

# A Survey of Roles and Responsibilities in Digital Business Ecosystems

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## Abstract

Digital Business Ecosystem is an emerging phenomenon aimed to reflect the behavior of natural ecosystems as a networked and online business model involving heterogeneous actors being engaged in a shared business vision and its implementation. Such as in an ecosystem, in a DBE, the actors are highly dependent on each other in terms of their capabilities and resources. It is, therefore, one of the essential needs for the research on DBEs to advance in understanding of which roles and responsibilities are entailed in enabling a DBE to function and sustain on a long-term basis. We have, in this study, performed a survey on the existing scientific studies related to the roles within DBEs, classified the collected results, and integrated them to a unified proposal. Using a recently developed and functioning DBE concerning the improvement of preventive healthcare by provisioning, exchanging, and using of a set of relevant resources, we have presented an initial validation of the correctness and fit of the proposal for the roles of actors and their responsibilities.

## Keywords

Digital Business Ecosystem, Role, Resource, Capability

## 1. Introduction

Digital Business Ecosystem (DBE) is a paradigm that has emerged in the recent years to enable describing, developing, and monitoring novel business models. A digital business ecosystem is an Internet-connected network of the organizational and individual actors engaged in the delivery and use of a product or a service through cooperation. The notion is based on Moore's concept of Business Ecosystem that, by following the notion of the ecosystem, is a complex system involving a co-evolutionary economic community of the organisms in the business world [1].

Being different from traditional multi-actor business models such as manufacturer, retailer, or franchise centered, using a shared digital environment, DBE implies heterogeneity, symbiosis, coevolution, and self-organization of the involved actors, which enables it to span different business domains as well as to exhibit diverse interests [2, 3]. For many organizations and individuals, DBE presents a novel collaborative approach to leverage offered and desired resources and enabling capabilities across the involved members to meet each of their goals. As such, it is foreseen to be of high value to the involved actors, but at the same time it is often complex and difficult to manage due to many correlated or dependent interactions and interrelationships among actors [4].

One of the essential aspects of DBE concerns understanding of the responsibilities of the involved actors in regard to their different capabilities and offering and need for resources that make it possible for an ecosystem to function and sustain according to its nature. As observed in an ongoing systematic literature review of DBE analysis and design conducting by the authors, the DBE-related scientific research has, so far, presented and described relevant roles, where the roles correspond to the DBE specific responsibilities of the actual involved actors. For certain roles, the proposals match; while, for others, they differ.

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The aim of this study has been to, by presenting a survey of the existing literature and research results concerning DBE roles, classify and unify the elicited roles and identify their corresponding responsibilities to provide a basis for modeling using a language. In order to provide an initial validation of the proposed DBE roles, we have examined their correctness and fit in a real case related to the Digital Vaccine DBE [5] consisting of heterogeneous actors, their complex interactions, capabilities, and exchanged resources occurring in the interest of providing a collective outcome - good quality preventive care to the citizens.

The task of unifying the roles and their corresponding responsibilities is one of the essential steps in order to understand how DBEs function in a multi-actor constellation and how a modeling language can, in turn, be defined to support the analysis, design, and run-time management of DBEs. The proposal for roles and responsibilities in DBEs can serve as a framework to analyze what roles are needed in a DBE, what roles an actor in the DBE can take on, what the actor is expected to fulfill in terms of responsibilities, resources, capabilities, etc. to support the functioning of the DBE.

The rest of the paper is structured in the following way: Section 2 reports a literature survey on DBE roles. Following that, Section 3 presents our effort and results for classifying and unifying identified roles, followed by an examination of their correctness and completeness in the Digital Vaccine DBE. A discussion of the results and concluding remarks is presented in section 4.

## 2. Background

The literature used in this study was a subset of 8 articles based on an ongoing systematic literature review (SLR) focusing on analysis and design of DBE. Following the guidelines and principles suggested by Kitchenham and Charters [6] and the Cochrane Handbook [7] as well as the PRISMA checklist, searches were conducted in electronic databases, namely Scopus, IEEE Xplore, ACM Digital Library, Web of Science, EBSCOhost, and ProQuest. Additionally, forward and backward searches were conducted to compensate the risk of missing relevant articles. Inclusion and exclusion criteria were applied during study selection, including the screening of titles and abstracts and the assessment of full-text articles. A total number of 3509 candidate records were retrieved, whereof 63 articles were included in the final qualitative analysis. For this study, we looked into the 63 articles and extracted those which elaborated on actors and roles within DBEs. In total, 8 articles were included in this study.

Since the concept of *digital business ecosystem* has its basis on Moore's *business ecosystem* [1], we started by looking into the roles of actors within BEs. Moore suggested that roles in BEs include leadership company, competitor, supplier, customer, and governmental institution. Iansiti and Levien [8] proposed a strategic view when classifying the roles of actors in BEs with three roles, namely keystone, niche player, and dominator. A keystone refers to an actor who actively looks over the whole ecosystem's health, focuses on creating platforms, and guides the balance of value sharing and extraction. A niche player refers to an actor who focuses on developing capabilities and creating values in specialized areas within an ecosystem. A dominator refers to an actor who aims to control and own a large part of an ecosystem through vertical and horizontal integration.

Several studies which concern digital and technological aspects of ecosystems suggested different roles of actors in DBEs. Combining the fundamentals of Moore's [1] and Iansiti and Levien's roles of BE actors [8], Senyo et al. [4] argued that, in DBEs, partners fit into the roles of keystone, complementor, and customer. A complementor refers to an actor who creates or improves its product and service innovations by using assets in a DBE. A customer refers to an actor who consumes value created in a DBE as a recipient of a DBE's interdependence efforts and a source of revenue for the value. The authors posited that not all these roles may be present in every DBE. The interdependency among DBE partners was analyzed together with resources and activities. In another study, Senyo et al. [9] suggested four categories of partners in DBEs: actor, client, provider, and regulator. An "actor" is an entity/actor who provides core processes within a DBE. A client represents an actor who benefits from a DBE's efforts. A provider refers to an actor who offers resources for the operation of a DBE. A regulator refers to an actor who provides guidelines that govern other partners in a DBE. Wieringa et al. [10] addressed six roles: supplier, customer, competitor, complementor, rule maker, and association based on Moore's idea [1] and Brandenburger and Nalebuff's view of members in an ecosystem [11]. A rule maker refers to an actor who defines the normative context within a DBE. The actor can represent

a government organization, a regulatory agency, or a standard body. An association refers to an actor, such as a trade association, a labor union, or a special interest group, who provides mechanisms in a domain. Radonjic-Simic and Pfisterer [12] argued that there are six DBE roles that actors can take, including consumer, provider, technology provider, knowledge provider, advisor/mediator, and reputation bank. Each role has its responsibilities within DBEs. A consumer is an actor who has particular needs and requests for products and/or services. A technology provider refers to an actor who provides technology, software or hardware, resources to support a DBE. A knowledge provider refers to an actor who provided structured and useful knowledge for a specific domain. An advisor/mediator refers to an actor who also provides knowledge and expertise to support decision making and dispute resolving. A reputation bank represents an actor who assesses reputations of actors within a DBE. Weill and Woerner [13] proposed two roles, namely ecosystem driver and modular producer, in an ecosystem design of the digital business model framework. An ecosystem driver represents an actor who organizes a coordinated network, i.e., an ecosystem, to create value for all actors within the ecosystem. A modular producer refers to an actor who provides “plug-and-play products or services” within a DBE. Giesecke [14] suggested five roles, including input provider, enabler, aggregator and provider, governor, and end user, in a domain specific DBE, an electric mobility business ecosystem. An input provider refers to an actor who provides inputs, such as energy, information, ideas, and funding, which can change during subsequent processes. An enabler refers to an actor who provides assets which do not change subsequently. An “aggregator and provider” is an actor who combines and aggregates inputs into products or services for end users. A governor refers to an actor who governs a DBE by defining and providing standards, laws, or policies. An end user is an actor who consumes products and/or services and may provide feedback and/or payment to others within a DBE.

### 3. Results

#### 3.1. Classification of the Roles Identified in the Literature

In total, 27 roles were identified based on the literature summarized in section 2. These roles were compared and classified into groups in Table 1 according to their similarities.

As shown in the first column of Table 1, the roles: Leadership Company, Keystone, and Ecosystem Driver were placed in the same group, Group 1: Driver, since they all have the characteristics of organizing, guiding, and looking over all actors within an ecosystem and concern value creation and balance. Aggregator and Provider shares some similarities with this group as it organizes, in terms of aggregating and combining, multiple resources within an ecosystem into products and services. However, it does not deal with leading a whole ecosystem with all involved actors. Consequently, the role aggregator and provider were placed in its own group, Group 2: Aggregator.

The roles: Supplier, Provider, Technology Provider, Knowledge Provider, Advisor/Mediator, Modular Producer, Input Provider, Enabler and Niche Player share similarities as they pertain to the development of capabilities and offering of resources, such as products, services, technologies, knowledge, financial funding, etc., in an ecosystem. Therefore, these roles were classified in one group, Group 3: Modular Producer. Even though the role of a Complementor resembles the role of a Niche Player who develops capabilities and creates values in specialized areas within an ecosystem, we argue that a Complementor is different from Supplier and Provider because its offerings as complements add extra value to the core resources of an ecosystem and these complements are often bundled by end users [15]. As a result, the role Complementor was separated into its own group, Group 4: Complementor.

Customer and Client are the beneficiaries of an ecosystem’s efforts and the sources of revenue as they pay for resources in an ecosystem. Whereas, Consumer and End User consume resources based on specific needs and provide feedback to other ecosystem actors. Hence, we placed the roles Customer and Client in one group, Group 5: Customer, and Consumer and End User in another, Group 6: End User.

The roles: Governor, Governmental Institution, Rule Maker, Regulator, Association were classified in the same group, Group 7: Governor, since they all share the characteristic of defining normative contexts, such as laws, policies, guidelines, and mechanisms, in an ecosystem.

The remaining roles: Reputation Bank, Actor, Dominator, and Competitor were each placed in its own group, respectively, Group 8: Reputation Guardian, Group 9, Group 10, and Group 11, as they do

not share similarities with other roles. However, we argue that the role “Actor” encompasses all the other roles as they all contribute to important processes in an ecosystem.

**Table 1**

Identified roles from the literature and mapping of them; x – means a role was identified in a reference

Roles in groups/Reference	[1]	[4]	[8]	[9]	[10]	[12]	[13]	[14]
<b>Group 1: Driver</b>								
Leadership Company	x							
Keystone		x	x					
Ecosystem Driver							x	
<b>Group 2: Aggregator</b>								
Aggregator and Provider								x
<b>Group 3: Modular Producer</b>								
Supplier	x				x			
Provider				x		x		
Technology Provider						x		
Knowledge Provider						x		
Advisor/Mediator						x		
Modular Producer							x	
Input Provider								x
Enabler								x
Niche Player			x					
<b>Group 4: Complementor</b>								
Complementor		x			x			
<b>Group 5: Customer</b>								
Customer	x	x			x			
Client				x				
<b>Group 6: End User</b>								
End User								x
Consumer						x		

(continued on next page)

Group 7: Governor			
Governor			x
Governmental Institution	x		
Rule Maker		x	
Regulator		x	
Association		x	
Group 8: Reputation Guardian			
Reputation Bank			x
Group 9			
Actor		x	
Group 10			
Dominator		x	
Group 11			
Competitor	x		x

### 3.2. Proposal of the DBE Roles and Responsibilities

Based on the classification of the 27 roles in Table 1 and the surveyed literature, we proposed a list of eight DBE roles -- namely Driver, Aggregator, Modular Producer, Complementor, Customer, End User, Governor, and Reputation Guardian -- and their responsibilities in DBEs as shown in Table 2. Some of the names of the roles have their close synonyms according to the surveyed literature, such as Provider as for Modular producer; in such cases we were choosing the name that was more specific and unique for DBE. A DBE role refers to an actor who takes on the corresponding DBE specific responsibilities within a digital business ecosystem. Based on the literature definitions and/or descriptions of all roles in each group (as in Table 1), the responsibilities of each proposed role in Table 2 were synthesized and rephrased.

**Table 2**  
Proposed DBE roles and lists of their responsibilities

DBE Role	Responsibilities
Driver	d1. It has the responsibility to set up a common vision for all actors in a DBE. d2. It has the responsibility to guide all DBE actors toward a common vision. d3. It has the responsibility to look over and improve the overall health - growth, survival, and reputation of a DBE. d4. It has the responsibility to provide and manage a digital platform. d5. It has the responsibility to optimize entry barriers for joining a DBE. d6. It has the responsibility to acquire and retain actors within a DBE.

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	<p>d7. It has the responsibility to provide end-products and/or services to customers and/or end users by integrating both its own capabilities and resources as well as those of other actors within a DBE.</p> <p>d8. It has the responsibility to collect and raise end users' events and feedback.</p> <p>d9. It has the responsibility to ensure an integrated end user experience.</p>
Aggregator	a1. It has the responsibility to aggregate capabilities and resources within a DBE into comprehensive products or services, which are aimed for end-users.
Modular Producer	m1. It has the responsibility to, using its capabilities, provide resources within a specialized domain of a DBE. A resource can be a product, or a service, or knowledge, or money, which is enabled by one or more of the producer's capabilities.
Complementor	c1. It has the responsibility to, using its capabilities, provide resources that complement the core resources (products, services, knowledge, money) offered in a DBE, with some added-value features.
Customer	c2. It has the responsibility to buy one or more resources created in a DBE.
End User	<p>e1. It has the responsibility to consume one or more resources offered in a DBE.</p> <p>e2. It has the responsibility to provide the information about its events and feedback to other roles within a DBE, through Driver.</p>
Governor	g1. It has the responsibility to govern all actors within a DBE by providing and/or defining the standards, laws, policies, guidelines, norms, and ethics related to the business concern of DBE.
Reputation Guardian	r1. It has the responsibility to survey and assess all DBE actors' trustworthiness, reliability, solvency, and worthiness.

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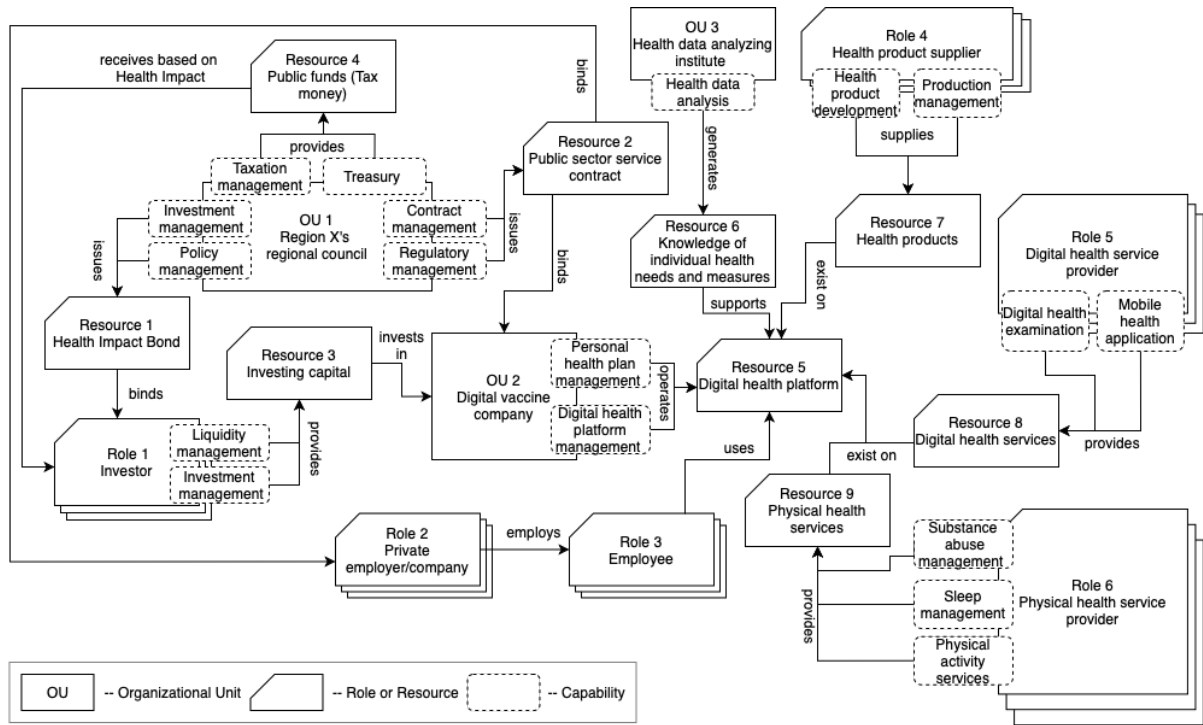
In addition to the unification of the DBE roles and their responsibilities in Table 2, we have concluded the following:

Neither Dominator nor Competitor is a DBE role because they do not concern the responsibilities related to DBE functionality or quality. Dominator describes a rule-over relation of a DBE actor towards the other DBE actors, whereas Competitor describes a relation of a DBE actor to the DBE actor(s) offering or consuming the same resource(s).

DBEs may be substantially different in their characteristics of exchanged resources and size in terms of the number of involved actors. Following the surveyed literature, we recognize Driver, Modular Producer, Customer, and End User as the essential roles for a DBE to function. The roles and the responsibilities of Aggregator, Complementor, Governor, and Reputation Guardian are given to the actors of an DBE when there is a need or a collective decision that they should be proclaimed. Also, depending on the size and maturity of a DBE, an actor who takes on, or is given a DBE role within the DBE, might not be able to realize all its responsibilities at the same time. It is important that, as the DBE develops over time, the actor will gradually be able to fulfill all these responsibilities.

### 3.3. Digital Vaccine: a Digital Business Ecosystem

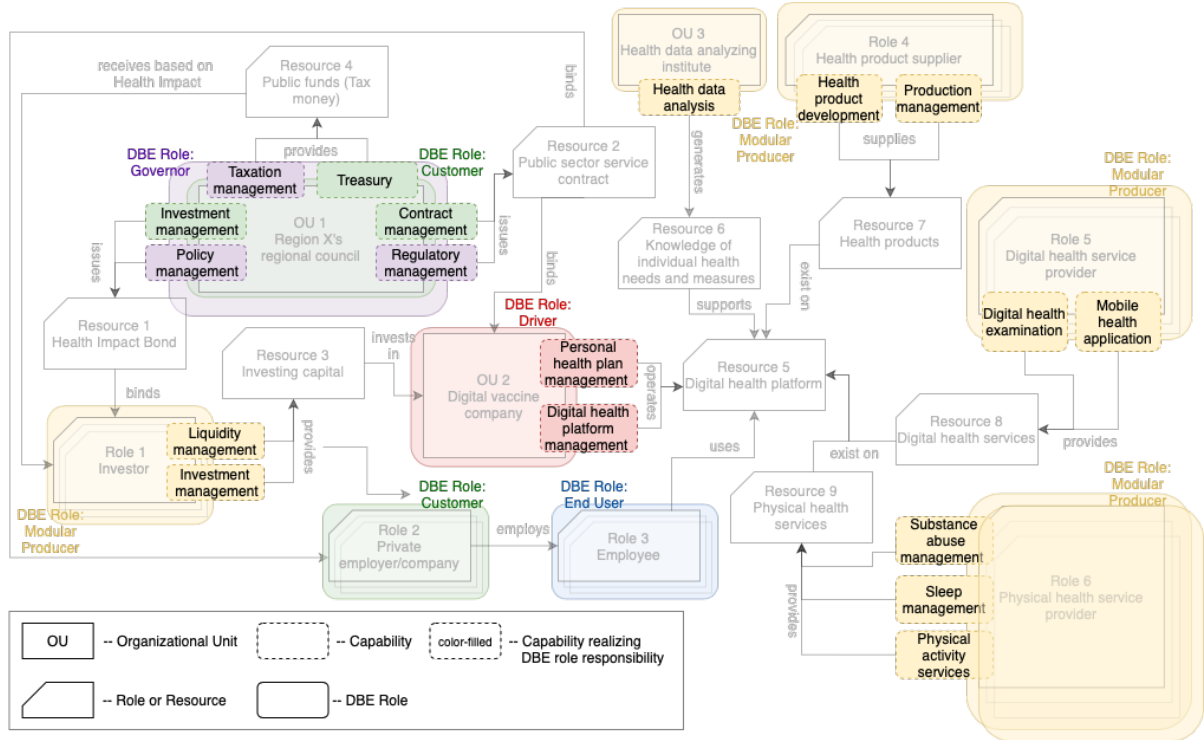
For the initial validation of the proposed DBE roles and responsibilities, we used an industrial case of a Digital Vaccine DBE [5]. The Digital Vaccine DBE consists of multiple heterogeneous actors, such as health service providers, the digital vaccine company (Health Integrator AB, "HI"), private employers and their employees as individual users, public sectors, etc. The vision of the Digital Vaccine DBE is to shift the focus in healthcare to personal tailored preventive care with a health outcome-based contracting model.



**Figure 1:** Extended actor-resource 4EM model of the Digital Vaccine DBE.

Figure 1, being extended from the authors' previous work [16], depicts actors, resources, and capabilities for this case in an extension of 4EM [17] Actors and Resources Model. The employees (Role 3) as individual users use the digital health platform operated by HI (OU 2) and its capabilities. Service providers (Role 5 and Role 6) and product suppliers (Role 4) own capabilities that enable the offerings of various resources in the Digital Vaccine DBE. A data analyzing institute (OU 3) provides knowledge on individual health needs through its capabilities. The public sector (OU 1), through its capabilities, provide policies and regulations concerning the health outcomes-based contracting model which the private employers (Role 2) and HI (OU 2) are bound to. Investors (Role 1), also being bound to this model, offer financial funding with its capabilities.

In Figure 2, we applied the proposed DBE roles and responsibilities (Table 2) to the Digital Vaccine DBE. The color coding indicates the different DBE roles. The capabilities enabling the realization of responsibilities of a specific DBE role are color-filled correspondingly. The OU 2 becomes Driver as its capabilities "digital health platform management" and "personal health plan management" enable realizing the responsibilities d4, d7, d8, and d9 (Table 2). The OU 3, Role 1, Role 4, Role 5, and Role 6 are Modular Producers since their capabilities in specialized domains enable them to provide relevant resources in those domains (responsibility m1 in Table 2). The OU 1 is Governor and Customer as its capabilities "policy management", "taxation management", and "regulatory management" enable it to provide laws, policies, and regulations governing a great numbers of actors in the DBE (responsibility g1 as in Table 2), while the capabilities "investment management", "treasury", and "contract management" enable it to issue impact bonds and public contracts through the contracting model, which, in turn, lead to payment for products and services (responsibility c2 in Table 2) consumed by Role 3. The Role 2, bound to the contracting model, is supported by OU 1 to buy resources and thus is also a Customer. The Role 3 is an End User as it consumes resources and provides individual health data and needs (responsibilities e1 and e2 in Table 2) to OU 2 and OU 3 within the DBE.



**Figure 2:** Extended actor-resource 4EM model of the Digital Vaccine DBE with DBE role and capability realizing DBE role responsibility.

Comparing the Digital Vaccine DBE case and our proposal of DBE roles and responsibilities, we concluded the following for the initial validation:

As shown in previous research, not all roles may be present or can be identified in every DBE [4]. Similarly, we observed this in the case of the Digital Vaccine DBE. The reasons for this could be, as mentioned in section 3.2, that the sizes and characteristics vary for different DBEs. However, we did identify all the essential DBE roles, namely Driver, Modular Producer, Customer, and End User, presenting in the case. Due to the scope of this model (Figure 2) and the maturity of the Digital Vaccine DBE, we did not identify that the actor (HI) who is the Driver was able to fulfill all responsibilities for its role as defined in Table 2. Of the other roles, which we consider non-essential DBE roles: Aggregator, Complementor, Governor, and Reputation Guardian, we only observed the presence of Governor. We have discussed that the main reason behind this lies in a recent emergence and immaturity of the ecosystem. In addition, we, based on the initial validation of the case, suggested that an actor can take on or be given more than one DBE role if it realizes the responsibilities of different DBE roles within a DBE.

## 4. Discussion, Conclusions, and Future Work

In this study, we have presented a proposal for the roles and their responsibilities for DBE by collecting and unifying the existing literature; in addition, we have examined the fit of the proposal on a real DBE concerning creation and offering of Digital Vaccine for better health care.

The performed survey has shown that despite the fact that research on DBE modeling, design, and monitoring is still ongoing, a notable number of studies have been addressing the roles of the involved actors. This shows that identifying distinguishing responsibilities in a DBE is an essential aspect for its functionality and management. Also, eliciting and understanding the responsibilities needed in a business model, in this case -- a complex, networked and with diverse types of actors, is the basis for determining the capabilities required for specific roles, as well as their use of the resources that characterize the ecosystem. This can further enable modeling of role-based capabilities which is highly important in design of heterogeneous and complex IS, and where adaptations for different runtime contexts are needed [18].



The conducted survey has shown that the current DBE related research acknowledges the elementary roles used in service and product exchange environments, but, in addition, proposes a number of other roles that are specific to initialization of a DBE, onboarding of the actors, the care of the platform, dissemination of knowledge, policies, and ethics, assurance of quality of exchanged resources, and many other. We have in the study made an effort to integrate and unify the identified roles, as well as to classify their responsibilities. Further, we contrasted the proposal with a model of an existing DBE concerning provisioning of a diapason of physical and cyber resources to organizations and individuals for the preventive self-care improvement purpose. A detailed analysis and discussion of the capabilities and the resources of the Digital Vaccine DBE, has shown that a) the proposed roles covered all the involved actors and their responsibilities identifiable in the model, and b) that some of the roles are not presented. The latter can be explained by the fact that the case has been recently implemented and that the number of actors is still relatively small, hence the capabilities for a refined and sustainable management of the ecosystem corresponding to some of the non-essential roles are still in a planning phase. Nevertheless, they are considered as a valuable guidance of how to ensure further improvements in terms of stability and resilience of the ecosystem.

Our further work will focus on investigating how the proposal for roles and responsibilities in DBEs can be extended to support different scenarios and domains. As a way of implementing the proposal, we will also focus on defining a modeling language for design and run-time management of DBE; for that research, a continuous analysis, definition, and validation of responsibilities of DBE actors to improve and expand the proposal has been recognized as one of main tasks.

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