Towards a Visual Language Approach for Modeling Business Ecosystems

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Abstract. Enterprises develop, produce, and distribute their products and services nowadays in complex and increasingly digital business ecosystems consisting of business partners, suppliers, competitors, start-ups, public institutions, and costumers. These business ecosystems exhibit a high dynamic: new actors enter and leave the ecosystem continuously. Thus, for enterprise business and IT strategy the knowledge about and active design of the business ecosystems are gaining more relevance. Various stakeholders within the enterprise need to collaborate to achieve a holistic understanding of the ecosystem, all with different requirements towards the ecosystem model. As visualizations have proven to support stakeholders in fulfilling their ecosystem related tasks, the aim of this research project is the modeling and visualizing of business ecosystems addressing the identified challenges.

Keywords: Business Ecosystems, Modeling, Decision Support System, Visualization

1 Introduction

The environment of an enterprise influences the business development of the same [1]. As "innovative companies can't evolve in a vacuum" [2] the business environment – to which we refer to as *business ecosystem* – can be a deciding factor for the success or failure of an enterprise [3]. Thereby,

> *Business ecosystem (BE)* describes the holistic environment of a company covering current and potential future business partners, customers, suppliers, competitors, regulatory institutions, and innovative start-ups. It exhibits a high dynamic as continuously entities enter and leave the ecosystem.

Thereby, a BE enlarges the classical value-added chain, consisting of suppliers and customers, and the known competitors active in the same market. It includes besides business partners on various levels of cooperations also potential interesting enterprises and start-ups for future collaboration, but also public institutions affecting the market direction with changes in laws, regulations, and

policies. For a comprehensive definition of business ecosystem we refer to [4]. Within their business ecosystems companies nowadays invent, create and offer products and services. This allows companies to focus on their expertise within the invention, development and selling process, but also makes them dependent on other entities within the ecosystem. Thus, it is vital for an enterprise to extract relevant insights by modeling and analyzing its BE. Only when knowledge of the elements of the BE and their interrelations is available for an enterprise, it is able to respond to changes in the ecosystem. Therefore, it is mandatory for enterprises to continuously analyze and model the BE. The identification of key players – together with the analysis of similarities and differences – is as relevant as the identification of niches within the ecosystem, addressable by new ecosystem players, or the analysis of changes in the ecosystem due to failed negotiation, an ending relationship, or the change of personnel of a manager in a leading position.

Especially in business areas which are affected by the digital disruption, such as the media or mobility industry, the business ecosystems are changing at a rapid pace. Technological innovations enable new actors to enter the business ecosystem with innovative business models and challenge existing BE stakeholders, taking over parts of their market share or even – in an extreme case – replace them. This is particularly true for large enterprises, which face great challenges when trying to adapt their business to recent market developments.

To model those continuously changing business ecosystems the market developments must be analyzed by scanning various data sources. These data sources can be newspaper articles, news feeds, social media, start-up databases, companies web pages, etc. The business ecosystem and its changes effect stakeholders of different business units within the enterprise which are responsible for business relations, market analysis, customer feedback, etc. All these stakeholders have requirements towards a particular part of the enterprise's BE.

2 Problem Description

Even though there has been research conducted addressing the relevance of the business ecosystem for companies (e.g., [5], [6], [7], or [8]), stakeholders are still seeking to find effective methods and techniques to help understand and manage the complexity of their business ecosystem ([3], [9]). When compared to the classical competitor or market analysis, the business ecosystems nowadays change much more rapidly [1]. New companies enter and leave the market continuously [10], ranging from innovative start-ups, to new competitors, or potential business partners. The problem addressed within this research project is

> **Problem Description.** Companies –especially larger ones– are lacking a comprehensive understanding of their business ecosystem, the comprising entites and existing relations, and the highly dynamic changes.

Therefore, we want to answer the following research questions

RQ 1. What is the current state of the art within enterprises addressing business ecosystem modeling and where are the main challenges?

Up to now, the relevance of business ecosystems for enterprise success has been identified and discussed widely, but how companies address this task and what challenges they face have not been analyzed. RQ 1 aims at understanding if companies are already addressing the management of business ecosystem models, how they process the ecosystem related information, if and what tools they use and where they have needs and requirements for addressing and/or improving this.

RQ 2. Which tasks and questions arise in the context of understanding and managing a business ecosystem model?

To understand how enterprise representatives can be supported in understanding and managing their business ecosystem, it is important to identify the tasks and questions the stakeholders are seeking to answer with a business ecosystem analysis (RQ 2).

RQ 3. How can business ecosystems be modeled considering the various requirements of different stakeholders?

In addition to suppliers, customers, business partners, and competitors, a business ecosystem comprises innovative start-ups and companies for potential future collaboration as well. To model a company‘s ecosystem, it is thus important to include different stakeholders of various business units, such as legal, market research analysis, competitor analysis, customer department, etc. Not only their already existing knowledge but also all stakeholder's requirements have to be included in the business ecosystem model. Answering RQ 3 will lead to the model, which is created following a collaborative approach.

RQ 4. Which decision support tools and features of these tools are suitable to support stakeholders in completing business ecosystem related tasks?

RQ 4 aims at fostering the understanding of which outcomes of an agile enterprise internal process are needed to support the stakeholders and decision makers. The outcomes thereby include visualizations, metrics, reports, etc. Finally, the research project will be evaluated and the approach validated. A comparison with similar approach is included.
With our research project, we are aiming at an enterprise internal process to collaboratively analyze and manage the business ecosystem considering different stakeholders' knowledge about and requirements towards the business ecosystem. Our focus thereby is within business areas affected by the technological changes and digital disruption. As these business ecosystems are continuously changing, the resulting business model must be adaptable as well.
The results of this research project mainly contribute to the fields information systems (IS), visual decision suppot (VDS) and computer supported cooperative work (CSCW).

3 Research Approach and Preliminary Results

To support the digital transformation in the area of Smart Mobility and Smart City, the TUM Living Lab Connected Mobility (TUM LLCM)[1] research project was initiated, funded by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology (StMWi) through the Center Digitisation.Bavaria, an initiative of the Bavarian State Government. One of the project goals is the networking of already established and currently arising mobility providers, service providers, developers and users on an organizational level. Within these networking activities we conducted several discussions about the connected mobility ecosystem, which is currently reshaping and drastically changing due to technological innovation, a phenomenon often referred to as digital disruption. The discussion partners, representatives of automotive OEMs, parts suppliers, IT consultants of the automotive industry, and start-ups offering innovative mobility services, all stated their inability to understand the continuous changes of the ecosystem. The amount of information, the distribution of responsibilities addressing different parts of the ecosystem, and the missing or insufficient tool support were named consistently as major challenges. These companies the usage of the Prototyp developed within this research project is offered to address the identified challenges.

3.1 Research Approach

To model business ecosystems, and to help understand and manage the complexity of business ecosystems, visual decision support and visual analytic systems and approaches have been proposed and evaluated (cf., [11], [12], [13], [9], and [14]), supporting stakeholders and decision-makers applying the "wide lens" [3] and making informed decisions. Thereby, a data-driven approach is applied to foster the understanding of the dynamics within ecosystems. Amongst other research results, a visual analytics system is presented analyzing a fixed supply network data set [12]. The described system provides multiple views in an integrated interface enabling users to interactively explore the supply network and additionally, providing data-driven analytic capabilities.
We see a great research opportunity to extend this research by addressing an enterprise internal approach to model the business ecosystem in an agile process supported by a visual decision support system.
In a first step of this research project, a prototype – which we refer to as the *Business Ecosystem Explorer (BEEx)* – was implemented to support the understanding of connected mobility ecosystem related to the TUM LLCM project. After a first evaluation phase conducted with project partners, we incorporated the feedback and developed the second version of the BEEx.

[1] www.tum-llcm.de/en

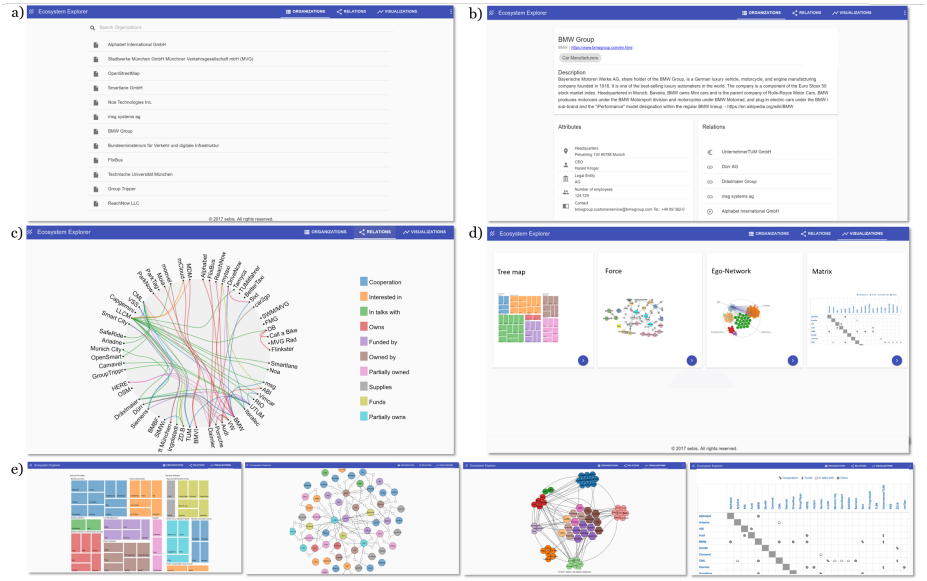

Fig. 1. Architecture of the Business Ecosystem Explorer (BEEx): a) Landing page with a list of all companies, b) Detailed information of the ecosystem entities, c) One view focusing on different types of relations between ecosystem entities, d) Overview of available visualizations, and e) Visualizations (from left to right): Tree Map Layout (TML), Force-Directed Layout (FDL), Modified Ego-Network Layout (MEL), Matrix Layout (MXL)

3.2 Preliminary Results

As a first result, the BEEx prototype, a web-based tool to model and visualize business ecosystems, can be presented. The current version of this prototype is visualized in Fig. 1. As this research project was initiated within the context of connected mobility, the current version of the BEEx addresses the connected mobility ecosystem.

The BEEx rests on a Hybrid Wiki approach as presented in [15] that serves as Knowledge Management System application development platform and contains features for data management, as well as collaboration and decision support. To create the BE model we use the Hybrid Wiki metamodel.

The business ecosystem model consists of entities and relations plus attributes describing these entities and types of relations (see Fig. 2). We use UML [16] to represent the ecosystem model. Within the decision support system – the BEEx – we use an explicit visual language to represent the BE model through useful interactive visualizations.

The first version of the prototype consisted of two visualizations, a matrix layout, and a force-directed layout, representing the project's ecosystem. Additionally, it provided – as the latest version as well – the feature to easily enter missing

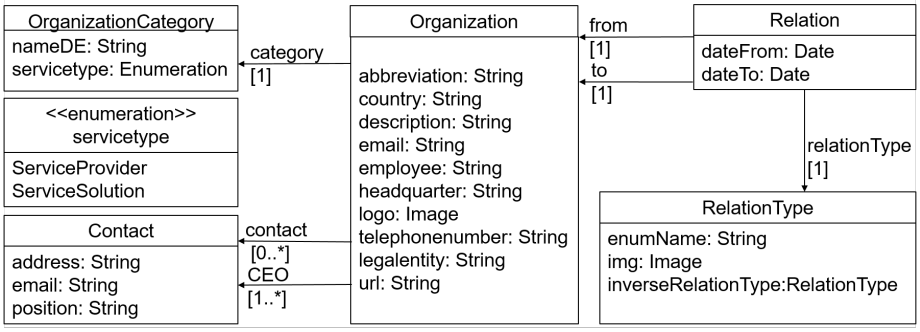

Fig. 2. Preliminary information model of the business ecosystem

entities, relations between them and integrating further information. This version of the BEEx was evaluated in 12 expert interviews, thereof nine aiming at the goal to identify visualizations as appropriated support to better understand the ecosystem, and three semi-structured in-depth expert interviews, discussing which information and visualization might be helpful to add to the existing version of the prototype. Besides the identification of networked graph and treemap as favored visualization types, the interactive features such as filtering, highlighting and clicking to get detailed information were named.
This feedback was included in the second version of the BEEx. As described in detail in Section 4 it is our goal to continuously evaluate the modeling and prototypical implementation.
In a parallel step, we initiated an anonymous survey. We contacted 51 representatives of German companies active in the area of enterprise modeling via e-mail, asking for their contribution to our survey. Additionally, we posted information about the survey including a link on LinkedIn. Thereby, the aim of the survey is to understand the state-of-the-art in practice on how enterprises analyze and manage their business ecosystems. The survey is still running at the date of submission.

4 Research Methodology

The research objective of this project is to develop information system artifacts, more precisely a business ecosystem model and the design and prototypical implementation of a web-based tool supporting business ecosystem stakeholders in ecosystem related tasks to collaboratively analyze and manage their business ecosystem. Therefore, a combination of the design science research approach proposed by Hevner et al. [17] and the action design research approach as presented by Sein et al. [18] is applied.
The adoption of the Information Systems Research Framework, ensuring an integration of the developed artifacts in the appropriate environment and knowledge base according to [17], is pictured in Fig. 3.

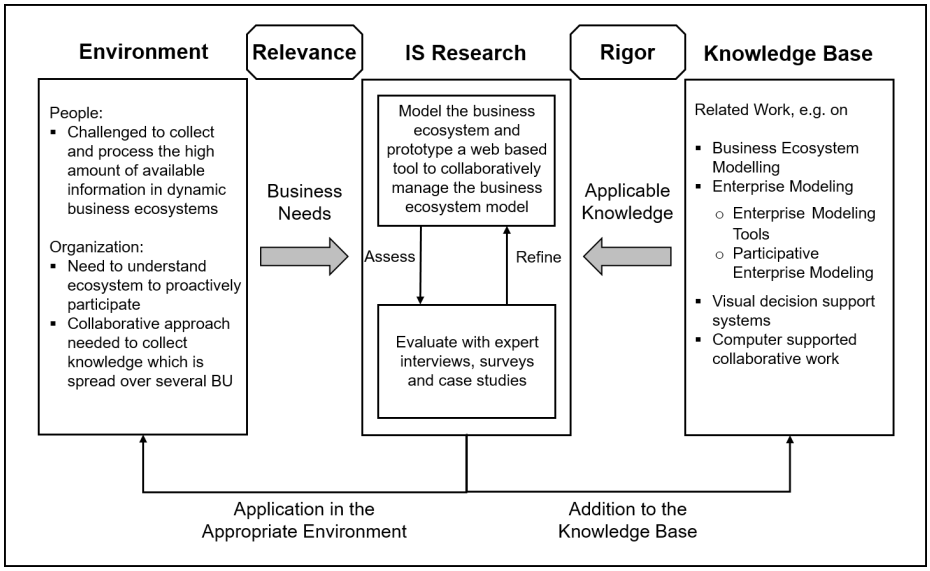

Fig. 3. Information Systems Research Framework [17] adapted to the present research project

As this research addresses the challenges perceived by ecosystem stakeholders to better understand the business ecosystem, the artifacts will emerge through the interaction of design and use [18], that means in short iterations of analysis, design, evaluation, and diffusion, as it is also proposed by [19].
The developed artifacts are thereby evaluated and validated with relevant literature identified in an extensive literature review, expert interviews, a survey addressing mainly German companies active in areas affected by digital transformation, and case studies. This iteratively received feedback will incorporate in the next analysis and design phase of the research project.

Acknowledgement

This PhD project is supervised by Prof. Dr. rer. nat. Florian Matthes, holding the chair Software Engineering for Business Information Systems at Technical University Munich.
This work is part of the TUM Living Lab Connected Mobility (TUM LLCM) project and has been funded by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology (StMWi) through the Center Digitisation.Bavaria, an initiative of the Bavarian State Government.

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