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A Foundation for Design, Analysis, and Management of Digital Business Ecosystem through Situational Method Engineering

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Abstract. Digital Business Ecosystem (DBE) supports organizations to combine their expertise in a novel collaborative network through information and communications technology. Despite its beneficial aspects, a DBE is intricate and difficult to manage due to the dependent interactions and interrelationships among actors. Modelling, as a proven way to deal with complex problems in organisational settings, can support the capturing and documenting of a DBE. This can enhance the level of abstraction of the DBE to aid the analysis and decision-making. However, current scientific literature shows a lack of methodological guidance for modelling in support of the analysis, design, and management of DBEs. Hence, in this study, we have proposed a foundation for a DBE design, analysis, and management method based on Situational Method Engineering (SME). Using the requirements empirically collected from a number of industrial practitioners and experts, the main concepts and intentions relevant to DBE design, analysis and management were defined. Based on them, using the SME approach, we modelled and presented several method process parts that layout fulfilment of the intentions for the concepts' development using different, situation-related, strategies (i.e. method chunks).

Keywords: Digital Business Ecosystem, Method Engineering, Method Chunks

1 Introduction

Digital Business Ecosystem (DBE) is a notion based on Moore's concept of *Business ecosystem* which supports evolution and co-evolution in a complex system involving organisations and individuals of an economic community [1]. In the context of a DBE, as a new type of a collaborative network among organisations, the participating organisations and individual actors cooperate for product and service delivery or utilization through the support of information and communications technology (ICT).

A DBE, as compared to traditional multi-actor business models, possesses some unique characteristics, including heterogeneity, symbiosis, co-evolution, and self-organisation, which enables it to incorporate different business domains and diverse interests in its digital environment [2, 3]. These unique characteristics make DBE a highly-valued novel collaborative approach for organisations to, by engaging business

capabilities across the involved actors, meet each of their goals and to leverage the offered and desired resources among the actors.

Despite the beneficial aspect of being part of a DBE, many correlated or dependent interactions and interrelationships among the involved actors often lead to complexity and, in turns, difficulties related to management [4]. Conceptual modelling and Enterprise Modelling allow capturing and documenting a specific domain and enhancing the level of abstraction of the domain for analysis and decision making. The modelling approach has proven to be useful in dealing with complex problems in organisational settings [5]. However, current scientific research suggested that there is a lack of means of model development, analysis, measurement, and management supporting DBEs [3, 6]. An ongoing systematic literature review, conducted by the authors, reveals also a need for a holistic modelling method which provides explicit guidance on the analysis, design, and management of DBEs. To address this need, an interview study [7] was conducted to understand DBEs from viewpoints of industrial practitioners and experts and elicit requirements for a DBE design and modelling method as a part of an ongoing design science research project.

In this study, to continue the line of work of our previous studies, and as a part of the design science research project, we aim to explore the possibility of classifying and aggregating the elicited requirements concerning DBE design [7] into a methodological approach, based on *Method Engineering* (ME) [8].

The rest of this paper is organized as follows. Section 2 gives background on the current research in DBE modelling, *Method Engineering* (ME) and *Situational Method Engineering* (SME), and DBE roles and responsibilities. In section 3, results of the application of SME to the requirements are presented together with the examples of the DBE method process. Section 4 provides a discussion on the findings, while section 5 briefly concludes the study and outlines future work.

2 Related Work

2.1 State of the Art – DBE Design and Modelling Method

Using a modelling method as an approach, which aims to reduce complex domains through abstraction, can be an appropriate way for describing DBEs and addressing their complexity. Nevertheless, the current state of the art suggests that the area of DBE design and modelling methods lacks holistic yet feasible solutions that address the multiple aspects of a DBE and support the design and management of a DBE throughout its lifecycle.

This topic has been investigated in an ongoing systematic literature review, where 3509 studies were screened and 63 included in the analysis. The review has, so far, revealed that few scientific studies proposed a comprehensive conceptual modelling method for DBEs, consisting of a modelling language and guidelines or procedures for modelling DBEs. Modelling procedures of the proposed methods suggested by the analysed studies were scarce. Moreover, many of the analysed studies did not include some important concepts concerning DBEs in their modelling language constructs; resources and capabilities are some of such examples. Aldea's [9] study successfully

included more essential concepts (*actor, role, capability, relationship, and digital component*), but method for their design and analysis were not elaborated. A few examples of studies that suggested a more comprehensive method were the Methodology of Business Ecosystem Network Analysis (MOBENA) in [10], the methodology for modelling interdependencies between partners in a DBE in [4], and the approach for modelling and analysing DBEs from the value perspective in [9]; still, none of them have proposed a complete method encompassing all relevant concepts, nor the methods considered both design, analysis and management of DBE.

2.2 Situational Method Engineering

Method Engineering, and in particular *Situational Method Engineering* (SME) [8], provides theory and guidance to support the construction of methods that are situation-specific, adaptable, and configurable. A key feature of SME is the modularity of a method, which its definition varies from one SME approach to another in terms of method building blocks. As proposed in [11, 12], *method chunks* can be seen as method building blocks for a SME approach. A method chunk is an autonomous part of a method including its process and product elements. The process defines the activity of the method, whereas the product, with the help of a metamodel, formally defines the artefacts to be used and produced by the method chunk process. In addition, the method chunk user roles and supporting tools can be defined.

The composition of method chunks for the construction of a new method is based on the *Map* approach [7]. This approach is used to express the process model of the method in terms of engineering *intentions* (i.e., the engineering goal) and *strategies* to achieve the intentions. As one or more strategies can be defined to achieve an intention, the specification and implementation of the method are ensured to have a higher level of variability and flexibility. The process model takes the form of a labelled directed graph with intentions as nodes and strategies as edges between intentions. Each strategy in the map requires one or more method chunks specifying how to achieve the target intention by using the selected strategy. The Map approach provides method extension mechanisms as the adding of new strategies and new intentions leads to new method chunks.

In this study, we consider the SME approach using method chunks as method building blocks. Typically, SME relies on existing methods to facilitate design of situation-related method chunks when such a method does not exist, the focus is set on the product to be designed, i.e., DBE in this case. Main product elements are then used as the *concepts* for the method construction for guiding the Map in order to establish the method process [11]. Concerning the “situational” of the SME, we argue that the dynamics occurring in the context of a DBE are the situations being considered while applying the situational method. The contexts of DBEs concern specific domains, whereas the dynamic issues in the context of a DBE are situational.

2.3 Multi-view Modelling Methods

Multi-view or multi-perspective modelling approaches have had a long tradition in different application domains [13]. These approaches allow the representation of the different aspects or facets of a system through the use of different types of models or modelling languages. An example is the multi-perspective enterprise modelling (MEMO) [14], in which the author emphasised the different levels of perspectives and aspects being accounted for in an enterprise model while analysing and designing a system. In [15, 16], the authors looked further into the consistency between the different representations of models in multi-view modelling approaches and suggested a method for preserving consistency.

The idea of multi-view modelling approaches does not contradict the SME approach applied to the current study, where the method chunks support the modelling of different concepts in different situations concerning dynamic issues in DBEs and its process. In the concrete, the modelling views or perspectives known in multi-view modelling approaches could support the method chunks of SME, especially in structuring the product elements. Since the modelling views or perspectives are usually represented by different types of models, the approach could be jointly used in the situational method engineering process when defining the artefacts/modelling languages/types of models to be used, meaning the product elements of method chunks, during the creation of a new method.

2.4 DBE Roles and Responsibilities

Eight DBE roles and their corresponding responsibilities were proposed in [17] by synthesising existing scientific studies on the topic. A *Driver* has the characteristics of guiding and looking over all actors within an ecosystem, with responsibilities, such as setting up a common vision for all DBE actors, improving the overall health of a DBE, and collecting and raising end users' events and feedback. An *Aggregator* aggregates and combines multiple resources in a DBE into products and services without having the responsibility of leading a whole ecosystem and its involved actors. A *Modular Producer* pertains to the development of capabilities and offering of resources, such as products, services, technologies, knowledge, financial funding, etc., in a specialised domain within a DBE. A *Complementor* develops also capabilities and creates values in a specialised domain. However, its offerings are complements, often bundled by end users, that add extra value to the core resources of a DBE. A *Customer* is the beneficiary of a DBE's efforts and the sources of revenue as they pay for resources, whereas an *End User* consumes resources based on specific needs and provide feedback to other DBE actors. A *Governor* governs actors within a DBE by providing and/or defining normative contexts, such as standards, laws, policies, guidelines, norms, and ethics, related to the business concern of the DBE. A *Reputation Guardian* surveys and assesses DBE actors' trustworthiness, reliability, solvency, and worthiness.

These roles are of significance and serve as underlying knowledge for the method engineering process of the DBE method and starting points for some of the strategies in the DBE method application process (illustrated as examples in section 3.3).

3 A Foundation for the Method Engineering Process for DBE Design, Analysis, and Management

3.1 Problem Context

The current study was based on the foundation of a previous study [7], where 11 industrial practitioners and experts from different business domains were interviewed to explore and understand DBEs, with the purpose of eliciting requirements for developing a holistic method for designing and modelling DBEs. The empirical data led to 30 requirements (as shown in Table 1) encompassing the essential concepts concerning DBEs.

Due to the lack of a holistic DBE design and modelling method, we applied SME with a product-driven approach [12] to identify intentions related to the product parts and thus construct the method process in the current study. This approach means that the essential concepts in the requirements for DBE design, analysis, and management from [7] were used as the main concepts or artefacts (i.e., product parts) in order to facilitate the intentions of the process (similar as the Map as mentioned in section 2.2) of the DBE method that need to be constructed.

3.2 Identification of Main Concepts

In [7], we collected empirical data through interviews and conducted a thematic analysis on the data. Two themes, seven categories, and 25 codes emerged from the data analysis, which led to the elicitation of the requirements for a DBE design, analysis, and management method. Deriving from these requirements, 22 main concepts were used to drive the method engineering of the DBE method as products parts.

The 22 main concepts (shown in *italic*) correlated to the codes of the thematic analysis in [REF – accepted for a conference proceeding (BIR2021)] are described in the following. *Scope* of a DBE concerns business activities and value of the DBE based on its vision, whereas *boundaries* determine which actors are part of the DBE. *Vision* is a collection of *goals* on a strategic level. Based on this difference, both *goal* and *vision* are equally important artefacts in the context of DBE considering the multiple actors involved. *Actors* are organisations or individuals who take part in a DBE and establish *relationships* with each other. Each actor has specific *role(s)* and corresponding *responsibilities*. These DBE *roles* are defined in [17], including Driver, Aggregator, Modular Producer, Complementor, Customer, End User, Governor, and Reputation Guardian (c.f. [18] for the defined DBE roles and their responsibilities). Each actor has also its *domain specific focus area and interests*, *properties related to performance*, and *key performance indicators* (KPIs). Within a DBE, relevant *processes*, *capabilities*, *resources*, and *values* of participating actors are shared and exchanged, which contributes to the functioning and sustaining of the DBE. *Digital infrastructures* and *communication channels* shared and used between actors constitute the digital environment of a DBE, where *communication form(s)* agreed by the actors and *agreement(s)* about *exchanged information* between them are fundamental.

Policies are usually rules that are made by companies, organizations, groups, or governments in order to carry out a plan and achieve certain aims and goals. In the context of a DBE, there could be external policies to which the DBE needs to adhere, but also but also internal policies in the DBE to which the actors need to adhere. *Regulations* are distinguishable from policy in a way that they are often made and imposed by public agencies as restrictions, with the effect of law, on activities within a community [19].

3.3 Identification of Intentions

Table 1 shows the 32 intentions relevant to the DBE method being identified based on the main concepts in the 30 requirements. These intentions, or so-called engineering intentions, according to ME, are used as the starting point for constructing process maps and as the composition of method chunks. Note that six requirements, R3, R4, R9, R12, R19, and R20, do not lead to identification of intentions but are considered constraints of the DBE method.

Table 1. Requirements and ME Intentions for the DBE method

Requirement	Intention
<i>R1. The method shall aid the process of delimiting scope and boundaries of a DBE.</i>	I1. Delimit scope and boundaries
<i>R2. The method shall support assignment of DBE roles and responsibilities to actors.</i>	I2. Identify actors
<i>R5. The method shall support modelling of communication channels among actors.</i>	I3. Identify communication channels used in DBE
<i>R6. The method shall support modelling of commonly agreed form of communication among actors.</i>	I4. Identify agreed communication forms in DBE
<i>R7. The method shall support analysis of an actor's relevant part of a DBE.</i>	I5. Analyse DBE's scope and boundaries from single actor's viewpoint
<i>R8. The method shall support analysis of relationships and types of relationships among actors.</i>	I6. Identify relationships (type) between actors I7. Analyse DBE's relationship network
<i>R10. The method shall support modelling of actors' processes, capabilities, and resources on a DBE level.</i>	I8. Identify processes of actors relevant for DBE I9. Identify capabilities of actors relevant for DBE I10. Identify resources of actors relevant for DBE
<i>R11. The method shall be able to integrate actors' processes and streamline the overall process on a DBE level.</i>	I11. Analyse possible integration of processes in DBE
<i>R13. The method shall support modelling of values within a DBE.</i>	I12. Identify relevant exchanged values in DBE
<i>R14. The method shall support analysis of existing and future co-created values among actors.</i>	I13. Analyse possible co-created values in future state of DBE
<i>R15. The method shall support modelling of digital infrastructures within a DBE.</i>	I14. Identify digital infrastructures shared in DBE

<i>R16. The method shall support analysis of existing and future innovation created by shared infrastructures among actors.</i>	I15. Analyse possible new innovation based on shared infrastructures in future state of DBE
<i>R17. The method shall support modelling of policies and regulations within a DBE.</i>	I16. Identify policies relevant for actors and DBE I17. Identify regulations relevant for actors and DBE
<i>R18. The method shall support analysis of coverage of policies and regulations.</i>	I18. Analyse coverage of policies and regulations on all actors
<i>R21. The method should support identification of possible changes by obtaining relevant data.</i>	I19. Identify possible changes occurring in and to DBE (by analyse external context data and relevant data of DBE actors)
<i>R22. The method should support analysing of future state of a DBE when involving new actors.</i>	I20. Analyse DBE's future state upon new actor join (concerning all other groups)
<i>R23. The method shall support analysis of shareable and interchangeable capabilities and resources.</i>	I21. Analyse properties of capabilities and their interchangeability I22. Analyse properties of resources and their interchangeability
<i>R24. The method shall be able to show the agreement on what information and data are shared among actors.</i>	I23. Identify information shared in DBE
<i>R25. The method shall support modelling types of information exchanged and shared among actors.</i>	
<i>R26. The method shall support alignment of vision and goals among actors.</i>	I24. Align actors' visions in DBE
<i>R27. The method shall support management based on actors' domain specific focus areas and interests.</i>	I25. Align actors' goals in DBE I26. Identify actors' domain specific activities, competences, and skills relevant for DBE I27. Manage DBE based on selected domain catalogues of actors' activities, competences, and skills
<i>R28. The method shall support management and monitoring of various levels of processes and monitoring of the overall process at a DBE level.</i>	I28. Monitor integrated DBE processes
<i>R29. The method shall support monitoring of actors' KPIs and indicators.</i>	I29. Identify KPIs and indicators of actors relevant for DBE I30. Monitor KPIs and indicators of DBE (based on goals and vision)
<i>R30. The method shall support analysis of various data concerning actors' properties and performance.</i>	I31. Identify relevant properties related to actors' performance in DBE I32. Analyse new actors' fitness and qualification in joining DBE based on properties (and performance)
<i>R3. The method shall support inclusion of actors regardless of geographical locations.</i>	n/a; constraints
<i>R4. The method shall support exposure of a DBE regardless of its geographical location.</i>	n/a; constraints

R9. The method shall support the means and requirements for the accession to a DBE.	n/a; constraints
R12. The method shall support exposure of collaborating processes, capabilities, and resources among actors.	n/a; constraints
R19. The method shall be agile in order to support the dynamics of a DBE and fast decision-making withing the DBE.	n/a; constraints
R20. The method shall support an expandable knowledge base of the DBE framework and roles.	n/a; constraints

3.4 Examples of the DBE Method Process

Using the Map approach (c.f. section 2.2 and [7]), the process model of the DBE method, in terms of engineering intentions and different, situation-related, strategies to achieve the intentions, has been developed. Based on the entire set of intentions, a holistic process for the DBE method is aimed to be built. In this section, a few examples of parts of the process are defined and explained. The presented examples of the DBE method process, consisting of intentions and strategies, show also the dependencies between some of these intentions in different situations.

The green ellipses in the following figures represent the intentions and the arrows connecting them are the strategies used to achieve them. It is important to mention that the *Modelling (update, complement, modify)* strategy concerns the reuse of existing models of single actors, meaning that DBE actors' existing models shall be updated, complemented, and modified in line with the required information relevant in the DBE context.

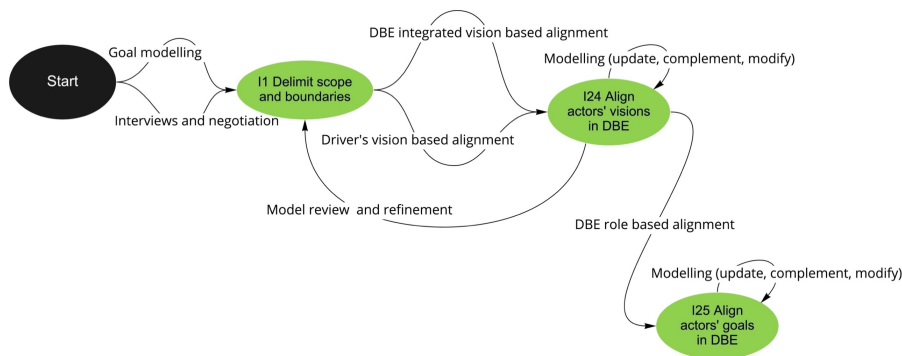


Fig. 1. DBE method process part (aka “map”) for identifying the scope, boundaries, visions, and goals concepts of a DBE

Figure 1 shows the process of delimiting scope and boundaries and aligning actors' visions and goals in a DBE. The dependencies between *I1 Delimit scope and*

boundaries, *I24 Align actors' visions in DBE*, and *I25 Align actors' goals in DBE* are established since the delimitation of the scope and boundaries of a DBE is often based on the overall vision of the DBE and the alignment of visions and goals should cohere with each other. To start with, two strategies can be used to achieve *I1*, either conducting a preliminary *goal modelling* or carrying out *interviews and negotiation* with the core actors of a DBE. After defining the scope and boundaries (moving from *I1* to *I24*), two strategies can facilitate the alignment of actors' visions by basing on either the *integrated DBE vision* or the *DBE role Driver's vision*. The alignment is carried out using the *modelling* strategy, which could be supported by existing methods, such as 4EM [20] and i* [21]. By *reviewing the models*, mismatches can be identified and assist the *refinement* of the defined scope and boundaries of the DBE. Once the visions are aligned (moving from *I24* to *I25*), *DBE role-based alignment strategy* can be applied to align actors' goals. This is described preliminarily in [22] on a Driver's viewpoint based on DBE resilience, but shall be applicable for all DBE roles. The alignment of goals is also carried out using the *modelling* strategy, which could be supported by similar methods as mentioned before.

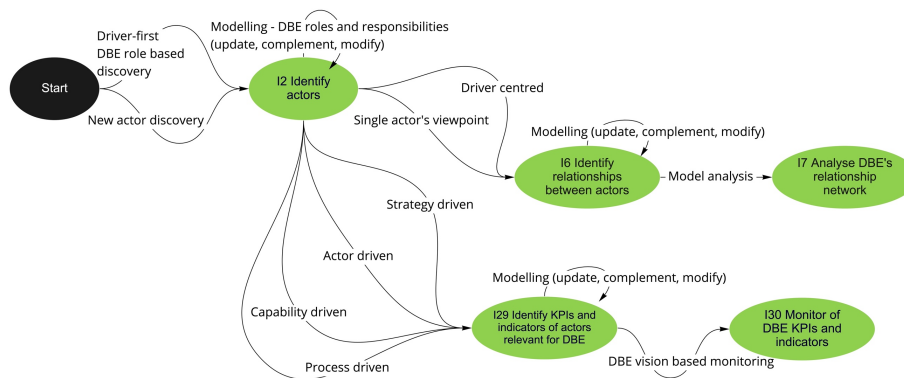


Fig. 2. DBE method process part for identifying the actor, relationship, and KPI concepts of a DBE

Figure 2 shows the process of identifying actors and their relationships and relevant KPIs. To start with, two strategies can be used to achieve *I2 Identify actors*. By a *Driver-first DBE role-based discovery* strategy, the actor(s) who has the DBE role *Driver* (c.f. section 2.3) is first identified to facilitate the process of further actor identification as it is often easier to achieve this identification based on the revisiting of a DBE's scope, boundaries, and visions from the viewpoint of the central role – *Driver*. On the other hand, a *new actor discovery* strategy focuses on the condition when a new actor emerges or joins a DBE. The identification is carried out using the *modelling* strategy which should specifically focus on the roles and responsibilities suggested in section 2.3 [17] and other studies [23-26]. To move from *I2* to *I6 Identify relationships between actors*, either *Driver centred* or *single actor's viewpoint* strategy can be applied. By *Driver centred* strategy, the relationships between the *Driver(s)* and

other DBE actors are identified, whereas *single actor's viewpoint* strategy aims to identify all relationships among all DBE actors from each and every actor's viewpoint. The identification is carried out using the *modelling* strategy, which could be supported by existing methods, such as the methodology for modelling interdependencies between partners in a DBE suggested in [4]. *Model analysis*, as a strategy, can be applied in order to move from *I6* to *I7 Analyses DBE's relationship network*. Several existing tools, such as [27-29], supports the visualisations and relationships of such networks in the context of a DBE. To move from *I2* to *I29 Identify KPIs and indicators of actors relevant for DBE*, different driven strategies can be applied, including *strategy driven*, *actor driven*, *capability driven*, and *process driven*. The identification is done by the *modelling* strategy, which could be supported by existing approaches, such as the ones mentioned in [18, 22, 30]. The *DBE vision-based monitoring* strategy can be used to move from *I29* to *I30 Monitor of DBE KPIs and indicators* in order to achieve *I30*. This could be supported by the approach described in [22], where examples were given based high-level DBE resilience goals that shall be further aligned with the vision(s) of the DBE.

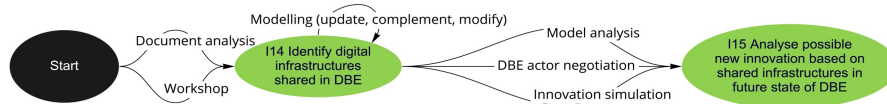


Fig. 3. DBE method process part for identifying the digital infrastructures and innovation concepts based on shared infrastructures in a DBE

Figure 3 shows the process of identifying digital infrastructures and analysing possible innovation based on shared infrastructure in a DBE. Two strategies, namely *document analysis* and *workshop*, can be used to achieve *I14 Identify digital infrastructures shared in DBE*. The identification is carried out using the *modelling* strategy, which could be supported by extending existing methods, such as Technical Components and Requirements Model of 4EM [20]. The *modelling* strategy can even be combined and used in the previous stage - *workshop* strategy, and be supported by the collaborative ecosystem modelling approach suggested in [29, 31]. After the identification of shared infrastructures (moving from *I14* to *I15 Analyse possible new innovation based on shared infrastructures in future state of DBE*), three strategies, *model analysis*, *DBE actor negotiation* (in terms of negotiation meetings among DBE actors), and *innovation simulation*, can facilitate the analysis of possible new innovation based on shared infrastructures, especially in the future state of a DBE, such as under the condition of new joining actors. The strategy *innovation simulation* could be supported by the many existing scientific research and approaches, such as in [32-34].

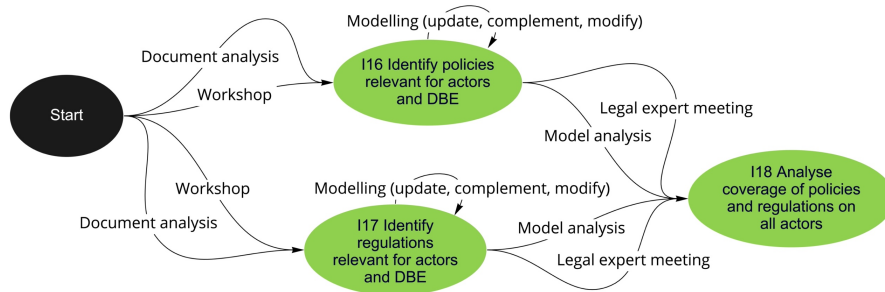


Fig. 4. DBE method process part for identifying the policies and regulations concepts, and their coverage analysis on all actors in a DBE

Figure 4 shows the process of identifying relevant policies and regulations and analysing coverage of them in a DBE. To achieve both *I16 Identify policies relevant for actors and DBE* and *I17 Identify regulations relevant for actors and DBE*, *document analysis* and *workshop* strategies can be used. The identification is carried out using the *modelling* strategy, which could be supported by modifying and extending existing methods, such as Business Rules Model of 4EM [20]. As mentioned above, the *modelling* strategy can also be combined here and used in the previous stage - *workshop* strategy, and be supported by the collaborative ecosystem modelling approach suggested in [29, 31]. After the identification (moving from *I16 and I17* to *I18 Analyse coverage of policies and regulations on all actors*), two strategies, *model analysis* and *legal expert meeting* can be used to achieve intention of the analysis of policy and regulation coverage.

Table 2. Example of method chunk for DBE actor modelling as shown in the process part in Figure 2

Method chunk	Content
Name	Model the involving actors, their roles and responsibilities in a DBE
Intention	I2 Identify actors
Strategy	Modelling – DBE roles and responsibilities (update, complement, modify)
Goal	Create model(s) of the actors, their roles and responsibilities in a DBE from viewpoint of the DBE
Input	Lists of the involving actors, their DBE roles and responsibilities; existing models belonging to the actors based on viewpoint of a single organization (actor)
Activity	Update, complement, and modify the existing actor models; document, illustrate, and model the actors and their DBE roles and responsibilities
Output	DBE actor model(s) of the involving actors, their roles and responsibilities
Roles	--
Related chunk(s)	<<requires>> Identify actors by Driver-first DBE role-based discovery OR <<requires>> Identify actors by new actor discovery

Each of these strategies described in the four examples would require one or more method chunks specifying how to achieve the target intention. Due to the word limit, two examples based on the process part for identifying the actor and relationship concepts (as in Figure 2) are given in the following Table 2 and 3.

Table 3. Example of method chunk for relationship identification as shown in the process part in Figure 2

Method chunk	Content
Name	Identify relationships of actors based on viewpoint of DBE Driver(s)
Intention	I6 Identify relationships between actors
Strategy	Driver centred
Goal	Establish a relationship network between the DBE Driver(s) and the DBE actors who have a relationship with the Driver(s)
Input	DBE actor model(s) of the involving actors, their roles and responsibilities
Activity	Associate and link the related DBE actors with the DBE Driver(s) in a relationship network
Output	Driver-centred relationship network of the DBE
Roles	--
Related chunk(s)	<<requires>> Model DBE actors – roles and responsibilities

4 Discussion

Considering the complexity of DBEs, the examples of the DBE method process parts and identification of the method chunks shown in section 3 reflect a delicate work of applying such a method in practice. As the overall process of the method based on all the intentions is extensive and requires involvement of many different DBE roles, we envision that a catalogue should be used for documenting the modular parts of the overall process (as shown in the examples) and different user roles will either be responsible or participate in these parts. In practice, the organisations or actors playing specific DBE roles (c.f. section 2.3) could be assigned to these parts as either the responsible or the participatory. For example, the actor(s) with the role *Governor* can be assigned as the responsible for the part of the DBE method process for the policies, regulations, and coverage analysis (Figure 4). This assignment is based upon the responsibility for providing and/or defining normative contexts of a *Governor* in a DBE. At a more detailed level, various working roles (such as modeller, DBE analyst, legal content analyst, lawyer, etc.) can be assigned to the method chunks and strategies as parts of the overall DBE method process. For instance, the *legal expert meeting* strategy being used to achieve *I18 Analyse coverage of policies and regulations on all actors* in Figure 4 can be assigned to working roles, e.g., legal content analyst and industrial lawyer.

Due to the complexity of the overall process of the DBE method, the application of the method to design, analyse, and manage a DBE is likely to be a compound and sizeable project. Whether the project should be a single one steered by one organisation

or be divided into interconnected small projects steered by various organisations is uncertain. Future work should focus on practical applications of the method to industrial cases in order to validate the best practice.

We presented several elaborated parts of the overall DBE method process. Because of the complexity of DBEs, many of the main concepts related to DBE are interconnected. This means that the dependencies between the intentions are also highly intricate, which makes it difficult to illustrate an overall process of the method in a single Map concerning the word and space limit. Also, the listed strategies (in the examples) and intentions might not be a complete list, which is considered a limitation but also highlight the possibility and advantage of the Map approach as it provides extension mechanisms.

In the current study, we made a preliminary attempt to illustrate the possibility of supporting the modelling of various aspects of DBEs with the variety of method chunks under different situations. Further attempts should focus on the identification of how existing methods support each of the method chunks, especially the product elements. This will lead to a clearer picture of the method chunks not being supported sufficiently by existing methods and the inadequacy of these methods, which, in turns, facilitates creation of new methods using the DBE method process with the SME approach.

5 Conclusions

This study aimed to establish a methodological approach for development of DBE using the Situational Method Engineering methodology, based on a set of empirically elicited requirements from industry experts and practitioners. Using SME and its related Map approach, we have laid the foundations for the method process for the DBE design, analysis, and management method, especially in demonstrating some of the dependencies between the intentions and the possibility of compiling different parts of the overall process of the method. We further presented how each of the strategies for fulfilling the intentions described in the examples would require one or more method chunks specifying how to achieve the target intention. Aside from the ability of reusing method process parts for different DBE development, the method chunks may be reused within the single method process setting.

In the future work, we will continue designing and demonstrating the envisioned holistic process of the DBE method, by further exploring capabilities and fit of existing supporting methods and tools, and validating the method through the practical applications to industrial cases in order to elicit best practices.

References

1. Moore, J.F.: Predators and prey: a new ecology of competition. *Harv. Bus. Rev.* 71, 75-86 (1993)
2. Nachira, F., Dini, P., Nicolai, A.: A network of digital business ecosystems for Europe: roots, processes and perspectives. In: Nachira, F., Nicolai, A., Dini, P., Le Louarn, M., Rivera Leon, L. (eds.) *Digital Business Ecosystems*, pp. 1-20. European Commission, Bruxelles (2007)

3. Senyo, P.K., Liu, K., Effah, J.: Digital business ecosystem: Literature review and a framework for future research. *International Journal of Information Management* 47, 52-64 (2019)
4. Senyo, P.K., Liu, K., Effah, J.: Towards a methodology for modelling interdependencies between partners in digital business ecosystems. In: *IEEE international conference on logistics, informatics and service sciences (LISS 2017)*, pp. 1165-1170. IEEE (2017)
5. Persson, A., Stirna, J.: *Why Enterprise Modelling? An Explorative Study into Current Practice*. In: *Advanced Information Systems Engineering*, pp. 465-468. Springer Berlin Heidelberg (2001)
6. Pittl, B., Bork, D.: Modeling Digital Enterprise Ecosystems with ArchiMate: A Mobility Provision Case Study. In: *5th International Conference on Serviceology for Services, ICServ 2017*, pp. 178-189. (2017)
7. Tsai, C.H., Zdravkovic, J., Stirna, J.: Requirements for a Digital Business Ecosystem Modelling Method: An Interview Study with Experts and Practitioners. In: Buchmann R.A., Polini A., Johansson B., Karagiannis D. (eds) *Perspectives in Business Informatics Research, BIR 2021*, pp. 236-252. Springer International Publishing (2021)
8. Henderson-Sellers, B., Ralyté, J., Ågerfalk, P.J., Rossi, M.: *Situational Method Engineering*. Springer Berlin Heidelberg, Berlin, Heidelberg (2014)
9. Aldea, A., Kusumaningrum, M.C., Iacob, M.E., Daneva, M.: Modeling and analyzing digital business ecosystems: An approach and evaluation. In: *20th IEEE International Conference on Business Informatics, CBI 2018*, pp. 156-163. Institute of Electrical and Electronics Engineers Inc. (2018)
10. Battistella, C., Colucci, K., Nonino, F.: Methodology of business ecosystems network analysis: A field study in telecom italia future centre. In: De Marco, M., Te'eni, D., Albano, V., Za, S. (eds.) *Information Systems: Crossroads for Organization, Management, Accounting and Engineering: ItAIS: The Italian Association for Information Systems*, pp. 239-249. Physica, Heidelberg (2012)
11. Mirbel, I., Ralyté, J.: Situational method engineering: combining assembly-based and roadmap-driven approaches. *Requirements Engineering* 11, 58-78 (2006)
12. Ralyté, J., Rolland, C.: An Approach for Method Reengineering. In: *Conceptual Modeling — ER 2001*, pp. 471-484. Springer Berlin Heidelberg (2001)
13. Kheir, A., Naja, H., Oussalah, M., Tout, K.: Overview of an Approach Describing Multi-Views/Multi-Abstraction Levels Software Architecture. *ENASE 2013 - Proceedings of the 8th International Conference on Evaluation of Novel Approaches to Software Engineering* (2013)
14. Frank, U.: Multi-perspective enterprise modeling: foundational concepts, prospects and future research challenges. *Software & Systems Modeling* 13, 941-962 (2014)
15. Bork, D., Buchmann, R., Karagiannis, D.: Preserving Multi-view Consistency in Diagrammatic Knowledge Representation. In: *Knowledge Science, Engineering and Management*, pp. 177-182. Springer International Publishing (2015)
16. Bork, D., Karagiannis, D.: Model-driven development of multi-view modelling tools the muviemot approach. In: *2014 9th International Conference on Software Paradigm Trends (ICSOFT-PT)*, pp. IS-11-IS-23. IEEE (2014)
17. Tsai, C.H., Zdravkovic, J.: A Survey of Roles and Responsibilities in Digital Business Ecosystems. *Proceedings of the Forum at Practice of Enterprise Modeling 2020 co-located with the 13th IFIP WG Working Conference on the Practice of Enterprise Modeling (PoEM 2020) CEUR Workshop Proceedings* 44-53 (2020)

18. del Río-Ortega, A., Resinas, M., Ruiz-Cortés, A.: Towards modelling and tracing key performance indicators in business processes. II Taller sobre Procesos de Negocio e Ingeniería de Servicios, PNIS (2009)
19. Selznick, P.: Focusing Organisational Research on Regulation. In: Noll, R.G. (ed.) *Regulatory Policy and the Social Sciences*, pp. 363-364. University of California Press, Berkeley (1985)
20. Sandkuhl, K., Stirna, J., Persson, A., Wißotzki, M.: *Enterprise Modeling [Elektronisk resurs] Tackling Business Challenges with the 4EM Method*. Springer Berlin Heidelberg :, Berlin, Heidelberg (2014)
21. Yu, E.S.K.: Towards modelling and reasoning support for early-phase requirements engineering. In: *Proceedings of ISRE '97: 3rd IEEE International Symposium on Requirements Engineering*, pp. 226-235. (1997)
22. Tsai, C.H., Zdravkovic, J., Stirna, J.: *Capability Management of Digital Business Ecosystems – A Case of Resilience Modeling in the Healthcare Domain*. *Advanced Information Systems Engineering Lecture Notes in Business Information Processing* 126-137 (2020)
23. Giesecke, R.: The electric mobility business ecosystem. In: *2014 Ninth International Conference on Ecological Vehicles and Renewable Energies (EVER)*, pp. 1-13. (2014)
24. Senyo, P.K., Liu, K., Effah, J.: Understanding behaviour patterns of multi-agents in digital business ecosystems: an organisational semiotics inspired framework. In: *International Conference on Applied Human Factors and Ergonomics*, pp. 206-217. Springer (2018)
25. Weill, P., Woerner, S.: *What's your digital business model?: six questions to help you build the next-generation enterprise*. Harvard Business Press (2018)
26. Wieringa, R.J., Engelsman, W., Gordijn, J., Ionita, D.: *A Business Ecosystem Architecture Modeling Framework*. In: *2019 IEEE 21st Conference on Business Informatics (CBI)*, pp. 147-156. (2019)
27. Basole, R.C., Srinivasan, A., Park, H., Patel, S.: *ecoxight: Discovery, Exploration, and Analysis of Business Ecosystems Using Interactive Visualization*. *ACM Trans. Manage. Inf. Syst.* 9, Article 6 (2018)
28. Faber, A.: *Towards a Visual Language Approach for Modeling Business Ecosystems*. In: *PoEM Doctoral Consortium*, pp. 1-8. (2017)
29. Faber, A., Rehm, S.-V., Hernandez-Mendez, A., Matthes, F.: *Modeling and Visualizing Smart City Mobility Business Ecosystems: Insights from a Case Study*. *Information* 9, 270 (2018)
30. Zdravkovic, J., Stirna, J.: *Towards Data-Driven Capability Interface*. *IFAC-PapersOnLine* 52, 1126-1131 (2019)
31. Faber, A., Hernandez-Mendez, A., Rehm, S.-V., Matthes, F.: *Visualizing business ecosystems: Applying a collaborative modelling process in two case studies*. (2018)
32. Rehm, S.-V., Goel, L.: *Using information systems to achieve complementarity in SME innovation networks*. *Information & Management* 54, 438-451 (2017)
33. Repenning, N.P.: *A Simulation-Based Approach to Understanding the Dynamics of Innovation Implementation*. *Organization Science* 13, 109-127 (2002)
34. Windrum, P.: *Simulation Models of Technological Innovation*. *American Behavioral Scientist* 42, 1531-1550 (1999)