

Digital Platforms: Novel Business Model as one-stop-shops for cross-sector collaboration

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Abstract

In the digital era, online platforms redefine business by promoting agility, connectivity, innovation and collaboration. The paper focuses on the work conducted in the DIH4CPS project, which involves developing a semantic model and a web-based tool called the Ei2Network platform for managing organizational networks. This platform prioritizes service management, aiming for expansiveness and reusability. Its primary targets are small to medium-sized companies and Digital Innovation Hubs (DIHs), offering improved visibility and user-friendly management of service and competency portfolios. The platform's contribution lies in enhancing organizational networks, facilitating collaboration, and supporting the efficient management of services and competencies in the digital age.

Keywords

Digital Transformation, Digital Innovation Hubs, Collaborative Manufacturing, Service Modeling for Business, Semantic Web-based approach, Business Model for Interoperability, Ei2Network.

1. Introduction

The digital revolution has transformed the economy into a new economy and new strategies based on multi-sided platforms and communities with increasing importance given estimates of double-digit annual growth around the world [1] and [2]. Digital platforms can link individuals, organizations, and resources, aiming to simplify interactions between businesses and consumers as well as maximize efficiency in business management [3].

In order to remove virtual borders, boost digital connectivity, and make it easier for consumers to access cross-border online content across the European Union, The Digital Single Market (DSM) strategy was adopted on 6 May 2015 and is one of the European Commission's priorities [4]. The DSM focuses on three policy pillars:

- **Access:** better access for consumers and businesses to digital goods and services across Europe;
- **Environment:** creating the right conditions and a level playing field for digital networks and innovative services to flourish;
- **Economy & Society:** maximizing the growth potential of the digital economy.

Online platforms are strong drivers of innovation and play an important role in Europe's digital society and economy [5]. Online platforms can be described as software-based facilities offering two even multi-sided markets where providers and users of content, goods and services can meet. As such,

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the term can cover a wide range of different types of platforms, whose functions and characteristics can differ considerably [6]. They cover a wide range of activities including online marketplaces, social media, creative content outlets, app stores, price comparison websites, platforms for the collaborative economy as well as search engines. The concept of Digital Innovation Hubs (DIHs) originated from the European Commission in 2016 within the framework of the initial industry-focused initiative of the Digital Single Market package [7]. They stand as pivotal pillars in the overarching effort to digitize European industry. The success achieved thus far by these hubs can be largely attributed to the collaborative networks formed within the innovation ecosystems they foster [8].

This paper presents one of the main results of the **DIH4CPS [9]** project **Ei2Network platform [10]**. The paper is divided into two parts, the first part discusses the business aspects of digital transformation and green deals, and the second part presents the technical development of the web-based platform.

2. Business Context

In today's dynamic business environment, companies face many challenges but also many opportunities. However, to achieve success they need to keep pace with emerging trends, technologies, and market shifts. This section presents some key elements of the business context for digital platforms with a special focus on the EU green deal.

2.1. Business trends in the digital era

Digitization with the emergence of digital platforms has fundamentally transformed the meaning of business. Companies have revolutionized the way they operate, interact with customers, and conduct transactions. The essence of business in this digital landscape could be characterized by several key characteristics such as outreach and accessibility, where companies could reach audiences far beyond their local markets. Another key characteristic of digital business is customer interaction and engagement in which companies have direct communication to gather feedback on issues and concerns and customers' preferences [11]. In the digital era, online platforms play a crucial role for companies in driving growth by providing access to a wider audience beyond the traditional market boundaries. But also, platforms provide better visibility for companies with their online presence to attract more customers. Furthermore, online platforms empower companies to align their strategies aligning strategies, enhancing collaboration and communication. With such capabilities, companies have the capacity to adapt and adjust to dynamic market conditions, foster innovation, and attain sustainable growth [12]. Online platforms are pivotal in advancing the European Union's Green Deal, aimed at climate neutrality and sustainable development. They provide market access for eco-friendly products, promote transparency in sourcing and manufacturing, and facilitate circular economy initiatives by exchanging pre-owned goods (recycled materials, recovered components, repurposed products, second-hand goods etc.) [13]. Moreover, platforms support sustainable supply chains and foster green innovation through partnerships and knowledge exchange. They also serve as educational tools, raising awareness and mobilizing action. By promoting sustainability and collaboration, online platforms contribute significantly to the transition to a more resilient economy [14]. The manufacturing industry is one of the industries that experiencing major transformations driven by advancements in technologies and the widespread adoption of online platforms. A significant market trend in manufacturing is Smart Manufacturing (SM). SM can be defined as the combination of the smart use of people's capabilities, the smart use of technology and the deployment of a (self-) learning production system [15]. The objective of smart manufacturing efforts is to enhance productivity, efficiency, and flexibility through the networking of machines, sensors, and systems. This is achieved by integrating digital technology into manufacturing processes, including cloud computing, big data analytics, IoT (Internet of Things), and AI (Artificial Intelligence) [16].

The following subsection will present an overview of the Ei2Network platform, which stands as one of the outcomes of the DIH4CPS project, finalized by the end of 2022. It was defined as a business plan to explore the Ei2Network and was transferred to the organization I-VLab [17] to explore it.

2.2. Ei2Network Ecosystem

DIH4CPS project was launched to enhance capabilities of the European Start-ups, SMEs, and Mid-Caps to create innovative products with advanced digital technologies. This is to be accomplished by setting up a dynamic, comprehensive, and cross-sector one-stop shop for SMEs, DIHs, and technology providers to collaborate. The **Ei2Network platform** (European Network for Innovation and Interoperability) was launched by the end of the project. The **Ei2Network** platform is a navigation tool to find the relevant information regarding the services & competencies that can be provided by the network members. The platform allows organizations to showcase their products, services, competencies and skills. Organizations can register and create profiles on the platform, providing details about their business, including their industry, size, location, and areas of expertise. They can also highlight their services, products, competencies, and skills and above all their contact point. Further details are provided in section three.

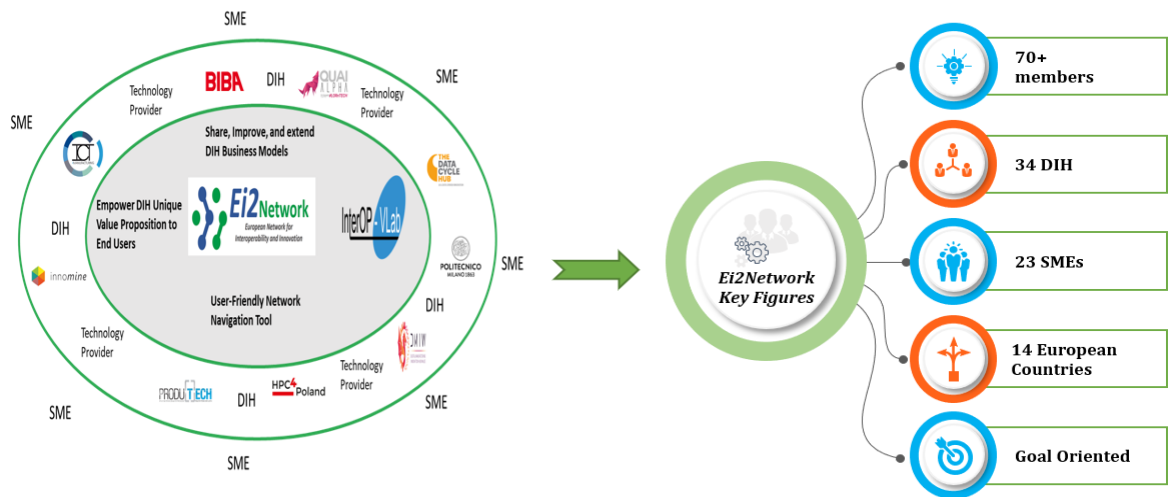


Figure 1 - Ei2Network Ecosystem

The Ei2Network platform ecosystem boasts over 70 members, including 34 Digital Innovation Hubs (DIH), and 23 Small and Medium Enterprises (SMEs), spanning across 14 European countries. The platform serves as a valuable tool for organizations to connect, showcase their offerings, and find potential partners or service providers.

3. Development Context

Our contribution to this topic consists of a semantic model in the domain of organizational networks and a web-based tool for its management and user-friendly access. We used semantic web technologies to enhance service management, modeling expansiveness and reusability of the platform. The main goal of the system is to provide more visibility for small and medium-sized organizations and DIHs. Organizations can use it to facilitate user-friendly management and configuration of their service and competence portfolios as well as for a structured search for needed services and collaboration opportunities in the network. These functions can be accessed via a user interface developed as part of the DIH4CPS project, which enables direct and user-friendly interaction with and use of the ontology.

The system consists of several modules, whose interaction is roughly summarized in Figure 2. The Jena Fuseki framework plays a major role, acting as a triple store and providing an API to query and update the RDF data held in the organizational networks ontology using SPARQL. The ontology

formally specifies the competencies, services and experiences of organizations and their context. Apache Jena Fuseki was set up on a server and is connected to the Triple Store Access (TSA) module. TSA is a JAVA-based module that uses the Jena API to access the RDF entities (classes, individuals and properties) on the Fuseki server. The TSA module implements the access to the ontology, implements the logical constraints of the ontology on the user interface, and ensures that the ontology remains consistent and specification coherent.

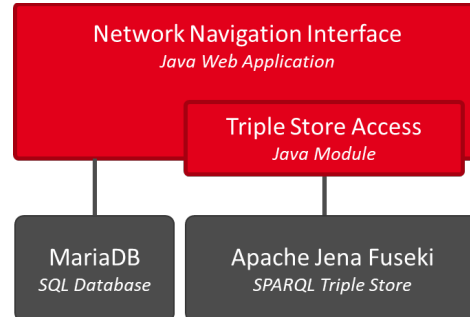


Figure 2 - DIH Network Web Portal Architecture

On top of these two modules, the Network Navigation Interface (NNI) as the main module of the stack implements the user interface and logic functions of the tool. It includes the TSA module and uses its exposed interfaces for storing and retrieving data. For the management of login and user account information, the module integrates an SQL database, based on MariaDB.

3.1. Ontology Overview

We developed the semantic model in Resource Description Framework (RDF) following the principles from NeOn Methodology [18] and assisted by the Protégé tool. We opted for RDF rather than the more expressive OWL because we wanted to keep the model as lean as possible for performance reasons. Long waiting times for answering a query due to computationally more intensive OWL constraints will have a negative impact on acceptance and therefore on the use of the search interface. The ontology is divided into three modules, so-called domain ontologies: the *organization*, the *capabilities* and the *custom service* ontology. We have reused concepts from the schema.org initiative in the development process wherever possible to allow a semi-automatic tagging of content on the web-based platform and optimize it for search engines.

Organization ontology: The *Organization Ontology* defines how organizations are defined and managed. We have defined concepts and properties that are necessary to answer the core questions of the requirements - besides descriptive properties about the *organization* itself (size, organization type, number of employees, etc.), this includes information necessary to filter search results. This includes a catalogue of *languages* and geographical information on the *country* and *region*, based on Eurostat's NUTS code [19]. The ontology allows to creation of *ContactPoints* and *Persons* for an organization, to be able to model sub-organizations (departments) and affiliations that have different areas of expertise and want to be differentiated in the platform. This way, we can connect specific contact options to specific competencies and service offers.

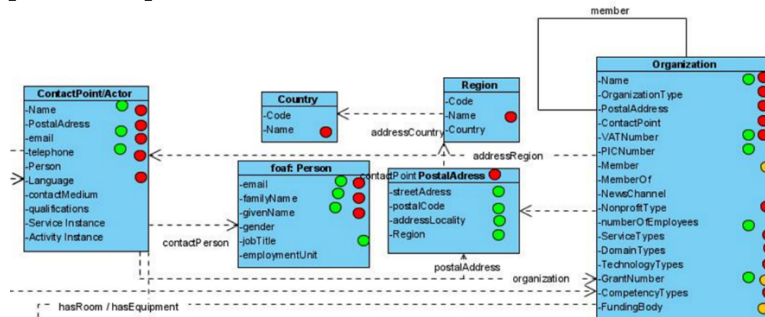


Figure 3 - Organisation ontology class diagram

As explained above, the ontology characterizes a part of the real world, namely organizational networks and their capabilities. Users are also part of the ontology but role management is realized by an attached SQL database module.

Ontology Complexity: Informal, Low, **Medium**, High

The ontology contains both class hierarchies/subclass relations, but also other relations (see 2.1).

Ontology Usage Time: Design Time, **Run Time**

The Ontology is part of the user interface and is hence used when the system is executed.

Ontology Visualization: No presentation, Lists, **Graphical**, Verbalized, Source Code

The interface visualizes different catalogues mainly through lists or tree structures.

Ontology Interaction: No interaction, View only, **View and edit**

The NNI enables users without an ontology engineering background to modify the contents of the ontology. While full modification is restricted for administrators, registered users can create individuals and relations using the functions provided by the NNI. Sticking to the above systemization, we show the implementation of some functions through screen views in NNI, subdivided into **view** and **edit** functions.

View: The view functions relate in particular to the search function, which allows you to search the underlying ontology for the right partners to support your own experiments or development tasks. Figure 5 shows the landing page of the NNI, which gives information on the network and is accessible to any user of the portal. The user can use this page to register or log in to his account, or search the network as an unregistered user via the search field. The display of the search result can be seen on the right-hand side of Figure 5. The view visualizes different types of results (classes of the ontology) using symbolic icons. The results can be filtered down using interactive elements (e.g. limiting the search results to organizations or services).



Figure 5 - Landing page screenshot (left) and search results (right) of the DIH4CPS portal

View and edit: Different views are used to enter the organizational information and describe the competencies in the ontology. The TSA module translates the changes in the NNI and transmits them to the ontology to guarantee compatibility with the model. All changes are immediately persisted in the ontology and are reflected in the search results for all users. Users can use these views to edit the organizational data by changing corresponding properties in the organizational ontology. **Error! Reference source not found.** shows the screens Company Details and Company Portfolio, which are used to edit various organization-specific information.

The master data of the organization can be changed using the Company Details page (left). This concerns simple properties, such as the organization's name or its PIC number, but also related concepts, such as the creation of contact points.

The company portfolio view (right) allows the user to select which capabilities his organization offers. For this purpose, the catalogues are visualized as a tree diagram and a relation between the organization and the respective category is persisted in the ontology by clicking on it. The catalogues derive from the ontology in the categories and cannot be altered. Similarly, users can also describe customized services according to the ontology using a mix of data fields and service category tree views.

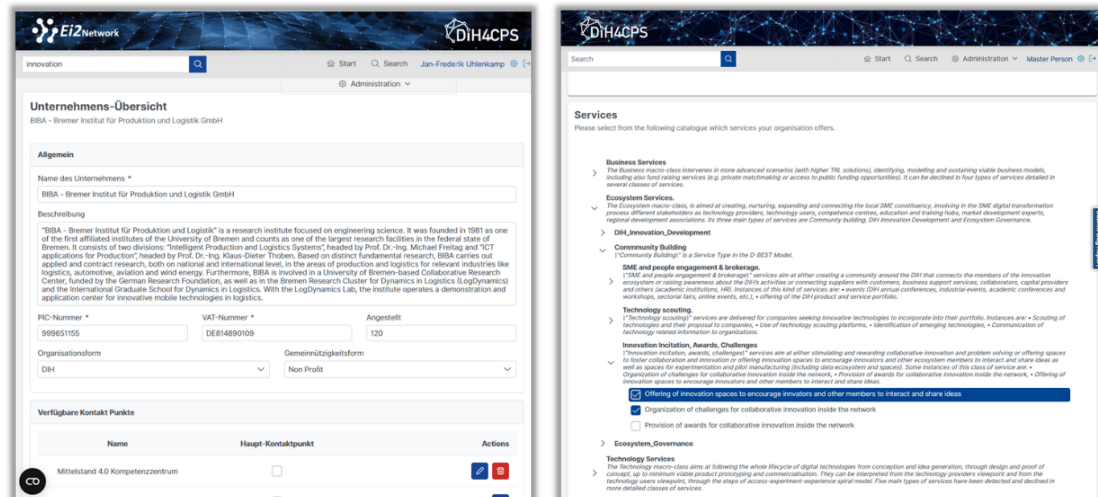


Figure 6 - Company Details (left) and Company Portfolio Page with selected services (right)

4. Conclusion

The paper's contribution centers around the work conducted in the DIH4CPS project in developing a semantic model and a web-based tool (**Ei2Network platform**) tailored for managing organizational networks. The platform emphasizes service management, aiming for expansiveness and reusability. The main targets are small to medium-sized companies and Digital Innovation Hubs (DIHs), offering enhanced visibility and facilitating user-friendly management of service and competency portfolios. In the digital era, online platforms redefine business by promoting agility, connectivity, innovation and collaboration. They are the backbone of modern business, enabling companies to grow their end-user base, reach a wider audience, use data insights, and increase productivity. Digital platforms are driving a fast-digital change in the manufacturing sector. Adopting industry trends improves customer value, innovation, and operational effectiveness. The digital landscape accelerates product lifecycles, changes the dynamics of the market, and increases worldwide competitiveness. In today's dynamic environment, manufacturers need to adopt digital efforts to fulfil changing requirements and enhance development. **Ei2Network** will continue growing and adding value to its existing knowledge transfer capabilities and ensure the sustainability of the growing network.

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Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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