HOW TO DEFINE THE CONCEPT OF A COMPLEX PLATFORM?

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Abstract: *Today, complex platforms have evolved rapidly and are shaping not only the economy but also our daily lives. In the age of platforms, our daily habits, business opportunities and labour market structures are undergoing significant transformations. A review of the literature shows that the definition of complex platforms is not uniform. The aim of our research is to explore the platform definitions in the literature and to synthesize them into a complex platform definition that encompasses the characteristics of existing platforms. The research method is a detailed review of the literature on platforms, a mapping of the concept of platform from different aspects and the definition of a new classification criterion. We formulate a complex platform definition that combines the main elements of platform definitions in the literature. In this research, we pointed out how to define complex platforms, combining the main elements of the definitions found in the literature.*

Keywords: *platform, complex platform, value creation, monetization, renewal*

JEL Classification: *O32*

Introduction

The technology we use today, which permeates almost every aspect of our lives, has evolved in a very short time. Because we can connect to the internet from almost anywhere in the world and browsers are readily available, we do not really care where or how a particular system we are using is actually running. Most often we use YouTube or even Facebook. These are platforms. And we are interested in these "services" being available quickly and preferably for free.

If we think of platform as a concept, it has an interesting history, as the word has existed in the Hungarian language for several centuries, yet the term platform is most commonly used today to refer to the major Internet services that exist today. The use of this name is the result of a longer process, which is still ongoing.

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The literature on platforms is growing day by day and we can see that there are several ways to characterize each platform. In most cases, they have specific characteristics and we tend to associate the term with the Internet, but we can also understand them as a specific system. The use of platforms is very widespread in our daily lives, whether in service delivery, entertainment software, tourism systems or personalized passenger transport services.

Despite the fact that today many authors deal with the phenomenon of platformization, there is little theoretical literature on the classification and definition of platformization.

Bartelheimer and colleagues (2022) analyzed 11 049 publications on platform research, spanning 44 years of research on text mining and unsupervised machine learning, but did not provide a general, comprehensive definition of the concept.

According to several authors, platforms have now become global and dominant in terms of market value, making them successful and valuable for companies (Saberian et al., 2020; Kiesling, 2020).

The platform concepts referred to in various international studies are often not identical or even compatible. On the one hand, researchers use different terms for the same concept (e.g. internet platform and online platform), and on the other hand, they use the same terms for different concepts. This lexical fragmentation makes it difficult for practitioners to consistently identify and define platforms and the characteristics of each platform type (Bartelheimer et al., 2022).

According to McIntyre and Srinivasan (2017), standards define the technical specification of the platform that supports the ecosystem and create value through a common architecture.

Since the term platform became common after the global spread of the Internet, it is often mistakenly used to identify only Internet-related platforms (Hein et al., 2018).

Companies are taking advantage of the opportunities offered by platforms and other ICT technologies to varying degrees. It is up to the company to decide which economy it wants to be part of. Many companies are trying to differentiate themselves from their competitors by using different platforms. First, new technology has developed that is leading to a complete restructuring of the economy. Second, they represent a new communication structure that is changing the way the economy itself operates.

The aim of this study is to review the platform definitions in the international literature, to formulate a generally accepted definition of a complex platform based on these definitions, and to categorize and classify complex platforms according to their functionality.

How did the concept of platform evolve?

If we look at platform as a concept, it has an interesting history, as it has existed in the English language for centuries, and the sense in which we use it today is the result of a long process and transformation.

The origin of the word, which appeared in the English language as early as the 16th century (Oxford English Dictionary), is “an elevated surface on which people or things can stand, a separate structure for a specific activity or activity”. In addition, platform has another figurative meaning: “a plan, a concept, an idea, something that serves as a pattern or model.” (Török and Ződi, 2022)

With the spread of information technology innovations, communication between natural and/or legal persons has undergone transformations. The properties of physical means are no longer necessarily required, and are in most cases replaced by the efficient transmission of data and information. Digitalization brings with it the need for a completely new understanding of the value provided to users. Like all change, digital transformation is not without its problems. One of the biggest challenges, apart from the high costs, is the extraction of information from data and its use in decision-making. Of course, there are other sources of problems besides cost, such as unstructured data, unreliable sources, inaccuracy of data, which may require additional resources, increasing both cost and time (Nagy, 2017). In this new and rapidly changing environment, intellectual capital is also becoming increasingly valuable, and companies that are able to transform

data information more efficiently and quickly and ultimately make the necessary decisions will be in a better competitive position.

The emergence of computer operating systems has given the word platform a new meaning. In many cases it becomes a standard on which certain software can be developed. The notion of the Windows platform as a multi-tasking single-user operating system and the Unix or Linux platform as a multi-tasking and multi-user operating system are emerging. The term platform typically refers to a specific operating system or hardware architecture.

In the 2000s, platform, in the sense in which it was used in everyday life, was a term for IT and marketing.

In their research, Zhu and Iansiti, as early as 2007, point out that the power of a platform is increased by user activity, i.e. direct and indirect network effects (Zhu and Iansiti, 2022). Google played an important role in the development of the word platform in 2006, when it acquired YouTube and replaced the terms website, community site, forum with platform in its marketing campaigns.

Social networking sites have become the dominant communication tool of the 21st century. They are evolving rapidly, both in terms of the number of users and in terms of technical solutions.

In the software industry, the term platform is also often used to refer to a technical foundation on which additional software can be built (Yoo et al., 2010; Debortoli et al., 2016). Platforms can also be understood as specialized networks, where interactions between members or participants are influenced by the network effect.

As digitalization has enabled platforms to provide easily accessible information, it reduces uncertainty and allows more participants to join (Asadullah et al., 2018).

If we look at platforms from a managerial perspective, we can see that they have an impact on online communities, enabling professionals to better understand and design value creation strategies with platforms.

In his research, Daradkeh examined platforms from multiple angles, including market, technology, organization, and value perspectives. The diverse viewpoints found in the literature on digital platforms have resulted in a wide range of definitions (Daradkeh, 2023).

From a market perspective, a platform can be understood as a collection of technologies, products, or services specifically designed to enable and support direct interactions between two or more distinct groups of customers or participants. These platforms serve as intermediaries that connect different user groups, facilitating exchanges, transactions, or collaborations in a seamless and efficient manner (de Reuver et al., 2018).

From a technology perspective, a platform can be described as an extensible code base built upon a software system that delivers essential core functionalities, along with operator interfaces that allow various components to seamlessly interact and interoperate with it. Furthermore, it encompasses an adaptable and expandable digital core that remains open to third-party developers, enabling them to contribute enhancements, develop complementary features, or integrate additional functionalities that further extend the platform's capabilities (Kim and Min, 2019).

From an organizational viewpoint, digital platforms are systems that enable and streamline communication, interaction, and collaboration across various stakeholders. These platforms play a crucial role in supporting both economic transactions and social activities by providing a digital infrastructure that fosters innovation, facilitates the exchange of ideas, and connects individuals or organizations to drive mutual benefits. They are designed to create environments where diverse participants can engage, share resources, and contribute to the growth and development of both economic and social initiatives (Holzmann and Gregori, 2023).

From a value perspective, a platform can be seen as a comprehensive collection of digital resources, which include various services, tools, and content designed to enable meaningful interactions between external producers and consumers. These interactions serve as a foundation for creating value, as they facilitate the exchange of goods, services, or information, and allow both

producers and consumers to contribute to and benefit from the creation of new products, solutions, or experiences. The platform acts as a conduit, bringing together diverse participants to collaborate, innovate, and generate value through their engagement and exchanges (Foltean and Bruggen, 2022).

General model of platforms

It is difficult to clearly distinguish between the different types of platforms. The distinction can be made from a number of factors and perspectives. In the present research, we classify and construct a general model of the concept of platform according to their function. Before describing the model in detail, for ease of reference, the typology we have developed is presented in fig. no.1.

<table>
<tr><td rowspan="9">platform</td><td rowspan="4">hardware</td><td>– internet/intranet</td><td></td></tr>
<tr><td>– cloud-based</td><td></td></tr>
<tr><td>– mobile</td><td></td></tr>
<tr><td>– development</td><td></td></tr>
<tr><td>– computing</td><td></td></tr>
<tr><td rowspan="9">software</td><td rowspan="5">community</td><td>– sharing</td></tr>
<tr><td>– social media</td></tr>
<tr><td>– communications</td></tr>
<tr><td>– dating</td></tr>
<tr><td>– evaluator</td></tr>
<tr><td rowspan="5">e-commerce</td><td>– online store</td></tr>
<tr><td>– e-commerce</td></tr>
<tr><td>– blog</td></tr>
<tr><td>– marketplace</td></tr>
<tr><td>– browser</td></tr>
</table>

Figure no. 1. General model of the platform

Source: Author's creation

Within the platform category, the hardware and software category appear as a narrower category.

Hardware platform is basically a generic term used to describe a component of an analogue or digital computer or a physical network. The term hardware distinguishes the tangible aspects of a computing device from software, which consists of written, machine-readable instructions or programs/applications.

"A software platform is a software package that enables the implementation of application systems. [...] Together with the organizational knowledge about hardware and the design and operation of application systems, the software platforms used form the IT infrastructure of the company." (Taudes et al., 2000)

The term Internet platform refers to the way the Internet remotely connects different groups of users by allowing different transactions to be carried out using specific protocols in conjunction with the IT infrastructure.

In cloud platforms, services are not hosted on a specific hardware device, but distributed across the provider's devices, hiding the operational details from the user.

We use mobile platform as a term when we think of smartphones or other mobile devices that are based on mobile network operators and mobile application developers.

The term development platform refers to tools and frameworks that support programmers in the software development process (Gerber et al., 2012).

A computing platform is an information technology platform that provides computing resources and can be used to solve computational problems.

Social platforms are interactive sites that offer content with different social features, which can be shared, adapted or supplemented in some way. Social platforms can be grouped according to several criteria, such as: time of publication, country of origin, reach, etc. From a practical approach, the most important grouping criterion is the approach based on their functionality. According to the operational grouping, one category is the sharing platform.

By definition, sharing platforms "facilitate sharing between people who do not know each other and who do not have mutual friends or connections, but make stranger sharing less risky and more attractive, as users can be considered by reputation and ratings." (Frenken and Schor, 2017)

The English equivalent of the term social media platform is social media platform. It is a collection of social media platforms that are filled with content by users. When we participate in social media, we become part of it and we ourselves become a channel, a medium.

Communication platforms (e.g. WhatsApp, Viber, etc.) are used to connect users. Users send messages, pictures, videos, and make live voice and video calls. The content is only available in a closed system where users register with their own details.

Dating platforms (e.g. Grindr, Tinder, etc.) are systems where users create their own profile and can search other users' profiles. There is no central site, but users can only interact with each other.

Rating platforms allow users to rate different services that are visible to other users. Such platforms aim to provide unedited information on the quality of a service. Communities can also create and follow reviews on specific topics and share them.

With an e-business platform, companies usually connect with their customers, clients, suppliers, government and all the sales chains via the internet. It also involves the electronification of the company's operations. It includes all financial and commercial transactions conducted electronically, electronic data interchange (EDI), electronic funds transfer (EFT) and all credit/debit card activity (Avornicului et al., 2019).

The ecommerce platform is a merchant-operated, product distribution site. They usually do not have a social feature, as customers cannot interact with each other.

The e-commerce platform provides users with a variety of business services through which users can carry out on-line transaction processes. E-commerce platforms not only provide users with on-line transaction functions, but also offer a range of other services.

Blogs from the early days of the internet cannot be classified as blog platforms. Today's blogs can be classified as platforms, as most of these sites are part of some kind of online platform. On these platforms, users can register their own blogs on which they can publish their own content and which mostly serve as a one-way communication tool.

In the case of marketplace platforms (e.g. eBay, airbnb, etc.), the operators of the services only provide a platform for users to trade with each other. There is no central selling entity, users can buy or use services from other people.

Browser platforms are the systems that allow you to view content on the internet - mostly web pages - on your computer or mobile device, and to use services available over the internet.

Figure 1 shows that it is not an easy task to distinguish between the different types of platforms. In our model, we have approximated platforms by their functionality, thereby defining a new classification criteria.

Defining and conceptualizing the notion of a complex platform

As a concept, the platform can be approached from several angles. In everyday life and in the literature, the terms social media, social platform, internet platform, community site or even community platform are often used. Many people use these terms synonymously, but of course each has a different meaning.

How can we define the concept of a complex platform?

In the literature review, the following keywords and terms were used in English and Hungarian in the Web of Science, Emerald, ScienceDirect and Google Scholar databases to analyze the different platform definitions:

"Platform", "Digital Platform", "Hardware Platform", "Software Platform", "Social Platform" and "E-business Platform".

The search covers the period 2017-2023, as it is important from an IT perspective that studies older than 5-10 years should not be considered due to the rapid evolution of technology and the novelty of the topic, which requires a time horizon of about seven to eight years. After analyzing the titles and abstracts of the articles, 71 studies remained, focusing on the essence of the platforms. In general, most articles are related to digital platforms. After a thorough reading of the articles, we identified 8 studies relevant to the research (table no. 1).

Table no. 1. Research on key platforms

Literature source	Perspectives	Defined concepts
Frenken, K., & Schor, J. (2017)	System approach	Digital Platform
McIntyre, D. P., Srinivansan, A. (2017)	Systems approach	E-business Platform
Asadullah, A., Faik, I., & Kankanhalli, A. (2018)	Data-driven approach	Digital Platform
Hein, A., Böhm, M., & Krcmar, H. (2018)	System approach	Hardware Platform
Kiesling, L. (2020)	Data-driven approach	Digital Platform
Kimura, R., Jiang, K., Zhang, D., Nakajima, T. (2020)	Game theory approach	Software Platform
Saberian, F., Amirshahi, M., Ebrahimi, M., Nazemi, A. (2020)	Data-driven approach	Digital Platform
Bartelheimer, C., zur Heiden, P., Lüttenberg, H. et al. (2022)	Data-driven approach	Hardware Platform, Software Platform, Social Platform and E-business Platform

Platforms do not resemble any existing organizational form, they do not have hierarchies (Kimura et al., 2020). Furthermore, although platforms have network-like characteristics, they are not simple networks. Most platforms process and monetize the data collected, connect users and resources, and are characterized by algorithmic coordination. This allows a specific relationship to be established between the platform and its users.

For certain platforms, patterns recognized by the algorithm, data copies of the individual, profiles and predictions play an important role. Social platforms use machine learning and can therefore create and manage an unlimited number of profiles with large amounts of data. This can even be used to make accurate predictions about an individual's behavior.

The platform is therefore not a simple technological product, but a data and/or information processing system based on some kind of coordination. The platform offers benefits and in return it uses our data in most cases.

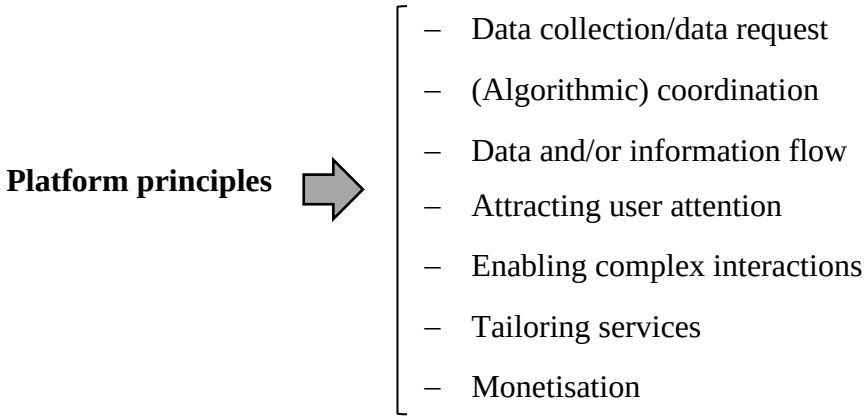

Figure no. 2. Main principles of platforms
Source: Author's creation

Fig. no. 2 shows the basic principles of platforms, which form the basis for the definition of a complex platform. We consider a complex system to be any system that is simultaneously classified according to several properties (Kindler and Papp, 1977).

Definition: by complex platform we mean an IT system that collects or requests data from its users, flows it appropriately depending on its specificity and then monetizes it under specific conditions. At the same time, it enables user interactions and provides customized services.

The quality of a complex platform depends on the combined effect of several complex factors, for example, the accessibility of the platform to its users. An analysis of the literature suggests that the quality of the platform is of paramount importance to users (Bartelheimer et al., 2022).

As a user, the platform always offers something, which the user accepts, in exchange for his activity and data. As the platform is complex and non-linear, it encourages its users to take action. Membership of the system is also important because it is only when a sufficient number of users join that we can talk about a platform. This reinforces the network effect.

In the literature, McIntyre and Srinivasan (2017), in their research on platforms, identified five aspects that should be addressed in research: the strength of the network effect, the quality of the platform, the drivers of the indirect network effect, the nature of the complements and the dynamics of the complements.

Figure 3 illustrates how the five issues can be generalized to any complex platform, covering basically three main areas of investigation: platform participants, platform quality and monetization.

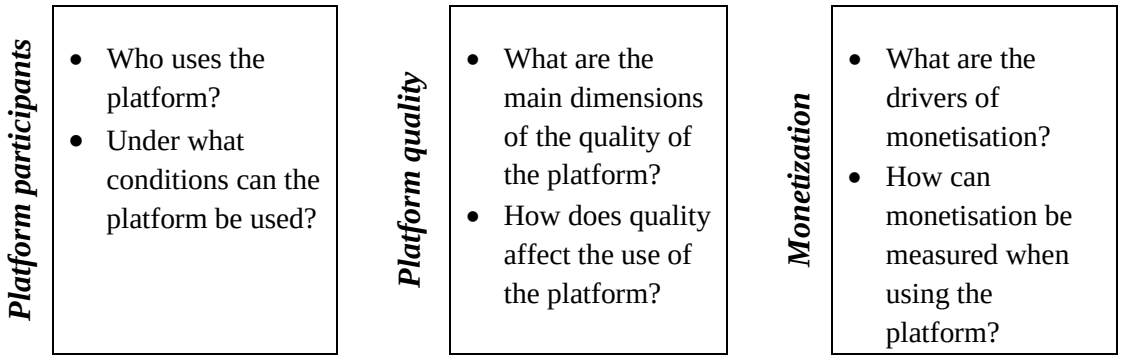

Figure no. 3. Three main issues for platform analysis
Source: Author's creation

Platforms can be easily integrated into the life of an economic community, provided that the digitalization is at the right scale and the economic organization is at the right level of digital maturity (Sándor and Gubán, 2021). This is due to the robustness of the digital lifecycle function, which can intervene in the life of the organization in a stable and long term indirect way (Sándor and Gubán, 2022).

Conclusion

In this research, we have defined our new platform model and the concept of a complex platform.

The platform has transformed the economy and our daily lives. It is a complex system that processes information and data, in many cases permanently engaging and monitoring the user, and providing tailored services.

The strategy for the platforms should include all the ideas concerning the use of modern information technology tools. In essence, a comprehensive complex platform strategy seeks to answer the following questions: how can a business use modern information technology in creative ways to grow, improve its efficiency and exploit its capabilities; how can it interact more effectively with its customers, suppliers and partners; how can it increase revenues and reduce costs; how can it compete more effectively and gain sustainable competitive advantage.

The platform, as a set of technological developments, is therefore the basis for the development of certain processes, activities and new systems, and offers its users varied, fast and efficient solutions. The use of platforms offers a multitude of challenges and opportunities, and at the same time forces users to innovate strategically.

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