

Design of the platform ecosystem – healthcare case in patients with Parkinson’s disease

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ABSTRACT

The platforms of the software ecosystems have developed sharply since the introduction of the virtual computing and related services such as ‘Infrastructure as a Service’, ‘Platform as a Service’ and ‘Software as a Service’. New related business’ models have emerged along including ‘easy to scale’ and ‘pay as use’ approaches. This study investigates how a pilot platform ecosystem was introduced for a hospital for care of patients with Parkinson’s disease. This study depicts an interaction model between the technology, ecosystem platform studies, funding and research institutes, industry partners and individuals with their platform ecosystem visions. This virtual computing technology provides a possibility to introduce specialized global players for health care. The result of the study comprises a set of tentative rules, or propositions, how to design and construct an ecosystem platform. The keystones of the propositions consist of (1) the architecture model to attract third parties involvement, (2) business constraints and health care issues solved by the technology and architecture, (3) cooperation model to build a pilot system, and (4) employing science community deploy the results. The study crosses several science disciplines including medical, information technology, electronic system, programming, biomedical science and industrial economics. The study demonstrates how the various concept trajectories in space and time with the help of the individuals’ knowledge network end up proposing novel concept trajectories. The study uses inductive research approach with case study methodology. Research findings are discussed in the view of the current literature including business networks, ecosystem platform, and the industrial revolution. The study contributes to the exact literature by providing a cross-disciplinary approach to the creation of a new platform ecosystem since its ideation.

Keywords: platform ecosystems, virtual computing, scalable business models, healthcare

1. Introduction

Scholars, Hanh et al. (2016) define platform ecosystems as follows: it combines the streams of product families, e.g., modularization and architecture, and market intermediaries, e.g., multi-sided markets. Attour et al. (2016) discuss that platform ecosystems are modular structures where several components, originally independent, are interconnected through a key asset: a technological platform. This platform can take the form of a product, a service, a system or technology. Tiwana et al. (2010) state, that software platform ecosystems connect specific platform module developer with end customer or other developers in the Business-to-Business market. This approach creates two side-sided markets.

According to Van der Meulen (2017), digital platform ecosystems are one of the most important concepts affecting digital business. Scholars highlights that software platform ecosystems shift the competition and innovations toward platform ecosystems (e.g., Yoo et al., 2010). Taylor (2017) says that the large, varied, and relatively uncoordinated participants can contribute to the evolution of the platform ecosystem by producing unprompted innovation and change. Platform ecosystem contexts can produce strong sociotechnical ties among participants, including strong social bonds with the hub firm. These ecosystems, platform ecosystems, and open innovations will change postindustrial mantras such as cost-conscious, effectiveness, productiveness and customer-centric values to be more capability and community-centric (Letaifa, 2014; Pitelis, 2009).

The scholars state that there are significant gaps in platform ecosystem studies. For example, Hanh et al. (2016) state that there exist relatively few studies within this discipline of inquiry. Taylor. (2017) states that platform ecosystems are unique and less understood contexts in comparison to more traditional, tightly coupled alliances and supply chain networks. The technologies concerning the platform ecosystems develop fast, and new concepts are introduced continuously, such as Microservices and DevOps. This fast development of the concepts changes enterprises and societies. Therefore, it is essential for research to be able to anticipate the progress of this development and effect of it on the businesses and the societies in general.

This article increases the current pool of knowledge significantly as it plans to fulfill some of the key research gaps discussed by the scholars (e.g., Hanh, 2016; Taylor, 2017). This study contributes to the research of the platform ecosystem and current knowledge by studying how the business concepts can be created for a platform ecosystem within one industry. This project increases the understanding of the platform ecosystem especially in the setting of new businesses in the context of the business to business networks. This project executes constructive qualitative case studies in

the selected technology industry namely health care. Majority of studies have been done in the software platform ecosystems in the digital industry.

The remainder of this paper is organized as follows. First, in the literature review, we study the knowledge of how to create a platform ecosystem. On the basis of the review, we propose a tentative model. Second, we describe the constructive research methodology used in this study among patients with Parkinson's disease. Third, we introduce the framework built based on the design project that was executed to form a new ecosystem based on the technologies available and the industry needs. Finally, we discuss and identify further research avenues.

2. Literature review – theory background

In this study, we employ Teece's concept of complementary assets (Teece, 1986). The idea on Teece's paper is that innovation usually requires complementary assets for generating profit. Complementary assets can be for example another innovation needed by this new innovative design such as a memory card. Complementary assets can also be aftersales service, marketing or production capability. Nowadays, the Platform as a Service (PaaS) system provides many of the complementary assets for constructing new systems usually including lucrative scalable business models. For example, Heroku PaaS provides most of the databases and development tools, but also delivery platforms and tools to follow-up the quality of the software service. PaaS forms scalable platform ecosystems, in which users can generate products for wide audience worldwide, but also tools that can be employed other platform ecosystems' developers or users.

In this world of the ecosystems platforms, it might be difficult to distinguish what the complementary asset is and what the product is. Many of the products can be complementary assets and vice versa. Actually, service-oriented architecture (SOA) proposes that the each of the product provides service interface for other application to employ (Newcomer & Lomov, 2005). The standard way to provide it is to use digital RESTful API interfaces for delivering data in JSON or YAML format. The Swagger tool is employed to create standard YAML interface to ease the software development.

In ecosystem platform, each actor provides or employs standards or platform ecosystem's specific resources throughout various kinds of interfaces. The standard supply concept with specific product set-up in this business context is extended to be both supplier and customer in the specific platform

ecosystem. The suppliers provide a continuum of various kinds of platform ecosystems that are employed by the same suppliers and consumers. This statement is also supported by Bianco et al. (2014), who state that many time software platforms can be used as a stand-alone product, but at the same time it allows integration with other applications and tools, e.g., Google maps. In order to create a new platform ecosystem for a certain market, the specific market's desires that are many times latent cannot be identified only by platform ecosystem owner. These desires can be addressed by a vital platform ecosystem's community

In the literature, the classification of software ecosystems functionality is discussed relatively scantily in the literature. Dal Bianco (2014) et al. classifies the resources of the ecosystems in three categories that are Application Boundary Resources, Development Boundary Resources, and Social Boundary Resources. Fotrousi et al. (2014) classify the ecosystems platforms by their business areas, e.g., Software Development, Telecom, Business Management, Logistics, Transportation, Healthcare, Consumer or Unspecified. They also classify the ecosystem platforms to be either digital or software ecosystems. Lee et al. (2015) compare two platform ecosystems namely Google's and Apple's ones. They refer earlier studies in which Apple's iOS platform is defined to be an integrator platform with Apple's control over both assets and customers. It differs from Google's Android as it opens the content selection process. In addition, Da Silva et al. (2014) classifies the ecosystem platforms based on their capability to scale. They have several categories for it: Load, Space, Space-Time; Structural, Distance, and Speed Distance scalabilities. Also, they discuss artifact scalability as all the organizations bring in their own complexities and people scalability that references instability of the system in the front of the increasing number of users unpredictable behavior.

Based on this brief literature discussion, this researcher sees that the creation of the platform ecosystem is a project that combines various kinds of ecosystem together for complementary assets and thus forming a new ecosystem that can be employed to meet specific markets' latent and non-latent market desires.

3. Data and methods

3.1 Research setting

A study project was established to investigate the creation process of the platform ecosystems. The tentative idea for this approach was discussed as early as 2015 for another business area, and EU funded project was applied. The project was finally funded by the Finnish Government Agency, Business Finland, Tampere University of Technology, Satakunta Hospital District and three companies: Orionpharma Oy, Forciot Oy, and Suunto Oy. The fourth partner in this study was the Satakunta's District Hospital that was responsible for the clinical research and patient measurements. The two years project started in February 2017. The study project aimed at researching Parkinson patients' gait. The overall goal of the study project was to find tools to improve the Parkinson's patients' quality of life especially by taking care that the medication stays in the boundaries needed. The project works across science disciplines including medical, biomedical engineering, programming and industrial management. For each of the disciplines, the project has subgoals. In order to achieve the project goal, it was discussed how to build an ecosystem platform to collect data and then to analyze it to meet the industrial management discipline study's subgoals. The idea of how to collect data was based on the ideas and experience of the researchers.

3.2 Methods

This researcher used the constructive research approach (Kasanen et al., 1993) for this study. This approach aims to contribute to both theory and managerial problem solving through the creation of models and diagrams, such as organizational charts and plans. The first step of this approach is to build a tentative theoretical model by reviewing the relevant literature. The second step is to test the model with field data and to refine it to create the model by the experience gained of the system.

The constructive research approach is a well-recognized case study methodology in accounting research (e.g., Kaplan, 1998; Kasurinen, 2002; Labro & Tuomela, 2003; Tuomela, 2005), but it has also gained popularity in other research areas such as supply chain management and information system design (see Tynjälä, 2007). Kaplan (1998, p.91) emphasizes the interaction part of the constructive research practice and theory: "This process of using new theory to modify critical aspects of organizations and management enables the researchers of management processes to develop and test theories in actual organizations."

Kasanen et al. (1993) argue that constructive research, by its nature, is more associated with normative research than with descriptive research. They contend that the constructive research method can be either quantitative or qualitative or both although case study methods are usually

applied. This study follows the longitudinal case strategy with an embedded case that enables a rich description of each case (Eisenhardt, 1989; Halinen & Törnroos, 2005; Miles & Huberman, 1994). We employed the case study approach because the understanding of the virtualization of the organization on employees' innovative behavior and related IT systems is still relatively sparse. The case study approach represents a method for analyzing unexplored phenomena holistically.

3.3. Data collection

Several meetings with individual stakeholders were organized to discuss the details of the platform ecosystem framework. The stakeholders included clinicians working in the area, sensor manufacturers, expert from the medication company, patients and researchers specialized in the area. The outcome of the meetings was presented in the various project's leadership meetings. The overall implementation guidelines were discussed and agreed upon in several meetings. The data were mainly extracted from various meetings and review meetings that were arranged on monthly bases. The meetings typically lasted from one to two hours. Many other meetings were conducted from 2016 to 2018 – some of them weekly. The meeting attendees were from various companies and other project partners including members of the hospital, companies involved, government agency, leadership team, top management, and individual employees. The stakeholders' interviews were recorded manually as well as the related emails and the minutes of the meetings were archived to support the creation of the innovation management framework for this study purpose. The construction itself was tested tentatively by several test users prior to Parkinson's patients' tests.

4. Results with analysis

4.1 Case study in Health Care business

A research project was set-up with academics, industry and Satakunta Hospital District. The Tampere University of Technology applied the project funding for the consortium from the government agency with aiming to study Parkinsons' patients' gait outside the hospital automatically and remotely. For monitoring of the gait, several different sensors and applications from different manufacturers were utilized including, for example, acceleration sensors, force sensors, and an application that measured the medication intake. Together these sensors and apps from different manufacturers were used for demonstrating an ecosystem platform to collect and analyze the data and to meet the needs of the use case of home monitoring of chronic diseases. Satakunta Central Hospital co-operated providing academic knowledge of Medical Science,

Parkinsons' patients' medical treatment, and study design. Orionpharma was of the major manufacturer of Parkinson patients' drugs for Parkinson's disease . Suunto Oy provided electronic sports devices such as smart watches and bands for various sports activities with good matching as in this case the patient movements was planned to be monitored. Forciot was a Finnish start-up that designs smart insoles for example for sports activities to get also the gait information. The role of the Tampere University of Technology also was responsible for developing signal processing solutions for the analysis of the gait patterns and other sensor data collected. It also had a role to lead the project and to investigate how to build a platform ecosystem based on the inputs from the project members, market and general and commercial technology platform ecosystem providers for desired complementary assets or as an opensource.

4.1 Market desires

The aim of the constructing the system is to make it attractive to use and thus supporting the creation of the platform ecosystem. Therefore, the consortium decided to provide the project development results based on open source principle to make third parties to easy to contribute. The other decision was to apply Service Oriented Architecture in order to let the third parties design their solutions on the base of the others' solutions. Each user provides their solution with REST API and employing JSON with Swagger (YAML) approach, which is a standard to document the application interfaces. The REST API interface works on the top of Internet Protocol leading to distributed solutions with which to the whole globe can be targeted as a market. Each instant of the various applications can be run independently in many parts of the globe where the data can be delivered on IP networks. This means that patient can be in Thailand and the doctor monitoring the status of the patient could be in another country. This technology approach can lead that certain hospitals can specialize to treat specific diseases even globally.

From the technical aspects and implementation's point of view, the desire was to simplify the access to patients. Companies' ITs tend to be bureaucratic, and that often leads to the major delays in the implementation (e.g., Hickson et al., 2009). The hospitals are very careful with patients data security. According to them, it was important to ensure that there is no violation of data security and all the regulation are followed. They are reluctant in allowing the data to be followed in the countries in which they do not have juristic legislation power to protect patient data. Based on the interviews and various discussions, the data security was one of the major issues to meet in designing the ecosystem.

4.3 Platform ecosystem analysis

Two of the industrial partners provided their own ecosystem platforms. The Suunto's Movesense system was based on the smart wrist or chest band type of device for collecting information such as acceleration, gyroscopic and heart rate of the targets' movements. Suunto Oy provided various tools and open APIs for outside developers to build their own solution. Forciot Oy provided smart insoles with standard Bluetooth LE interface that helps the integration to a platform ecosystem. On the top that, it was decided to employ Google's Android phones for data collection and transfer. Android and its development environment with third-party tools form its own ecosystem. Other platforms to be employed were Linux based machines for the data collection and the analysis. The platform ecosystem to be employed for movement or gait analysis was an opensource Python based analysis libraries. The data was collected from the various platform ecosystem, and these platforms were integrated by employing standard REST APIs interfaces in which data was formatted to be compatible with JSON standard (see Figure 1).

The project's platform ecosystem consisted of various other ecosystems as described above. These various ecosystems were integrated together by employing RESTful APIs with sensors' specific mobile micro-services (Ruokolainen et al., 2018). Various business actors that can contribute to the ecosystem platform development can be pointed out: (1) Clinics hospitals and various instates can provide the market desires e.g. what the would like to have, (2) analysis software developer might have their knowledge what can be done and how to meet these desires, (3) devices manufactures can provide new hardware and related ecosystems and (4) these expressed elements can be integrated and maintained by platform ecosystem developers.

Figure 1 describes the architecture of the system with the related actors.

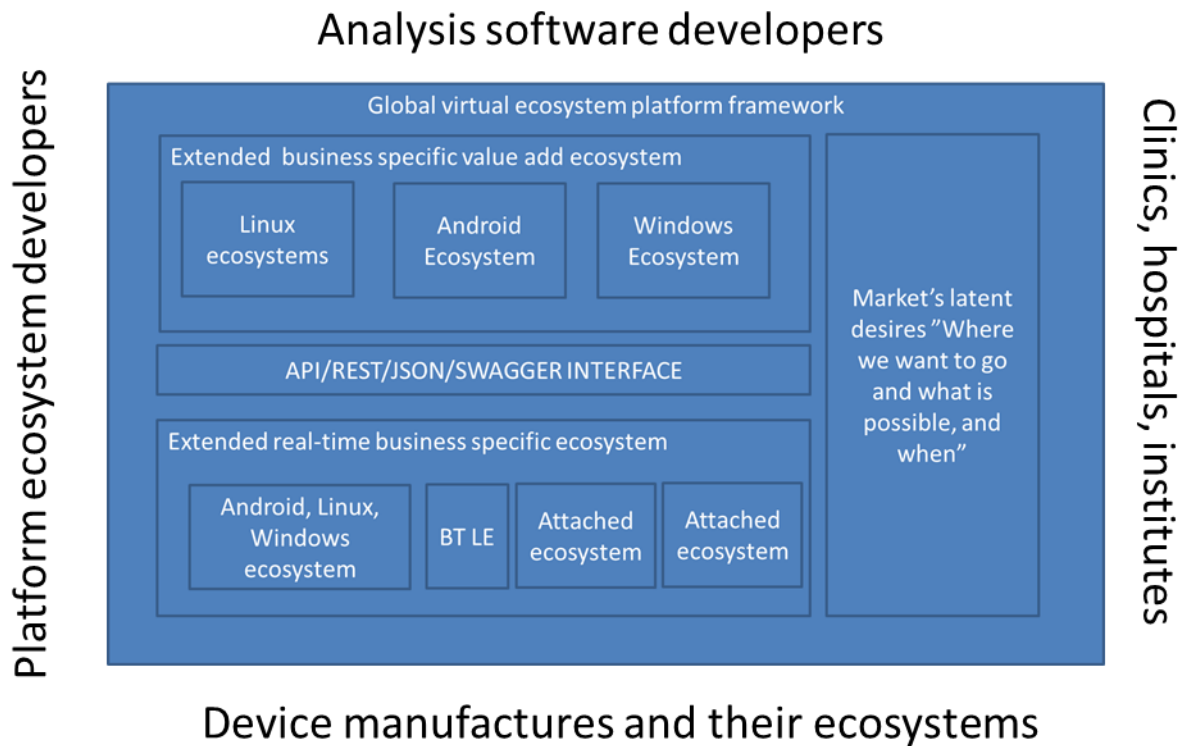


Figure 1: Platform ecosystem’s high-level architecture

5. Conclusion

The gaps mentioned by the literature related to the platform ecosystems are scarce studies of them, and their developments are less understood than the R&Ds’ of the traditional product developments (e.g., Hanh, 2016; Taylor, 2017). This study increased the understanding by demonstrating the development of the system for health care although the still needs further development.

This studies’ health care platform ecosystem was constructed from the complementary assets of the related platform ecosystems and those value-add services produced by the platform ecosystem’s users. This platform ecosystem is not a well-defined set-up but rather lives from ideas and innovations that can be implemented on the top of the other value-add services. In order to be a member of the ecosystem, value-add services and other elements in the ecosystems need to follow the ecosystem rules not to jeopardize other value-add services. The contributors of the ecosystem need to share some common understanding and rules to keep ecosystem up and to run.

The rules for building an ecosystem to meet certain business needs are as follows:

1. The platform ecosystem value-add services meet the specific market desires, e.g., in this study, they are related to Parkinson disease, patients,
2. A platform ecosystem brings together various other platform ecosystems under the common topic as in this case health care, and they provide complementary assets.
3. Platform ecosystems meet development users' desires for constructing value-add solutions.
4. The desires need to be strong enough to create social bond keeping the ecosystem and sub-ecosystem and value-add developers together.

One of the further studies is related that how the global aspects of these platform ecosystems specialization might change society and industries. The socioeconomic impacts of this kind of platform ecosystems have not been discussed in this study thoroughly and, thus, is to be discussed in the coming studies.

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