreme types. The problem community and the reputation market are the extreme types. The first one constitutes a place for discussion and sometimes other forms of collaboration, while the latter is a highly specialized mechanism of matchmaking of demand and supply. Object community and the object market are examples of neighboring types that share common properties, e.g., the user roles are complementary and contextual. It is, therefore, reasonable to conclude that virtual communities and multi-sided platforms can be considered distinct but related business models.

The companies analyzed in this study tend to cluster in particular places rather than being evenly spread throughout the typological space. This correlates with the approach adopted by Amit and Zott (2010), which states that a business model depicts how a company does business, as opposed to what exactly it does or when or where it does it. This approach better reflects the business models of the companies analyzed here than that of Casadesus-Masanell and Ricart (2011), in which a business model is a system of choices and consequences. When viewed from the perspective of this study, business models appear to display a kind of determinism that is the opposite of individual decisions made by managers. If a company belongs to a particular type, it is characterized by specific functions (e.g., user rating systems in reputation markets). This comes as no surprise because a similar situation occurs in traditional business models: a grocery store, for example, has several consistent features, such as product displays, cash registers, etc. In this sense, the ideal types identified in this study can hardly be considered innovative. If the analyzed companies and business models are innovative, it must therefore be the result of factors other than the general characteristics of the types of companies they are. Täuscher and

Laudien (2018) reach a similar conclusion in their taxonomy of marketplace businesses. They attribute the innovativeness of certain entities to a composition of several archetypal business models.

Similar observations can be made with regard to competitiveness. If one assumes that the companies in a given sector employ the same generic business models, then competition can occur based on the characteristics of individual elements of the business model (e.g., number of users), impact vectors (i.e., the interaction between elements), or emergent phenomena (e.g. brands, marker leadership). Companies can thereby compete based on a selected element or, more broadly, based on their business model, in the systemic sense of the term. As we analyzed companies in the course of our research, we also observed business model-based competition in the typological meaning of the term. Some object communities featuring recipes or essays for students competed with providers who offered similar content but had created or purchased it themselves. Some reputation markets competed in this manner with online retailers. This situation resembles the competitive relationship between a local open-air market and nearby grocery stores.

The business models of companies attributed to the same types are similar, even if they operate in different markets. One possible way of explaining the similarities between business models can be found in the concept of a dominant design, which posits that variety decreases in the later stages of a product's life cycle, and the product itself becomes standardized (Utterback & Abernathy, 1975). In this case, we apply the concept of dominant design to a business model rather than a product. The early years of the commercial Internet can be regarded as an era of ferment, with many alternative designs. Some business models discussed at the time no longer exist or have declined in popularity. One example of such a model is the e-mall, a place that aggregates online retailers belonging to a particular market (Timmers, 1998). In the following stage, the era of incremental change, a dominant design is a single architecture that establishes dominance in a category (Anderson & Tushman, 1990) and defines the design attributes that are widely accepted as meeting a users' needs (Tiwana, 2014). The business model that superseded thematic e-malls was the price comparison site, which allowed users to quickly search for products offered at low prices by reputable retailers. Price comparison sites are structured

around their users' current consumption needs, while e-malls listed offers from various stores in a given category.

The models identified in this study are generic. Internet companies operating at large scales often combine several business models. Facebook includes object community (users of the community post and comment on objects), problem community (discussion groups), object market (Facebook Marketplace), and to some degree, reputation market (fanpages vs. readers). This conclusion correlates with the approach adopted by Aversa et al. (2020), who identified six business models within the Amazon.com ecosystem. The diversification of business models, meaning the inclusion of their different types, helps achieve demand-side complementarities. Approaching the issue of the diversification of business models from the system dynamics perspective, one could mention another goal, namely the creation and reinforcement of feedback loops that are beneficial to the company (Casadesus-Masanell & Ricart, 2011).

The typology is also relevant in light of the discussion on the so-called sharing economy. The term itself, it should be noted, is imprecise, as there is no subsystem of the economy in which companies categorized with this label interact. There are, however, business models that rely on the sharing of resources. These types of companies often operate in traditional industries, influencing other entities within them and affecting the way they do business. What is more, offers of traditional commercial entities constitute a significant share of listing on sharing platforms (Gyódi, 2019). Also, in many ventures categorized as belonging to the "sharing economy," the economic component is relatively small (Jemielniak & Przegalińska, 2020). The idea of resource sharing can be applied in all of the types identified above. Access to a certain kind of value without the transfer of ownership takes place in some reputation markets, object markets enable peer-to-peer resource exchange, object communities are a form of peer production, and problem communities are forums where users share knowledge.

6. Conclusions, further research, and limitations

This article presents the common typology of virtual communities and multi-sided platforms. It was possible to develop the typology through the introduction of new concepts. The first one was the object, understood here as a unit of content that is the basis for subsequent user interactions. The next category of concepts was three dimensions of typology. They can be classified as contributing to the stream of research on platform architecture and referring to mechanism design theory (Hurwicz & Reiter, 2006). The resulting four ideal types are the next set of concepts. The relationships between the concepts was identified, discussed, and—in the case of the typology dimensions and ideal types—also verified quantitatively. Moreover, the resulting business models were depicted with the qualitative system dynamics models. Hence, the article contributes to building the theory explaining how virtual communities and multi-sided platforms create value.

A vital contribution of this study is that it draws attention to user multi-sidedness. This aspect has been mentioned in the context of multi-sided platforms; however—to the best of our knowledge—this article is the first to discuss user multi-sidedness as a continuum: from a homogeneous group of users performing similar roles at one end to two persistently distinct groups at the other. Each of the four identified groups ranked differently within the dimension of customer multi-sidedness.

The resulting set of business model archetypes might constitute a basis for further research. They are new research problems stemming from the identified business model. The first one is the revenue model, especially how the methods of generating income differ among the four types. Another potential area of study could refer to strategies formulated in relation to customers and competitors. The question of the extent to which the analyzed types contribute to category monopolization and disruption of adjacent markets is undoubtedly of greater importance. Finally, do some of these types occur together, i.e. are they often used simultaneously by one company? Their coexistence has been observed in multi-sided platforms encompassing problem community functions.

Another avenue of research would be to describe the identified types using a method other than system dynamics. Examples of such methods could include the Business Model Canvas (Osterwalder & Pigneur 2010) and their platform-related modifications [blindref], as well as Amit and Zott's approach involving four sources of value creation in e-business (2001). Given how different these approaches are, using them to identify the characteristics of the business models distinguished in this study could produce novel results.

A discussion of the findings must also mention their limitations. The main assumptions, particularly the typology dimensions, were chosen based on a subjective view of the current knowledge of virtual communities and multi-sided platforms. For this reason, the dimensions were consulted with academic researchers and practitioners. The assessment of the analyzed entities' development in the three dimensions was also, to a degree, marked by researcher bias. The subject of this analysis comprised the most popular web-based communities and multi-sided platforms in Poland. Aside from a few global websites, most of the analyzed entities are domestic, which might result from the high competitiveness of the Polish market. However, we did not perceive the significant impact the Polish market has on the identified business models, at least when compared to companies operating in the EU and the USA.

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8. Appendix. Quantitative verification of theoretical attributions

The correctness of the theoretical attribution of the analyzed entities to the types distinguished in the typology was verified by comparing it to a classification created using a quantitative method. This method involved identifying groups characterized by the greatest degree of internal homogeneity and the greatest degree of external heterogeneity.

The quantitative classification was conducted with the help of the general distance measure, which is used to group objects based on ordinal variables (Walesiak 1999). Four groups were identified using hierarchical agglomerative clustering with the average linkage method. The analysis was performed with the help of the clusterSim package available in the R programming environment.[1]

In this classification, the three dimensions of the typology were used as the axes of a multidimensional space. Virtual communities and multi-sided platforms were graded on a scale of 1–5, with the higher values representing a greater intensity of a particular feature. Due to using a weak and uniform scale of measurement, the variables were not normalized. The ratings assigned to the features are represented by points in the three-dimensional space. By comparing the distance between points using the clustering method, we can identify proximate objects (Walesiak & Gatnar, 2009).

The agglomerative method was used to determine the groups. This method produces a dendrogram that depicts a hierarchy and a method of linking the objects into groups with the greatest possible degree of homogeneity (Panek, 2009). The four identified groups form separate branches on the dendrogram. The average linkage method was used to group the objects, achieving a high validation score measured with the adjusted Rand index (Walesiak & Dudek, 2010).

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The clustering results are depicted in the form of a dendrogram (cf. fig. 1) and basic structure measures (Table 9). The dendrogram illustrates the connections and hierarchies between the analyzed entities. Cutting the tree at the dotted line produces four groups of entities of the following sizes: n1=16, n2=27, n3=13, and n4=13.

Figure 1. Dendrogram illustrating the grouping of multi-sided platforms
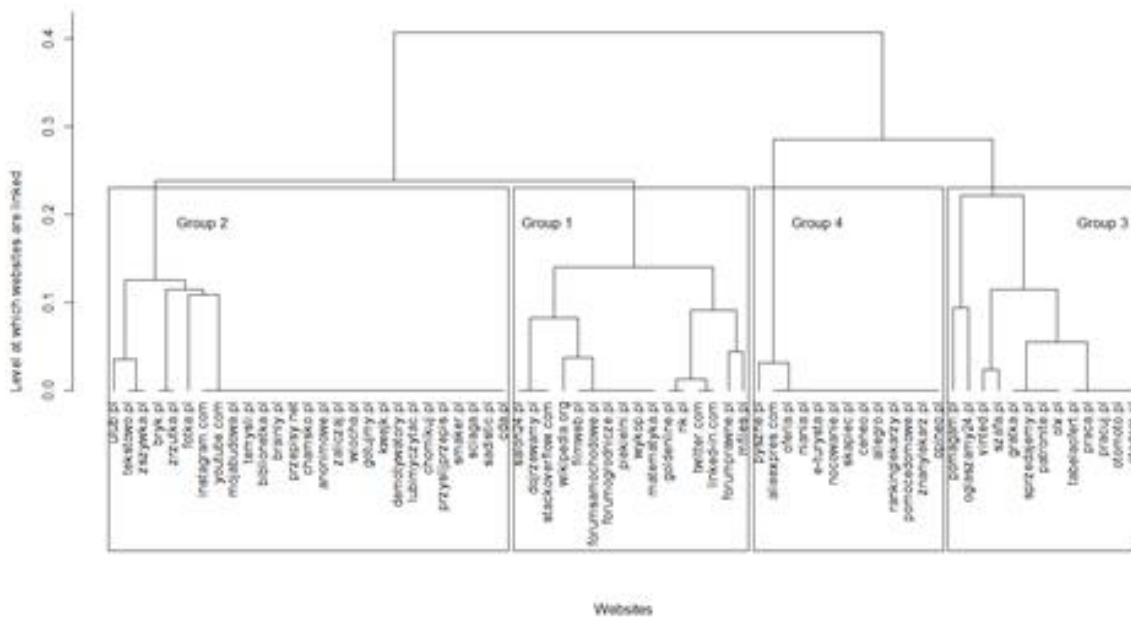
Structure analysis of individual rating dimensions enables the characterization of the distinguished groups (Table 9). The first group is marked by a high degree of collaboration among users and low mean values of reputation-based competition and user multi-sidedness. Notably, the collaboration value displays a small range, indicating a high concentration level for this feature. Entities with low collaboration values do not occur in this group. The opposite is true of reputation and multi-sidedness, which occur at varying levels but are concentrated at the bottom end of the range of grades (3 and lower). This group corresponds to the type defined as a problem community. Except for the dimension depicting user multi-sidedness, the median values of individual features assigned to the group using the method correspond to the ideal type. Five websites were classified differently. These entities were

assigned to the second type in theoretical attribution, defined as an object community. The greatest differences between the quantitative and theoretical attribution in the first group were observed.

The second group is the most numerous and is characterized by an average rating (approximately 3) in each dimension. A high concentration can be observed around the mean value, with collaboration receiving the lowest ratings, some of which fall below 3. The median values for individual features correspond perfectly to the ideal type of the object community. One entity, a crowdfunding platform, was classified differently in the theoretical attribution, where it was assigned to the object market rather than the object community.

The third group is marked by a very low collaboration value, average reputation-based user competition levels, and large average multi-sidedness. The range indicates a large divergence of grades in the case of competition, indicating a lack of full homogeneity in this group in this regard. As in the second group, complete correspondence is observed between the median values of individual features and the conceptually depicted ideal type. All observations assigned to the third group also belonged to the type defined as the object market.

The fourth group encompasses entities with average collaboration values but very high levels of reputation-based competition and multi-sidedness, with a bias towards the latter, where all entities scored 5 (with a range of 0). Complete concentration is also observed in customer collaboration, indicating high conformity of scores in this dimension. Furthermore, the fourth group displayed complete correspondence between quantitative and conceptual clustering. The median value of individual features produced by clustering is identical to that of the ideal type defined as the reputation market.

Table 9. Structure analysis of quantitative clustering and theoretical attribution

Group	Number of companies	Dimension	Mean	Standard deviation	Median	Min	Max	Range	Ideal type features	Number of companies	Ideal type
1	16	Collaboration	4.12	0.34	**4**	4	5	1	**4**	11	Problem community
		Competition	2.56	0.63	**3**	1	3	2	**3**		
		Multi-sidedness	2.44	0.73	**3**	1	3	2	**2**		
2	27	Collaboration	2.85	0.46	**3**	1	3	2	**3**	31	Object community
		Competition	3.04	0.19	**3**	3	4	1	**3**		
		Multi-sidedness	3.07	0.27	**3**	3	4	1	**3**		
3	13	Collaboration	1.23	0.60	**1**	1	3	2	**1**	14	Object market
		Competition	2.85	0.90	**3**	1	4	3	**3**		
		Multi-sidedness	4.38	0.51	**4**	4	5	1	**4**		
4	13	Collaboration	3	0	**3**	3	3	0	**3**	13	Reputation market
		Competition	4.92	0.28	**5**	4	5	1	**5**		
		Multi-sidedness	5	0	**5**	5	5	0	**5**		

The data presented in Table 9 reveals a high level of conformity between the median values of features assigned to groups using quantitative clustering and the characteristics of ideal types. One exception is user multi-sidedness in problem communities. The last two groups display high conformity with the size of the theoretically assigned groups. Greater differences occur in the first group, which was assigned more entities in the statistical clustering than in the theoretical attribution. Subsequent analysis reveals the validity of the latter.

In general, clustering using either technique produced convergent results. Among the 69 entities classified with the help of the quantitative method, 63 were assigned to the same group as in the theoretical attribution, indicating 91% conformity between the two analysis methods.