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Applying Service Design on Free Open Source Software (FOSS)

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Abstract

The emergence of Free Open Source Software provided various new possibilities and chances for the technological sector and offered alternatives to already existing commercial products. Because of the community driven development of this software, that principally gets developed by users for other users, this open movement gained fast popularity and was able to get successfully accepted by the society. Nevertheless, the overall success of such products is still today limited to certain branches and niches. As this thesis shows, Free Open Source Software projects are situated in a complex environment of many different actors and dependencies that shape it. Different jobs that such software needs to get done, various motivations of the contributors and users, as well as a variety of different other aspects are influencing the success and distribution of these free and open services.

Introducing methods and principles out of the field of Service Design allow it to analyze the environment and actors of a specific Free Open Source project in detail. Gaining an inside into the different roles, relationships between them, and their contribution to the value creation process, helps to align the provided offerings with the needs of this environment and its members. Applying several provided tools to do so, on the Austrian Catrobat project will unveil how potential room for improvement and further possibilities for the services can get identified. Especially by creating a common understanding of all the mentioned aspects within the project helps to encounter the challenges that arise from these complex conditions and a process of change that is driven through new innovations and technologies. Considering such software projects out of different perspectives and by different methods is an essential factor to detect the actual jobs, needs and pains that the consumers, but also contributors, are facing and to create solutions that meet them. By doing so it is possible to establish an agile environment of different actors that can drive innovation and ensure success of such projects.

Kurzfassung

Das Aufkommen von Freier Open Source Software eröffnete viele neue Möglichkeiten für den IT Sektor und bietet Alternativen zu anderen bestehenden kommerziellen Produkten. Durch die Entwicklung dieser Software, die grundsätzlich von Anwendern für Anwender erstellt wird, entsprachen diese Produkte bereits früh den Erwartungen ihrer Zielgruppen und konnten rasch an Zuspruch gewinnen. Nichtsdestotrotz konnte der große Durchbruch bis heute noch nicht gelingen und die Verbreitung solcher Software beschränkt sich auf gewisse Branchen und Nischen. Wie diese Arbeit aufzeigt sind solche Software-Projekte in komplexen Umgebungen eingebettet und sind daher dem Einfluss vieler unterschiedlicher Aktoren unterlegen. Verschiedene zu lösende Probleme, Beweggründe für das Mitwirken am Projekt und Abhängigkeiten zu anderen Faktoren führen dazu, dass der Erfolg und die Verbreitung von freier Software von einer dynamischen und vielschichtigen Umgebung abhängen.

Mit Hilfen von Methoden und vor allem Denkweisen des Bereichs des Service Designs kann diese Umgebung detailliert und umfangreich analysiert werden. Einblicke in die verschiedenen mitwirkenden Rollen, Abhängigkeiten zwischen ihnen und eine Betrachtung der eigentlich erstellten Leistungen ermöglichen es ein solches Projekt noch gezielter auf diese Umwelt und die Personen in ihr auszurichten. Wie praktische Beispiele dieser Ansatzweisen am österreichischen Open Source Projekt Catrobat aufzeigen, können bereits einfache Werkzeuge dieser Forschungsrichtung dazu beitragen Verbesserungspotential und mögliche existierende Schwachstellen der Dienste widerzuspiegeln. Insbesondere ein gemeinsames Verständnis aller beteiligten Personen für das Projekt und dessen Umfeld trägt essentiell dazu bei dass die durch Fortschritt und Technik neu entstandenen Anforderungen, die an Software und Dienstleistungen im Allgemeinen gestellt werden, explizit entgegnet werden können. Durch die Betrachtung verschiedener Blickweisen und die Anwendung vielseitiger Analysemethoden ist es somit möglich gezielt auf die Bedürfnisse und Wünsche der Nutzer sowie der Projektmitglieder einzugehen, was in der weiteren Folge Innovation vorantreibt, ein agiles Umfeld schafft und insbesondere eine Grundlage für Erfolg bieten kann.

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1 Introduction

1.1 Motivation

Free Open Source Software (FOSS), as well as Free Software (FS) and Open Source Software (OSS), change the way users and also developers, nowadays have access to programs, tools and frameworks. A variety of software solutions has been implemented under public domain and helped companies and individuals to get powerful and freely available software on a comparable high qualitative level. Projects such as Linux, Wikimedia or GIMP have shown that Open Source can be a successful alternative to proprietary software and can be used within different application areas. For more than already 20 years, voluntary contributors drive these movements and thus foster innovation and furthermore, create new chances for businesses and users. Worldwide, young students as well as senior developers and other people with different backgrounds engage in these communities and contribute for various reasons, what leads to a broad spectrum of different experiences and ideas, that flows into the development of this software and is the basis for the further potential success of these applications.

Although Open Source Software is an important part of our technological world today, there is still the prejudice that this kind of software misses the common needs of users. On the other side the emerging research field of Service Design provides new ways to identify and meet these important user needs and shows ways how to create suitable solutions to precisely meet them. Thus, current research techniques out of this field can help to analyze this prejudice and show ways how users can be involved more intense in the development process of FOSS. In addition to that, toolsets such as Business Models or Value Networks, also provide the possibility to examine an additional different business, or respectively value oriented, view, which is also strongly connected to the user aspects considered by the Service Design principles. Another reason that such tools and methods can create benefits for FOSS projects is, that these projects are often situated in a network of different stakeholders, people and organizations that influence, and that are influenced by, its outcomes. Since most FOSS projects emerge from engineers and developers, who are consequently the main driver of them, these specific views haven't been considered in many projects till now, although different

research and practical examples have already shown how informative and interesting this may be.

To show how such tools can be combined and adopted for the use within Open Source projects, the practical example of the Catrobat Project is perfectly suited. This young, Austrian based non-profit project, follows the vision of providing a free mobile coding tool, suited especially for young beginners and educational purposes. Developed by mainly Computer Science students, it is just successfully starting to create a global user base for its free mobile visual programming language. Embedded in a dynamic and diverse environment, it just sets off to establish an international network of contributors, partners and supporters, who back this non-profit project and provide the future directions for the further development and, respectively, innovation. Hence, taking a closer look on the corresponding user and business related part of this project, also by considering the general structure and characteristics of FOSS projects, can unleash a deep insight into the dependencies and entities, which can be used for further strategic and operative decisions.

Combining these different fields and aspects will hopefully discover interesting relationships and dependencies, that will outline how FOSS is able to capture success and how it already now manages to drive its development and progress through the underlying community, particularly users. Especially this common community character leads to many touchpoints that are of interest out of a Service Design perspective, since usually such projects originated from solving user related issues and needs. Hence, analyzing the benefits, that likely can get gained from the usage of Service Design principles on Free Open Source Software, will show if such projects can even receive further relevance in the future und thus succeed in even more markets.

1.2 Overview

This thesis aims to show how different tools, that are already commonly used in for-profit businesses, can also be positively used for non-profit Open Source projects. Furthermore, the evaluation of how contributors and involved people can easily use these tools will also outline the relevance of these principles for similar situated projects. All in all, it is desired to analyze if there exists a guideline on how existing FOSS projects may profit from the usage of Service Design and how they can gain a new insight into the organization, as well as into the actual users of the provided services and products.

Introduction

Analyzing FOSS projects will also unveil, maybe till now unnoted, characteristics of such projects, that will allow to receive new insights into their occurring value processes. Since the Open Source movements are following their very own, well defined principles, plenty of research has already dealt with the backgrounds of such organizations. Thus, whereas a practical example will demonstrate the application of the different suggested tools, cross-referencing different common literature will allow to connect these outcomes to general FOSS projects and their principles. Although the projects vary by their vision, communities and internal processes, they're all based on several general assumptions that shape the overall movement. Hence concluding from this one practical example could also provide important findings for other projects out of this field.

To do so, Service Design provides a holistic approach that helps to analyze internal as well as external relationships and actors that influence the considered Catrobat Project. Looking on these relations and actors from different views and in different levels of detail, will, dependently on the situation, help to optimize the value creation and capturing process. By taking all of these connected actors into account, it will also get ensured that a certain degree of health within the network will get kept. This health will lead to an overall value, meaning that each actor has a certain net benefit through its participation in the value processes. Thus, the crucial actors within this Value Network will get identified and analyzed separately and in context to each other. This approach will help to generate an overall picture of the project, the services it provides, and the actors who receive and co-create them. Resulting in an interconnected system of different elements that share the common element of value and influence the overall behavior of the regarded processes.

2 Definitions

2.1 Service Design

To stay competitive, Design plays a major role in today's management of businesses. Whereas for a long time the primary focus was on how to design perfect interfaces and forms, principles are now also used to create an immaterial experience that reaches customers through multiple touchpoints in their journey that is provided through a service (Løvlie, Downs, & Reason, 2008, p. 74). Nevertheless, in current literature there are many different definitions, approaches and techniques that all together define this new and rising discipline. Summed up the following two definitions of this term may give an overview about this widespread emerging field:

> *"Service Design is a holistic way for a business to gain a comprehensive, empathic understanding of customer needs"*
>
> *Frontier Service Design, 2010 (Stickdorn & Schneider, 2015, p. 31)*

> *"Service Design is all about making the service you deliver useful, usable, efficient, effective and desirable"*
>
> *UK Design Council, 2010 (Stickdorn & Schneider, 2015, p. 30)*

Simply characterized, Service Design describes methods, strategies and tools to understand customers, to gain new perspectives, and to create services which meet the customers' expectations during their service experience. From an historic point of view markets changed within the last decades and the field of Service Design is a new one which just has its roots the 1990s (Mager, 2008, p. 354). But, it emerged fast in the early 21st century and is currently still gaining importance, especially because of three major trends in today's businesses:

- *Economical: The trend toward value in services*
- *Social: The increase of customer expectations*
- *Technical: The change in services through the growth of digital*

(Reason, Løvlie, & Flue, 2016, p. 2f)

Services may be seen as a series of interactions that is described by different touchpoints between the customer and the service itself (Stickdorn & Schneider, 2015, p. 80). These touchpoints may be created on different channels, either digital or personal, may occur in different orders and an appropriate reaction to them by the service is essential for the satisfaction of the customers' needs. Another challenging trend regarding these aspects is the rising number of mobile devices, which even creates a larger number of touchpoints, so called Micro Moments, which aren't necessarily directly connected to a specific service or brand, but do influence them (Adams, Burkholder, & Hamilton, 2015, p. 4). Hence, Service Design takes place in an environment of steady change, where innovation and technology constantly create new touchpoints and potential channels. Whereas channels on which the touchpoints occur are often still considered separately, a well-designed customer journey allows crossing these different channels and also leads the customers to the most effective channel of the service (Reason, Løvlie, & Flue, 2016, p. 27). The rising number of possible channels, especially through social media networks and web services, makes it important to understand the user and its preferred channels, to be able to provide a guided and smooth customer journey. Furthermore, due to the permanently changing environment, these arising channels need to be constantly evaluated and added to the customer journey of the services. Service Design therefore provides different tools, such as customer journey maps, personas, customer lifecycles or scenarios, which support managers to achieve an user-centered view on a service as a response to these emerging challenges (Reason, Løvlie, & Flue, 2016, p. 161ff) (Stickdorn & Schneider, 2015, p. 148ff). Nevertheless, the approach of how to apply these principles of a user centered service on an organization and which tools to use therefore, may vary by domain, target customers and the surrounding circumstances, which in fact is intended by the dynamic definition of this field. Instead of giving exact instructions on how to design a service, Service Design, and its principles, define a toolset that can guide an organization to identify its customers' needs and create suitable solutions for these unique needs.

2.2 Business Model

Managers and entrepreneurs are nowadays facing a fast changing, dynamic and uncertain economy. To stay competitive businesses and especially established branches must rethink their ways of creating value for their customer, communicate these ways and accordingly adapt their picture of

their customers to it. The major driving force in this context is the extremely increased usage and the arising new possibilities, of ICT and the thereby generated variety of possible business configurations (Osterwalder A. , 2004, p. 11f). Furthermore, today more services than ever before are provided to the customers in different ways. To succeed in comparison to the company's competitors, they need to meet their expectations by creating a unique experience. To describe this creation process, the ongoing change of a business and the adding of value to services, a Business Model provides a framework to communicate this contiguous process. Thus, from a management point of view, a Business Model is a tool to analyze, implement and communicate strategic choices to all people involved (Shafer, Smith, & Linder, 2005, p. 200).

Nevertheless, there are currently many different definitions of what a Business Model exactly is and how it can be characterized. Furthermore, literature refers to many, slightly different, models that shape a Business Model and the logic behind it. One of the currently most known domain experts in the field of Business Modeling is the Swiss business theorist Alexander Osterwalder. He defines a Business Model as following:

> *"A Business Model describes the rationale of how an organization creates, delivers and captures value. "*
>
> *(Osterwalder & Pigneur, 2010, p. 14)*

As an example of how a Business Model can look like, Osterwalder defines four blocks that are present in every business (customer, offer, infrastructure and financial viability), which are split up into nine building blocks that tend to show the logic of a business and the plan of how to create value out of it. The main component of this block model is the Value Proposition (VP), which shall describe how a certain value is created for a specific customer and how to encounter its individual needs. To handle the domain of the customer, Osterwalder differs between varying customer segments (C$), their channels to the business (CH) as well as their relationship to it (CR). From an entrepreneur's viewpoint, Osterwalder furthermore also considers the business' key activities (KA), key resources (KR), and key partners (KP) as essential components of a Business Model. To also include the financial perspectives into this model, his theory completes with the elements of the cost structure (C$) and targeted revenue streams (R$). All together these nine blocks are used to create an easy to use visual canvas, which potentially can reflect any possible Business Model. (Osterwalder & Pigneur, 2010, p. 15ff)

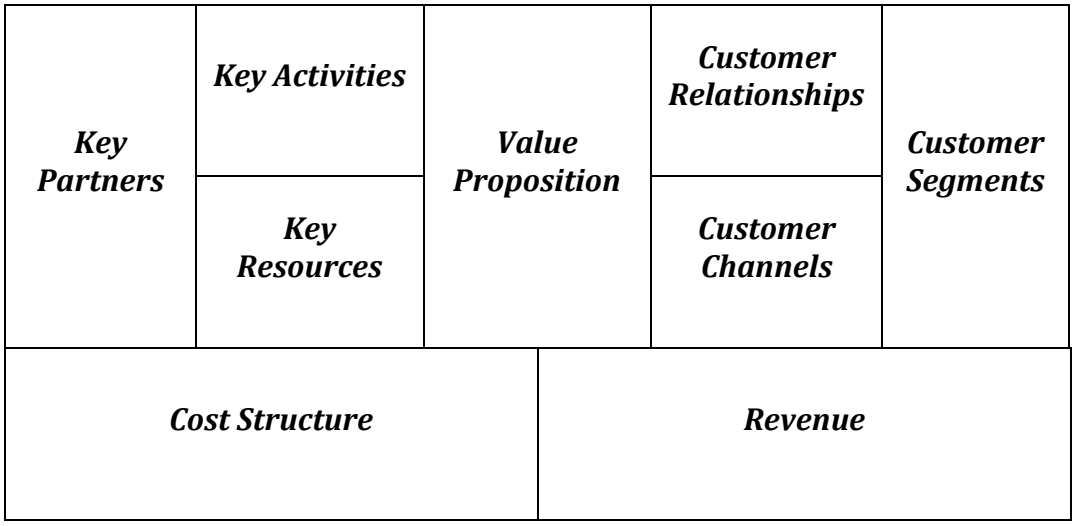


Figure 1 A. Osterwalder's schema of a Business Model and its nine building blocks (Osterwalder & Pigneur, 2010, p. 18f)

Although other experts use similar explanations, they differ in the required root components to describe a Business Model. Whereas Osterwalder describes it as a combination of the mentioned nine building blocks, for instance Johnson et al. minimize it to four core elements. In their point of view, value is taken together, created, and delivered through the four interlocking elements of the Customer Value Proposition (CVP), the profit formula, the key resources and the key processes (Johnson, Christensen, & Kagermann, 2008, p. 60f). Even though similar aspects and dependencies get considered within these blocks, the main structure which is used to represent the model discerns comprehensively, as it can be seen in Figure 1 and Figure 2.

Nevertheless, to understand the relevance of a Business Model, there exist more formal definitions by different business theorists. A very general but coherent definition of a Business Model is provided by KMLab Inc.:

> *"... a Business Model is a description of how your company intends to create value in the marketplace. It includes that unique combination of products, services, image, and distribution that your company carries forward. It also includes the underlying organization of people, and the operational infrastructure that they use to accomplish their work."*
>
> *KMLab Inc., 2002 (Chesbrough & Rosenbloom, 2002, p. 532)*

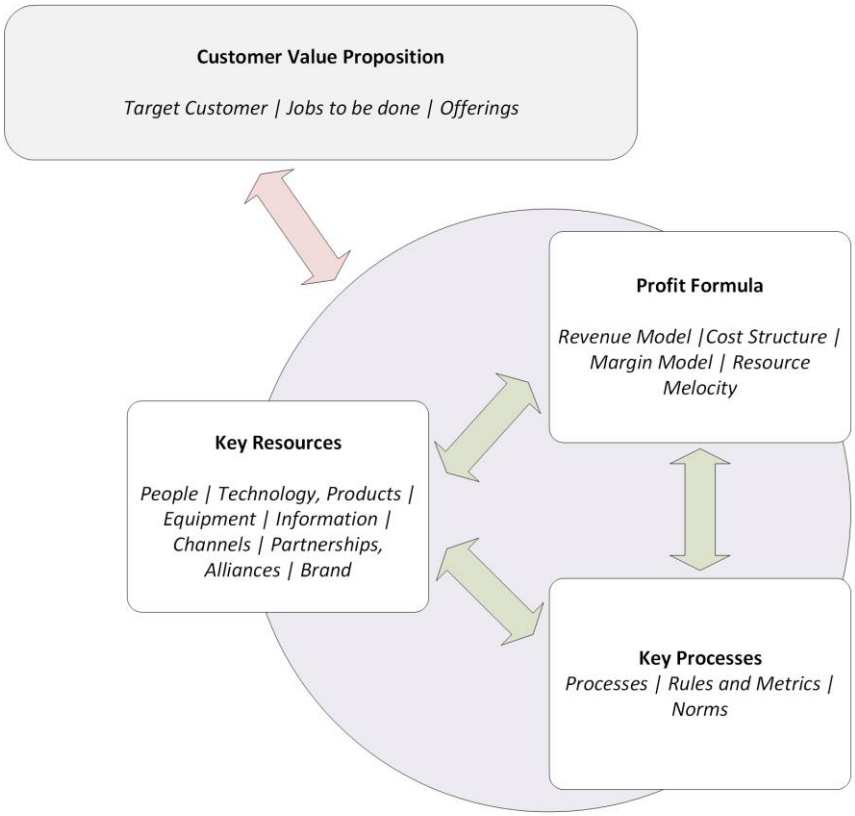


Figure 2 The four elements of a successful Business Model adopted from (Johnson, Christensen, & Kagermann, 2008, p. 62)

Furthermore, Chesbrough and Rosenbloom mention the impact of innovation and new technologies on Business Models in their work in 2002. Business Models can get used as a tool to analyze the impact of technical decisions, such as the integration of external values into a system, as well as of technical potentials, on an economic outcome (Chesbrough, 2006, p. 63). Although Chesbrough and Rosenbloom have already considered the effects of new trends, such as e-commerce, the recent years showed that the digital transformation and new possibilities of connectivity changed existing Business Models and brought up totally new ones. This fast-changing environment made Business Model innovation a core competence when it comes to staying competitive and to find new possibilities to capture revenue (Berman & Bell, 2011, p. 3). Consequently, to keep a certain level of competition, a Business Model is a dynamic structure which has to be adapted as soon as new circumstances, changing markets or emerging technologies arise. Additionally, it can outline new ways to create value and find alternatives to existing, already working solutions.

As the examples have shown, there is no strict definition of the term Business Model. It can be concluded that the main point of a Business Model is to communicate and represent the role of value and the therewith corresponding aspects of value creation, value distribution and offered services. A Business Model is a dynamic structure which represents a current or a to-be stage of a business, and the correlations within it on the way to create value and success by considering the organization's and customers' viewpoint. However, important to note that a Business Model should not be confounded with a (business-) strategy, since a strategy is focusing on a more general perspective of choices, relationships and competition (Chesbrough & Rosenbloom, 2002, p. 535) (Magretta, 2002, p. 6f) (Shafer, Smith, & Linder, 2005, p. 203). All together a Business Model is a tool that shows a certain direction a business is currently moving to or wants to move to, by considering the value creation and distribution process from a business, partner, and value point of view.

2.2.1 Value Proposition

As already mentioned, the Value Proposition is in many theories an essential part of a Business Model. But a Value Proposition, as well as other components of Business Models, cannot act as a Business Model by itself, as it was mistakenly supposed in the past, although it may be used to build up a Business Model on it (Shafer, Smith, & Linder, 2005, p. 205) (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 152f) (Johnson, Christensen, & Kagermann, 2008, p. 61). In simple terms a Value Proposition basically represents the connection between the needs of potential users, or rather buyers, and the value a venture is creating for them by their offerings. It is described as mixture of the provided products, the relationship to the customers and the corporate image of a company, which specifies how an organization differs from its competitors (Kaplan & Norton, 2000, p. 53). From this perspective, the Value Proposition is the center of the Business Model, since it illustrates the core component of a business – how to fulfil the wishes of the customers and how to outperform competitors out of the industry by regarding a product from a new value perspective. Thus, Osterwalder et al. especially focus in their description on the customer, but without any competitive aspects, and describe a Value Proposition as following:

> *"Value Proposition: Describes the benefits customers can expect from your products and services"*
>
> *(Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 6)*

An important point of defining a Value Proposition is to answer the question how to provide which benefit for whom uniquely well (Skok, 2013). This indicates that several perspectives should get considered when it comes to construct a Value Proposition for an organization. An important step to do so is to gain knowledge about the market with its customers, their special needs and wants. On the other hand, these insights have to be opposed with the organizational processes that create value for the customers. One challenging task to realize this is to define a proper framework which communicates this unique Value Proposition in a visual way, to make it clearly understandable for everyone involved in this process.

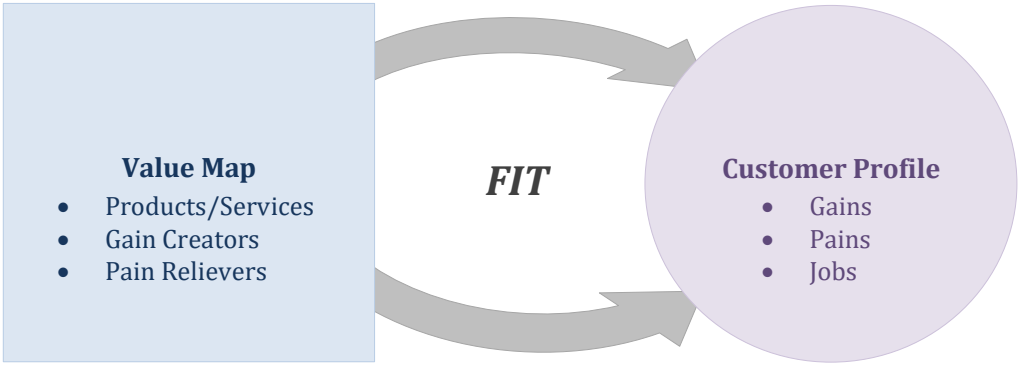


Figure 3 The Value Proposition as fitting between Value Map and Customer Profile adopted from (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 42f)

An applied tool therefore has been designed by Osterwalder et al. as the Value Proposition Canvas in Figure 3. This canvas distinguishes between the customer on the one side and the created value by the organization on the other side, before their fitting is analyzed. Each part of the canvas is created separately to identify the certain specifics of them. This canvas especially tries to classify the individual facets of a target customer (or several target customers) through a Customer Profile by pinpointing the jobs they need to get done, as well as their pains and gains which arise during the execution of these jobs. From a business' oriented view, the canvas further considers the

provided products and services along with the generated pain relievers and gain creators as a so-called Value Map. The Value Proposition then gets analyzed by fitting these two components. (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 8f)

A very similar approach is described by Christensen, Johnson and Kagermann. By their definition, the identification of the Value Proposition is the first, and an indispensable step to create a Business Model. Therefore, precise knowledge about the customer is needed. They define the Value Proposition as the way of creating value that helps customers to get a job done. As it can be seen in Figure 2 these two fundamentals, the target customer and the job to be done, face the provided offerings of the company. Following their theory, a great Customer Value Proposition originates from understanding the customers job, why currently available products, which tend to solve that job, are unsatisfiable and how a better solution for these jobs can be provided. The clue to do that successfully, is to find a target customers' problem which hasn't yet been solved directly by alternatives. (Johnson, Christensen, & Kagermann, 2008, p. 60)

Already years ago, companies realized that they may control value and its connected success by redefining their Value Proposition. As an example, Dell Computer and Home Depot adapted their value definition in the late 20th century, by building the capability to produce individualized and also more products in comparison to their competitors and thus were able to raise the customers' expectations. They became a leader in the market through focusing on delivering customer value in line with either operational excellence, customer intimacy or product leadership (Treacy & Wiersema, 1993, p. 84). As these examples show a proper and user centered definition of value, and the customers that are targeted, may be the key to success. A Value Proposition acts as powerful tool to track current unsolved or just poorly solved jobs of the customers and, if used correctly, is offering appropriate solutions for them.

2.2.2 Value Networks

A Value Network is an important factor in innovation, which defines the context in which a business is identifying and correspondingly responding to customers' needs as well as performing the procuration of inputs and analyzing possible competitors (Christensen & Rosenbloom, 1995, p. 234). Thus, the environment, in which a business is placed, can be described as network of different actors involved, which are connected by certain relations and are characterized through specific transfer processes. A brief definition of this principle is provided by Biem and Caswell:

> *"Value Network as a model of inter-organizational exchanges is an attempt to address the increasing intricateness of inter-firm relationships, pushed by a more and more connected economy."*
>
> *(Biem & Caswell, 2008, p. 1)*

By considering this described approach, Value Network analysis enables businesses to identify and adapt the conversion of values, either tangible or intangible ones, into other forms of value within the network, to create a greater overall value for the business itself (Allee, 2008, p. 5). Therefore, different roles, or respectively entities, need to be considered within this network, to highlight the different value transfers they are involved in. Hence, the actual value delivered to the customer, by a certain product or innovation, is influenced by different actors within the Value Network, as Chesbrough points out:

> *"The Value Network created around a given business shapes the role that suppliers, customers, and third parties play in influencing the value captured from the commercialization of an innovation."*
>
> *(Chesbrough, 2006, p. 68) (Chesbrough & Rosenbloom, 2002, p. 534)*

This kind of value modeling reflects a structure of value creation, recognition and capturing, which targets on delivering a common Value Proposition to a specified customer or market (Biem & Caswell, 2008, p. 3). Combing all these aspects together in a Value Network provides a brief overview of the involved entities and the occurring exchanges of which each provides value for at least one entity within this network. The representation as network also gives the possibility to use network related algorithms and analysis methods to gain a

deeper understanding of them, which is also supported by the visual representation of such a network. By regarding these specific aspects and methods, Value Network analysis creates a benefit for a business by providing a visual approach to illustrate the complex value processes and dependencies that lead to a clear and common understanding of an organization and its relationships.

2.2.3 Free Open Source Software (FOSS)

The term "Free Open Source Software" combines several different principles and theories and has been shaped by various movements in the past. To define it a brief history about the communities behind it is necessary, since it has its origins in the two different principles of "Free Software" and "Open Source Software". One of the key persons of the Free Software (FS) community is Richard M. Stallman, who clearly describes his philosophy in the Book "Free Software, Free Society". Stallman defines FS by having four essential freedoms:

The freedom of..

- .. running a program for any purpose
- .. studying how a program works and changing it to personal wishes
- .. redistributing copies
- .. distributing modified versions to others

(Stallman M. R., 2010, p. 3):

By this definition, software is only considered as Free Software, if developers and users have all of these four freedoms and furthermore do not need to pay or ask for any permission to get them(Stallman M. R., 2010, p. 3). This manifest guarantees that not only the source code is published, it also guarantees that everything can be done with the available code. Free software can be compared to the freedom of speech and not, as often misunderstood, to a free product, since it is not tended to be zero price, it is tended to provide freedoms in the sense of the French word liberité (Stallman R. , 2009, p. 32) (Weber, 2004, p. 47f). Thus, Free Software may not be mixed up with the principle of Freeware, which explicitly focuses on the gratis distribution of a software product, but does not consider the other principles of freedom. Today the Free

Software Foundation (FSF) provides a couple of different licenses following these principles and furthermore it is the primary driver of this movement.

On the other hand, in the late 1990s the Open Source Software (OSS) movements emerged from similar principles as the described FS ones. One of reason for this division can be seen in the mentioned confusing interpretation of the word “free”, that early followers of the FS movement found confusing and frightening for large companies (Fink, 2003, p. 36). Furthermore, the Open Source community sees mainly benefits in the engagement of developers and users within a community as valuable way for businesses, not primarily the character of freedom. In the viewpoint of the Free Software movement, Stallman claims that the fundamental differences between the Open Source community and the Free Software movement are, that Open Source acts as a development methodology, whereas FS is a social movement, since OSS focuses on that open source code character, not on the aspects of freedom (Stallman R. , 2009, p. 31f). However, the Open Source Initiative published 10 criteria of open source which are comparable to the ones of the Free Software Foundation (Open Source Initiative, 2007). Nevertheless, formally these are nowadays two different movements, providing different philosophies and principles, although they’re similar in many aspects. This can also be proofed by Stallman's perception of describing nearly all Open Source Software as Free Software (Stallman R. , 2009, p. 31).

To avoid the controversy of the terms Free Software and Open Source Software, many, especially research projects, use nowadays the term Free Open Source Software (FOSS), also known as Free/Libre Open Source Software (FLOSS) to outline the character of freedom and openness, which combines both movements and is also widely accepted by these two communities. Today there exist thousands of projects and organizations that create software which can be characterized as FOSS. Many examples have shown that such community-driven development of free software may be successful and can compete to traditional commercial products. This successful user based innovation can be achieved if there are users with sufficient incentive to innovate, users which share their idea for innovation and if this idea can compete with commercial products (von Hippel, 2001, p. 84). Thus, when it comes to create a sustainable, competitive and qualitative product, a FOSS project needs to be successfully driven by its users and community behind it. Hence in this thesis the term “Open Source” will get used without considering the issues of this OSS and FS controversy and can be seen in this described F(L)OSS context.

Beside this ideological definition of Open Source, it can also be described as a development methodology that differs from traditional known processes (Fink, 2003, p. 52f). In the late 1990s Raymond already analyzed Linux and popclient (later known as Fetchmail), which inspired his theory of the cathedral and the bazaar. He describes common traditional software methodologies of developing software in small teams and a well-defined domain, as Cathedral, whereas the new Open Source methodology of Linux may be seen as a bazaar of different approaches that is driven by various aspects and people, that in the end lead together to success (Raymond, 1999, p. 24). During this decade, Open Source managed to become a new phenomenon in different fields, based on collaboration and a high quality of code (Weber, 2004, p. 94). This phenomenon even succeeds till today, as it can be reasoned from the statistics on Sourceforge[1], an open source community resource that supports developers with tools and furthermore provides an exchange platform for Open Source projects and contributors from all over the world. This online community lists more than 430.000 projects and hosts over 3.7 million registered users, hence it can be reasoned that the total numbers of Open Source projects, and also contributors, are even higher, since not all are part of this online community (Slashdot Media, 2016). However, due to the complexity of the community and issues in the measurement of this dynamic movement it is simply not possible to claim an exact number of contributors (Weber, 2004, p. 65).

Nonetheless, this Open Source methodology has been further characterized by different researchers over the last years, mostly influenced by Raymond's early insights. What almost all Open Source projects have in common is their starting point in a personal itch of an individual, who starts to work on solving this problem, which indeed attracts other individuals having the same or a similar interest in finding a solution for that issue (Raymond, 1999, p. 25) (Weber, 2004, p. 74). At this point it is important to outline the associated, simply called, laziness of Open Source initiators, who rather want to improve an existing solution than reinventing the wheel, since, out of the nature of Open Source, there is a high chance that someone else already had a similar problem and provided a solution, which may be adapted to solve the new problem, as it happened as an example with the original Linux operating system through different derivatives (Raymond, 1999, p. 25f) (Weber, 2004, p. 75f). Nevertheless, the most important part of Open Source projects is the involvement of and relation to the contributors and respectively the user-community. Hence respect and reputation between contributors may be seen as essential part of the community and constructive criticism as well as praise

[1] http://sourceforge.net

will lead to high quality code produced, thus contributors are a valuable resource for the project if they're treaded well (Raymond, 1999, p. 31f) (Fink, 2003, p. 55). Also a core element of an Open Source project is the large number of contributors and users, what results in fast feedback and a high number of different approaches to use the software, that introduce a broad testing framework that identifies bugs in a short time and with a high accuracy (Raymond, 1999, p. 29f) (Weber, 2004, p. 77f). Hence, very short release circles and even releasing early stages of the software take advantage of this large number of contributors and users, and thus create a benefit for the project, since although the software may be instable, there is a constant visible improvement in which the community is directly involved in (Raymond, 1999, p. 28f) (Fink, 2003, p. 56) (Weber, 2004, p. 80f). This strategy also enables a high degree of parallelization, since many releases and rapid bug reports occur, but the chances of duplications are still comparatively low and furthermore, especially in a debugging context, there is only a very little loss of effectiveness due to duplication, but a great benefit through various potential solutions (Raymond, 1999, p. 30) (Weber, 2004, p. 76f). In addition to that, this active contribution and software usage of different people drives the innovation within the project, since seen from an innovative aspect the community component, in terms of contributing ideas, is of highest importance for the further development of the software (Raymond, 1999, p. 32f) (von Hippel, 2001, p. 82ff). Thus, it can be summarized that Open Source, its development, and the innovation that it drives, is based on several principles that all rely on the community and their active contribution to the project.

3 The non-profit "Catrobat" Project

The practical focus of this thesis is based on the non-profit Catrobat Project, a relatively young and innovative Free Open Source Software project with a university background, that provides development tools for teenagers and educational purposes. Although this project doesn't represent the exact same structure and background as other, more famous, FOSS projects, as it will get discussed later, the main idea of an open approach of software development by contributors is also of highest interest for Catrobat. Since every FOSS project tries to meet a certain higher-level need, each project takes place in a different environment, but will face similar issues due to its concepts and used methods. Hence, Catrobat is a perfectly suited example of a FOSS project that has a clear need that it tries to solve as vision, and furthermore it has an accordingly well-definable environment it takes place in and can get analyzed.

3.1 General Introduction to the Project

Founded in spring 2010 at Graz University of Technology, the Catrobat Project, formerly known as Catroid Project, has set its goals to make programming available on smartphones and furthermore to make the underlying complex development process as simple as possible. The non-profit project follows the principles of Free Open Source Software, as described before, and has already attracted moreover 500 contributors and partners from several countries around the world (International Catrobat Association, 2016). Catrobat provides a visual programming language, as well as a set of various connected creativity tools, with a strong focus on teenagers and educational usage. For this reason, all apps and services are provided for free and without any advertisements or purchase possibilities in it, to totally align with the legal and individual needs of this specific target group. The app "Pocket Code"[2] implements this mentioned visual programming language and makes it currently available for Android users, although versions for iOS and an online HTML5 version are under development. The development of this brick-style programming framework was originally inspired by Scratch[3], a similar visual online programming framework by the MIT Media Lab. In contrast to Scratch, Catrobat concentrates on the creation of a framework for smartphones, where no PC or additional device is necessary (Slany, 2012) (Slany, 2014).

[2] http://catrob.at/pc
[3] https://scratch.mit.edu/

Furthermore, the app "Pocket Paint"[4] provides additional graphical tools that users may use within Pocket Code and has also been downloaded several thousand times during the last past years. The visual interface provided by the apps for these functionalities can be seen in Figure 4.

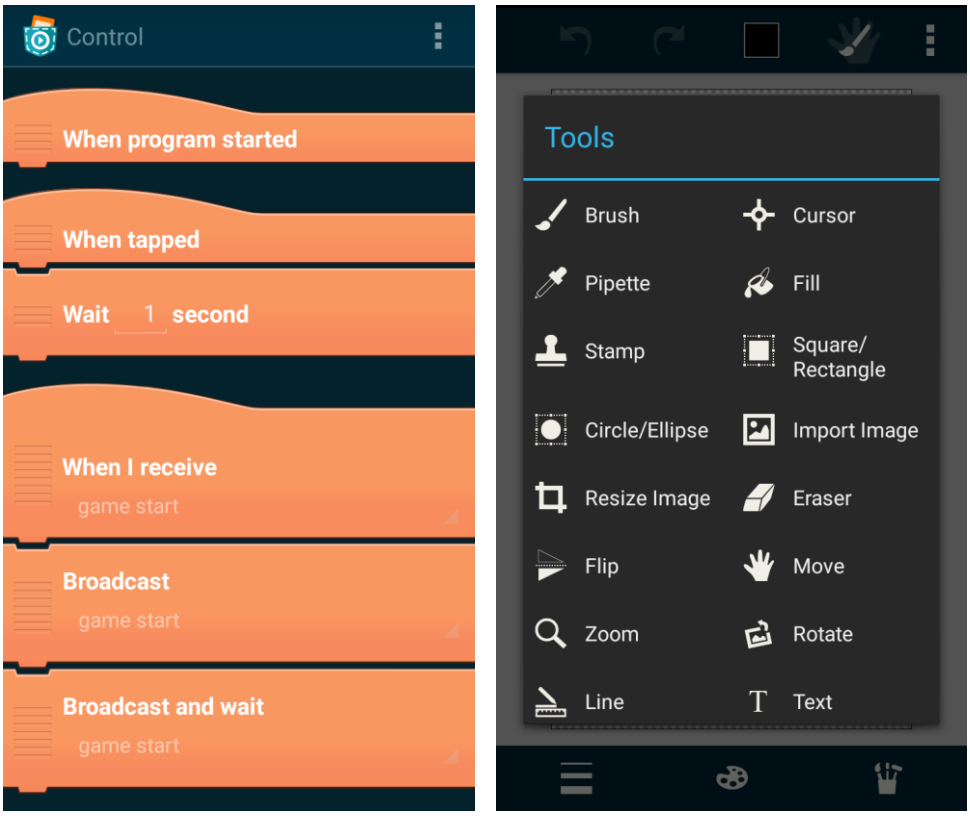


Figure 4 Screenshots of the visual brick interface of Pocket Code (left) and the "Tools" view within Pocket Paint (right)

Due to this mentioned target group of mainly kids and educational institutions, the contributors, mostly students, are not the primary users of the services, which indeed contrasts with most other FOSS projects (Fellhofer, Harzl, & Slany, 2015, p. 14). However, the users indirectly contribute to the project by providing and sharing content, especially programs or games, for other users. This can be done by a provided online platform[5], on which users may publish their created projects under an Open Source and Creative Commons (CC)

[4] http://catrob.at/PPoGP
[5] http://pocketcode.org

license, which fosters the understanding of Free Software, Open Source development, as well as the importance of open communities and data. Nonetheless, since these are two different aspects which must be dealt with, the development within Catrobat has a strong focus on usability and the users' needs behind it. Thus, to involve the actual users into the development process, the project benefits from partnerships with schools worldwide, which compensates the missing direct connection between developers and the target group. Today Catrobat provides a variety of services that either serve the pleasure of the users or help to close the gap to the users. Table 1 gives an overview on these services and how they're classified internally. Nevertheless, this alignment of usability and especially the agile development methods, used by the developers, still raise certain challenges, since there are strong dependencies between these two domains that need to be considered (Krnjic & Slany, 2013, p. 4). In addition to that, there is a complex organizational environment the project is situated in, which will be considered later.

Apps	***Web services***	***Websites***	***Channels***
 • Pocket Code • Pocket Paint	• Sharing Platform • APK Generator • Scratch Converter • HTML5 Player	• Project Website • Education Website • Developer Website	• E-Mail • Mailing Lists • Videos • Social Media • IRC[6]

Table 1 Services provided by Catrobat

Besides the mentioned educational and user driven aspects, the project follows also a strong consideration of technological and scientific views, especially due to its roots as a university project. Till now there have already been several papers and theses about this unique project, its development and also organizational aspects. This technical point of view is also strengthened by the FOSS character of the project, where individuals from all over the world have already contributed whether code or services, such as support, teaching or translation, to the project. Important to mention at this point is the usage of

[6] IRC (Internet Relay Chat), a text based chat system on the internet

common development methods, such as agile development methods, extreme programming or Test-Driven development (TDD), throughout the project, which highlights the importance of communication and a scaling infrastructure (Fellhofer, Harzl, & Slany, 2015, p. 14f). Because of being a university based project the biggest part of contributors has its origins at the Graz University of Technology. Hence many students just contribute for a limited amount of time, mostly several semesters, and thus there is constant change within the team of developers. Additionally, external partners and initiatives, such as No1LeftBehind (NOLB)[7], an EU funded project that tackles challenges in education by using game development, or the Google Summer of Code[8], a program that supports FOSS projects by sponsoring students to contribute, are considered within the development, since their influence and impact on the project are multifaceted. These different aspects are recapping the different characteristics of this unique project, that shapes its organization and followed vision.

3.2 Motivation behind the Project

As outlined before, the initial motivation behind the project, when it was founded in 2010, was to enable young smartphone users to understand their devices, the logic behind the modern technologies they use in their everyday life and to allow them to realize their own ideas of apps without any previous knowledge. The practical work of Catrobat has shown that most children already have an own, or at least access to a smartphone, but, instead of using it in a creative and meaningful way, they keep themselves busy with simple apps and games. Hence, Catrobat wants to motivate these young users to make the step from being a consumer to becoming a developer, to gain knowledge in various fields that will help them in their future career and life. Conceptual thinking, logical understanding and gaining creativity get fostered by using Pocket Code, a similar approach that is also followed by the Scratch project now successfully for several years. Since the dependency on software is growing within our society and a shortage of developers is recorded, offering programming for children allows to encounter the involving problem of a low understanding of software and limited skills in rational thinking (Slany, 2012, S. 265). As Mitch Resnick, the Founder of Scratch, describes, not everyone has to become a professional programmer, but the currently emerging generation, that in fact is build up on creative minds and systematic thinkers, needs new

[7] http://no1leftbehind.eu/
[8] http://summerofcode.withgoogle.com/

and innovative tools to express their ideas and minds (Resnick, et al., 2009). Whereas there are many overlaps in the vision of these two projects, in contrast to Scratch, Catrobat offers a mobile framework, without the need of a traditional PC, to do so. Considering that, Pocket Code exploited from the still ongoing growth of smartphone usage worldwide, as illustrated in Figure 5.

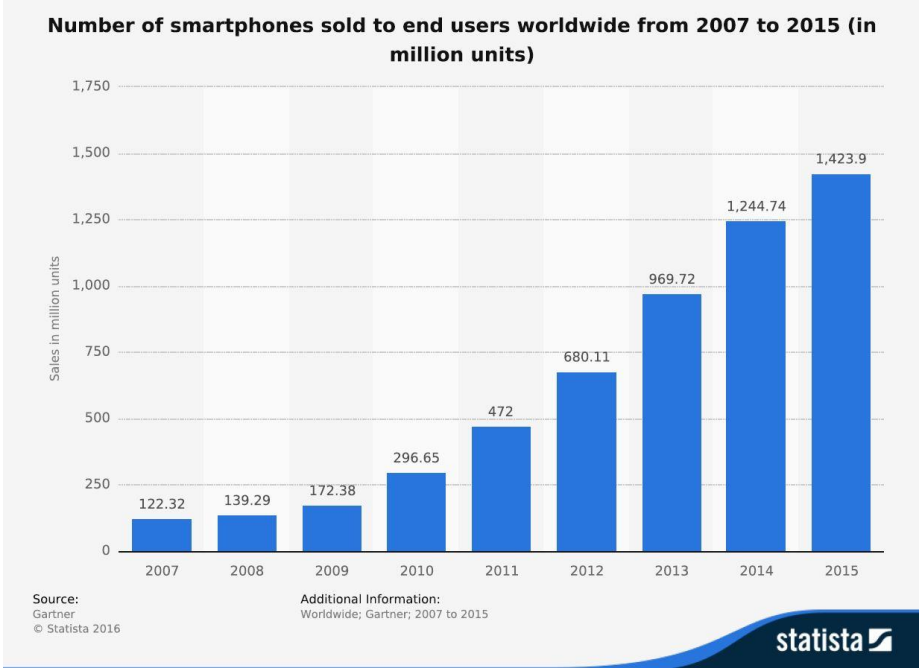


Figure 5 Worldwide growth of smartphone sales to end users (Statista, Gartner, 2016)

As the number of smartphone users is growing, it can also be concluded that soon most kids worldwide, even at a young age, will have their own smartphone (Slany, 2014, p. 1). This new availability of mobile devices also enables these young users to take advantage of upcoming new technologies, and the chances they provide, to which they otherwise wouldn't have access to. Catrobat provides several features and services that will help teenagers and coding beginners to actively participate in this digital environment. Focusing on smartphone users has several benefits that, beside the growing number of users, led to the creation of this mobile device based coding framework. One of the considerations for the development of Pocket Code, made by Slany and his team, was the fact of falling device prices and a broader availability of smartphones, even within development countries. As the cooperation of different institutions with Catrobat has shown, especially in Asia smartphones

offer new opportunities in regions where computers are still not widely available. Particularly at schools worldwide the need of low cost devices became a driving factor for choosing tablets and smartphones, instead of traditional computers, at schools. Furthermore, an interdisciplinary approach by adding ICT in different courses is getting higher importance in many schools, resulting in the usage of digital devices also in other classes than Computer Science. Thus, the usage of Pocket Code in classes such as math, physics or language courses, has shown that apps can enrich traditional teaching methods and can create an additional value for the pupils in class.

Although the educational character of Catrobat gained importance within the last years, the focus of the project is still on reaching teenagers and enabling them to become a creator instead of being a consumer. As Resnick et al. already mentioned, digital natives are comfortable with common technologies such as texting, playing games or web-browsing, however, the so-called fluency of new technologies also includes the creation of games, animations or simulations (Resnick, et al., 2009). To close this gap, Catrobat tries to reach its target group through different channel, events with partners, such as the #GalaxyGameJam in 2016[9], and through a strong consideration of usability aspects and respectively the users' needs. However, although these channels and other actions are currently present, the coordination and connection of these is just going to be set-up. Especially since for contributors and people involved within the project, other domain-specific channels, such as IRC or Jira, are also carried by the project, there are two different levels of communication that can be recognized (Fellhofer, Harzl, & Slany, 2015, p. 16ff). On the one side the project interacts with internal people, having a deep knowledge about the project, on the other side it must communicate its services by reaching out to its users, who just have little knowledge about the domain and the project's goals.

Another factor pushing the project is the university character that enables students to get involved in Catrobat during courses for their studies. Various institutes of different universities have already supported this unique project. But, the majority of contributors is committing as part of their bachelor's or master's thesis as well as through different exercise lectures offered by the Institute of Software Technology at Graz University of Technology. Hence students can contribute as part of their studies and gain additional practical knowledge or reputation through their individual work on the provided services. In contrast to this, external contributors, often teachers or students from abroad, mostly follow personal reasons, such as benefits for their classes or a personal interest in the field. Thus, the motivation of the contributors

[9] http://galaxygamejam.com

varies by their background and personal characteristics, since they're trying to achieve their own, individual goals.

As already mentioned, external partners can also be seen as motivators for the project, since they are pushing the project's goals. With the NOLB project and Google for Education[10] Catrobat is supported within its educational scope and can effectively reach teachers and educational institutions. Additional event driven partnerships, as an example with Google, Samsung Austria or regional organizations, help to reach a wider audience and hence to get in touch with the described target group. Beside these service oriented partnerships, Catrobat also cooperates with production and development companies that take use of Pocket Code. As an example, the project provides software for the Indian based company Robotix Learning Solutions Pvt. LTD[11], that funded a new educational robot, the so called "Phiro", through a successful Kickstarter campaign. All together Catrobat is situated within a fast growing network of supporters and beneficiaries of its apps and services, that backs the defined goals and helps to define them.

3.3 Organization of the Project

Catrobat is build up on an as flat as possible organizational structure. Thus, there exists steady communication between the contributors and, furthermore, there are no hierarchical boundaries that may lead to barriers of innovation. As already mentioned, the project offers different services and apps, thus it is split up into several teams that are assigned to these areas, as shown in Figure 6. Important to note is that these teams are under an ongoing change. Since new technologies arise and some subprojects are running out at a certain time, each year new teams appear or finished ones are removed from the organizational structure. Typically, each team is led by one coordinator and consists of a couple of members and senior members with advanced experience. Although the coordinators and senior members are contributing over a long term, in general more than a year, the challenging part is the high rotation of short term members that aren't working constantly and contribute from all over the world (Krnjic & Slany, 2013, p. 4). This structure, as well as the methods used for development and management, make especially the documentation and communication to crucial parts of the project (Fellhofer,

[10] https://www.google.com/edu/
[11] http://www.robotixedu.com

Harzl, & Slany, 2015, p. 21). The team collaboration software "Confluence"[12] and the issue ticketing application "Jira"[13] are used as a cross-team communication platform that supports this organizational structure, and also allows scalability on an international level, since contributors from all over the world are currently involved in the project. Whereas students from TU Graz and local contributors are active part of such a team, international contributors mostly work individually on specified tickets, without an explicit belonging to a certain team. Thus, especially for those contributors the communication channels of the project are of importance for their contribution.

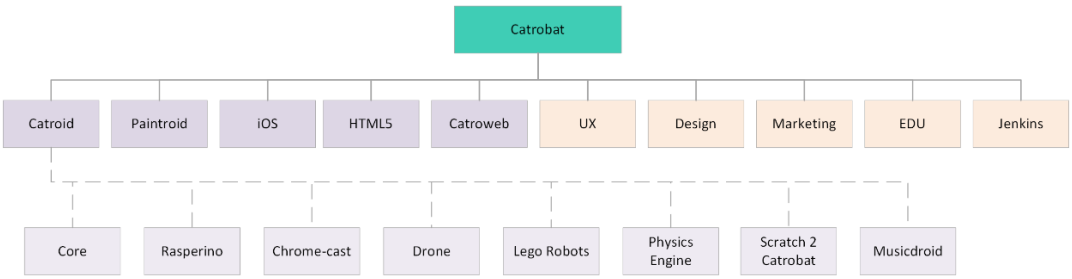


Figure 6 Organigram of Catrobat based on the internal structure of 2017

To encounter the problems of cross-team communication and enable an open culture of information, there are regular meetings of coordinators and inter-team meetings that lead to a fluent flow of information. Furthermore, IRC (Internet Relay Chat) channels and blogging functionalities on Confluence serve as a source of project-related information. Nonetheless, some of these channels and announcements are restricted to a certain target group, since especially TU Graz related content for local contributors, as well as further personal information about the contributors is not of public interest.

As mentioned before the target group of the services provided by Catrobat are mainly teenagers and educational institutions. However, the majority of Catrobat contributors are either university students with technical background or other software developers interested in the project. Although there are a few other contributors that come from the fields of design, education or management, the people involved in the project are not the main users of its services. This is in total contrast to many other Open Source

[12] http://confluence.catrob.at
[13] http://jira.catrob.at

projects, in which the contributors have a certain real benefit of, or interest in using the software (Raymond, 1999, p. 30). The fact that developers are working on a project that targets a different target group than themselves, could lead to a missing understanding of the actual user needs. Developers tend to focus on technical aspects, such as construction processes, the included features or the measured performance, but this often leads to that they design software that suites for other developers, not the requirements and ease-of-use of the actual user groups (Cooper, 2004, p. 14ff). To encounter this specific issue Catrobat introduced special teams, such as UX, Outreach and Education, that evaluate the users of the services and are in touch with them to receive their personal feedback. This direct contact to the users also fosters Raymonds principle of treating the users as co-developers, since their feedback and reports also help to identify needs, problems and bugs (Raymond, 1999, p. 27). Nevertheless, this makes it necessary to run different channels that enable the communication with the users and also to receive their feedback for the development process.

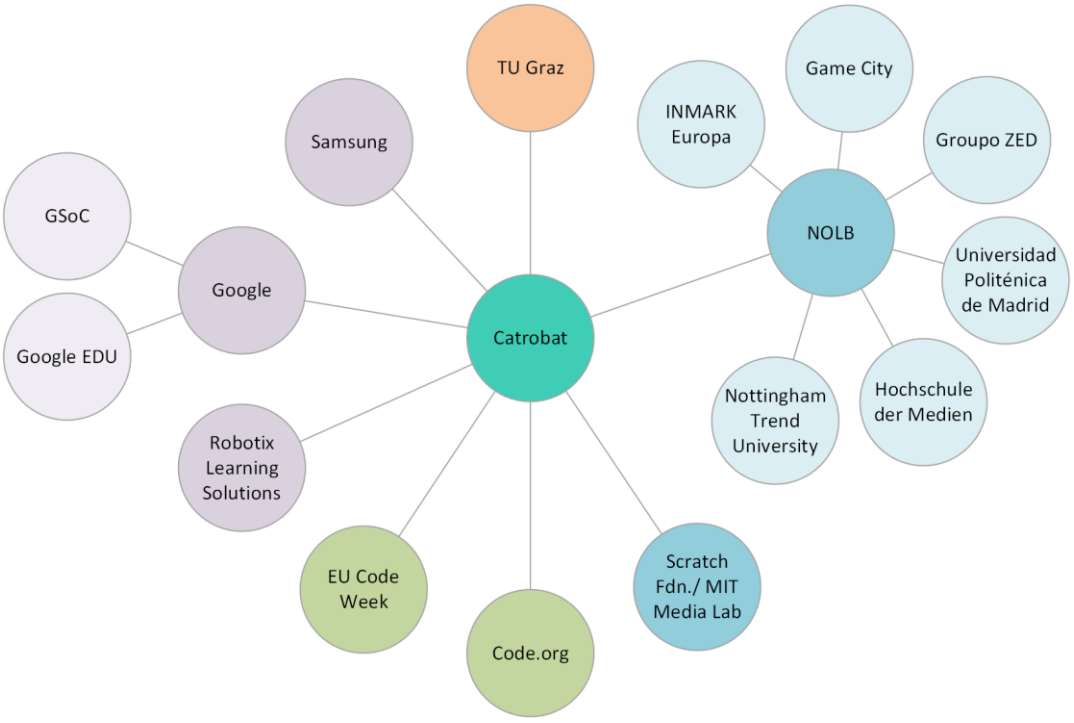


Figure 7 External Stakeholders of Catrobat in 2017

In addition to the contributors, there is a number of partners, or respectively stakeholders, involved in the project. As visualized in Figure 7 there are some external parties that have an active and important role within the project. Although the actual number of stakeholders is higher, at this stage some of them can be disregarded through their minimal or just temporary influence on the project. Beside these partners there also exists an advisory board consisting of different people out of the industry, education or other institutions. This board currently just has limited influence on the project, however, in the future it is planned that knowledge and suggestions of these experts is considered in the project's strategy. At the current state of Catrobat the following entities can be identified as strategic partners, who need to be considered by the project:

- **Graz University of Technology** – As University based project, Catrobat gets supported and a legal infrastructure by the TU Graz. Especially from a research point of view it enables scientific work, as well as access to resources and a wide educational network.
- **No One Left Behind** – This EU funded initiative was launched by different partners, amongst others the TU Graz with Catrobat, to forward the education-based creation of mobile games. Hence, there is a strong exchange of services between these parties to reach this goal together with Pocket Code. Although this specific initiative will phase out in summer 2017, similar corporations are supposable within the next years.
- **Scratch** – Since the project is inspired by Scratch and there are similar target groups, there have been several collaborations between them and Catrobat, such as working together at online game jams or the exchange of experiences on certain fields of development.
- **Code.org** – Beside a yearly coding event, the Hour of Code, this US-based initiative also intensively promotes the teaching and learning of coding. Beyond others, it also provides online tutorials about and references to Pocket Code.
- **EU Code Week** – This European coding initiative organizes a yearly coding event, through which Pocket Code benefits through the usage at different events.

- **Robotix Learning Solutions** – Funded by a Kickstarter campaign, Robotix LS produces an educational robot, which can be programmed with Pocket Code. To do so the company backs the project and fosters the creation of special bricks for their “Phiro” robot.
- **Google** - Google backs the project through different initiatives, such as the Google Summer of Code program or Google for Education. Different monetary funding, such as the Computer Science for High school (CS4HS) funding, has been provided to boost the development of Catrobat and its services.
- **Samsung** – The Austrian company office uses Pocket Code for local initiatives to teach children and teenagers coding. Thus, the app gets promoted at different events and furthermore the creation of relevant tutorials and materials gets funded.

As shown, the project has a complex structure of internal contributors as well as external stakeholders and users. Different services and channels are provided to fulfill their unique needs to interact with the project, as well as to capture their value through their contribution for the project. Furthermore, manifold relationships and dependencies occur through this organization, that on the one hand lead to interesting and seminal possibilities, but on the other hand are also challenging when it comes to provide services successfully through evaluating and considering their needs and wants.

4 Applying common Service Design tools in a FOSS context

This chapter will focus on the application of common Service Design methods and tools on FOSS projects, such as Catrobat. To do so, different aspects will get taken into consideration by zooming in from a very general view on the project to a very specific view on the customers, contributors and partners. This zooming perspective and its benefits will get summed up in the last section.

By the given definition of Service Design, there is a strong focus on the user and of understanding its needs and behavior. Although these definitions of Service Design are rather new and refer to research from the last years, the Open Source movement has already taken them into account by very similar approaches in the 1990s. As an example, Raymond claimed in his thesis "The Cathedral and the Bazaar" that software must follow the users' ideas, respectively needs, instead of considering own ideas, since this user related impact is the key to success (Raymond, 1999, p. 32). Looking onto this fact unveils that the users are a driving force of innovation in Open Source projects and that they are an active part of the service itself. Urban and von Hippel already claimed in the "Lead User" methodology that users can provide more information to services than only their unfilled needs, furthermore they can contribute insights about possible solutions to meet these needs (Urban & von Hippel, 1988, p. 569).

In addition to that, Open Source projects can be characterized as value driven and open, since a community of different entities are connected by a shared goal of creating a common product (Weber, 2004, p. 257ff). By summing up these facts, it can be concluded that it is important for every FOSS project to understand its user, as well as contributors, and what impact they have on, and what benefit they create for, the project. However, since the service itself is created and driven by users, it is important that Service Design in a FOSS context tries to align all these existing actors and relations on the common project's overall goals. To identify these relations, as well as the impact of the mentioned actors that are connected to the project, Value Networks provide a useful tool to represent all involved parties and analyze their relations through which value is created and shared.

From a more general perspective, Service Design as a discipline is user centered and thus it is important to understand the customers beyond its statistical description and empirical analysis of its needs. Consequently,

certain further tools can be used to understand the users' experiences and emotions (Stickdorn & Schneider, 2015, p. 36f). When it comes to Open Source projects, user communities may not just be seen as consumers of the service, in a certain way they are also fulfilling their needs by actively being part of the development of the services and benefiting from the contribution of others (von Hippel, 2001, p. 82). As already mentioned many of these principles have already been considered by the nature of Open Source, but, new tools provide advanced possibilities to analyze and successfully plan such a project by taking a closer look on these needs and the value they are contributing.

4.1 Using Value Networks for FOSS Projects

Service Design is holistic and hence a wider context in which the service process takes place needs to be considered (Stickdorn & Schneider, 2015, p. 44f). The involvement of stakeholders can be defined as crucial part of the value creation process, since there is a certain number of essential external dependencies and transfers within the value provision process. Service Design makes it necessary to consider these external customers and stakeholders within the organization, to achieve that all systems, processes and procedures lead to an intense customer understanding, a high motivation within the organization, and an increased market agility (Reason, Løvlie, & Flue, 2016, p. 6). The Value Network defines these necessary internal and external roles of contributors, customers and stakeholders that are part of the value related processes of an organization (Chesbrough, 2006, p. 68). Since the user is part of these processes, Value Networks can also help to gain further information about them, which indeed can highly support the following use of Service Design methods. Furthermore, Value Networks have the potential to outline new ways of value creation and the participation of new actors, which also makes them important for the early phases of the introduction of Service Design principles in an organization (Stickdorn & Schneider, 2015, p. 137ff). As Vorraber already outlines, especially Information Service Systems, like FOSS projects, can get analyzed systematically by using Value Networks as starting point (Vorraber, 2012, p. 71ff). Hence, the Value Network can act as starting point for identifying the core elements, respectively actors, that create value in and for an organization, and thus shapes the design of a service.

4.1.1 Possibilities to display Value Networks

Since, due to a more connected and global environment, the relationships in economy are increasing in complexity, a dynamic approach is necessary to gain a detailed insight into the different interactions and value exchanges of today's organizations (Biem & Caswell, 2008, p. 1). Thus, there exists the need of representing the exchange of values between these involved objects, resulting in a network. However, the more actors are involved in such a network, the more complex gets the necessary analysis of such models (Schiffer & Hauck, 2010, p. 232). Furthermore, when it comes to FOSS projects, in this example the Catrobat Project, most contributors have little or none economical background. Hence, a Value Network has to represent such a network in a way that on the one side can be used for proper analytics, but on the other side can also be used by people with just limited experience in interpreting the outcomes. Since there have been different individual requirements on such a network, different models arose over the last years. As an example, the value methodology by Gordijn and Akkerman aims to visualize the value viewpoint perspective, which represents how to create, exchange and consume value in a multi-actor network (Gordijn & Akkermans, 2001, p. 11f). This approach allows a detailed business view on organizations, but, in the case of Catrobat, it doesn't meet the demand of a fast and easy interpretable model for technical persons. In contrast to this, Schiffer and Hauck focus with their Net-Map methodology especially on the network aspects, the collection of information from the people involved and the possibilities of Social Network Analysis (SNA) (Schiffer & Hauck, 2010, p. 231). Whereas other models are created in a respectively statically way, Schiffer and Hauck describe a dynamic approach, that easily can be adapted to different circumstances and has a fairly visual character. The main model of Net-Map is build up on different interviews with project relevant persons, that results in a visualized network of actors, relations and influences (Schiffer & Hauck, 2010, p. 235ff). The benefits of this network, especially of using it with analytics algorithms and within qualitative perspectives, will get discussed in the following chapter "Methods to Analyze Value Networks".

A similar network based approach is provided by Allee in her previous research. However, she highlights the importance of intangible values and its transfers due to the growing importance of intellectual capital, human resources and other similar hard definable values (Allee, 2008, p. 5). Especially at FOSS projects, or respectively software projects in general, this transfer of intangible values, such as knowledge, structures or information, act as an important role within the network. In particular, the motivation of

contributors within Open Source projects is of an intangible nature and thus important for their voluntary activity within the project (Raymond, 1999, p. 40). Chesbrough mentions in his work that technology, as comparatively defined intangible value, itself hasn't any single objective value and the economic value just can be created through commercialization and an appropriate Business Model (Chesbrough, 2006, p. 64). But important to mention is that in his book "Open Business Models" he adds that Open Source projects challenge this claim and that commercialized Business Models, that need to be analyzed, are built around the project instead (Chesbrough, 2006, p. 42f). Thus, Open Source projects can highly influence external entities, but, can due to their effects also be influenced by them, what makes it crucial to outline such relations through a Value Network. However, Allee focuses rather on the conversion of intangible values into a negotiable form of value within the Value Network, without explicitly considering the mentioned commercial aspect (Allee, 2008, p. 5f). In her theories, she notes that a redefinition of wealth, value, and its creation process is needed on a business and macro-economic level, which moves from a monetized view towards an acceptance of value as currency with an expanded view on value defined by intellectual capital (Allee, 2000, p. 24ff). Thus, Value Networks may enable businesses to measure this value of intangibles as returned revenue for the transfer of either tangibles or intangibles within the network. As already pointed out, her network model combines the transfers of tangibles (marked as continuous arrow in the network) and intangibles (marked as dashed arrow) between the different actors (Allee, 2008, p. 14f). To illustrate this method and conversion, Figure 8 shows a generalized view of a Value Network that is build up on a possible common FOSS project. As it can be seen, this model just contains simple core elements, which can be interpreted easily, but, in contrast to other models, doesn't contain further details on the entities and the relations to each other.

At this point, to gain a better understanding of these models, it is necessary to give an insight in the characteristics of a FOSS project, which is represented in this figure. This visualized model of such a project, is created by reflecting common involved actors. Nevertheless, individual projects can differ from this view and, due to the applied generalization, they will consist of more detailed actors and more complex transactions, as it will get described later. But, from a very general view on the definition of open source, as initial point there can easily get identified the following superordinate actors of such a project:

- The actual FOSS Project, that with its infrastructure is responsible for the communication, organization, lead and allocation of tasks. Additionally, it may be seen as direct provider of the created software and channels to the users.
- Contributors, which add different values such as code or also expertise, supportive tasks and a regional character to the project. However, in detail the role of the contributor would have to be split up in different actors with different values that are exchanged on basis of various motivations.
- The different users of the services (although a contributor may also be seen as a user).

Although this simple abstraction of Open Source organizations helps to get a brief insight into the structure, we will see later that the interactions and entities in real are of a more complex and dynamic nature.

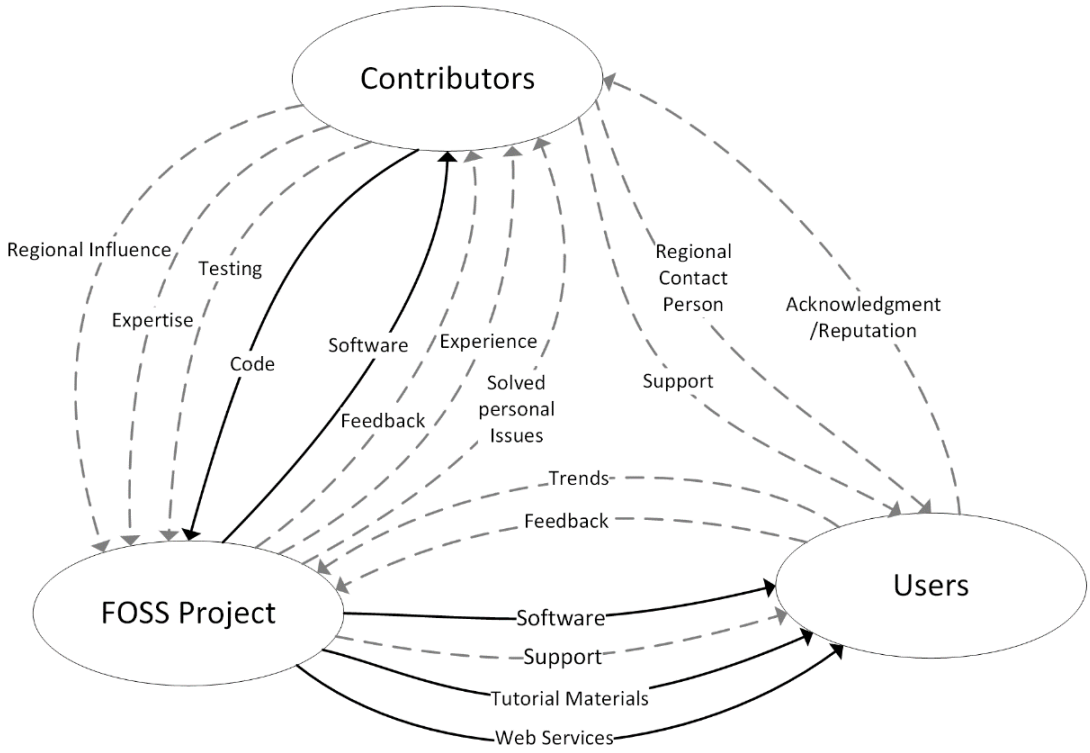


Figure 8 A simple generalization of a FOSS project by considering a Value Network of tangible and intangible assets inspired by Allee's Model

When it comes to the shown transactions between the actors, especially in such a voluntary environment as it occurs in FOSS projects, it's important to identify the intangible revenue streams, since these can be crucial to keep the project alive. Particularly the role of the contributors is of highest interest for analyzing such a specific Value Network. Different researchers have already analyzed the motivations of (F)OSS contributors and identified different reasons why doing so creates a unique benefit for them. The motivation to participate in and contribute to the project is a core element for the success of an Open Source project (Ye & Kishida, 2003, p. 1). Furthermore, the motivation behind initiating such a project can either be for personal, business or intellectual reasons that certain individuals endeavor (von Hippel & von Krogh, 2003, p. 211). It's important to note that there is a high degree of complexity when it comes to analyze motivations in contributions, since different reasons have to be considered and are weighted in different degrees for different projects and contributors (Hars & Ou, 2001, p. 7). All together the following motivation factors can be identified within FOSS projects:

- Improving the performance of other missions and thus creating a benefit as being a user too. An example would be employed system administrators who contribute to OSS projects to improve their own systems (Lerner & Tirole, 2002, p. 213) (von Hippel & von Krogh, 2003, p. 214).
- General enthusiasm on software development and thus, a feeling of competence or satisfaction through the contribution. Nonetheless, this can cause that the needs of the actual users aren't addressed by this type of contributor. (Hars & Ou, 2001, p. 3)
- An identification with the community, which drives them to contribute and to create benefits for others. The contributors try to achieve an aligning with the community (feeling of belonging and of being loved) and furthermore to preserve the community. (Hars & Ou, 2001, p. 3) (Ye & Kishida, 2003, p. 6)
- Future or delayed rewards, which don't arise immediately after the contribution, but they might have positive effects on the contributor later on, such as
    - Expertise and thus future job offers or career chances in general (Lerner & Tirole, 2002, p. 213) (Hars & Ou, 2001, p. 3)
    - Fame, ego, satisfaction and reputation e.g. through peer recognition or publications (Raymond, 1999, p. 40) (Lerner & Tirole, 2002, p. 213f) (Hars & Ou, 2001, p. 4) (Ye & Kishida, 2003, p. 8)

To summarize these different motivators, it can be assumed that the contributors have a personal net benefit or satisfaction, in which the outcomes of sharing work or even revealing innovations, overweight the costs for the contribution in Open Source projects (Lerner & Tirole, 2002, p. 212f) (von Hippel, 2001, p. 85) (von Hippel & von Krogh, 2003, p. 217). In addition to the differentiation of motivation causes, contributors may also be classified by their role within the community. A community can be defined as collection of individuals, or groups of individuals, represented by people with rather different background, that provide systems, development components, a certain access, or communication collaboratively to the project (Fink, 2003, p. 6) (Martinez Torres, Toral, Perales, & Barrero, 2011, p. 109). It's interesting to highlight that there is no strict hierarchical structure within the community, nevertheless different roles do have different influences on the project (Nakakoji, Yamamoto, Nishinaka, Kishida, & Ye, 2002, p. 79). Previous research has claimed that there is no explicit distinction between developers and users as it is in commercial projects, since there is a dynamic boundary and users can involve into a project and thus become a developer (Ye & Kishida, 2003, p. 1f). But, as the vision of Catrobat has shown, there are exceptions, where the contributors are actually not the main user, respectively they differ in their motivation when they use, or interact with, the services. This fact makes it necessary to consider them as totally different roles, with different influence, motivation and value that is provided.

To encounter these dynamic boundaries, different researchers tried to reduce the different roles within OSS projects and minimized them down to three types, whereas the frequency and the kind of contribution got considered (Martinez Torres, Toral, Perales, & Barrero, 2011, p. 109). But early definitions of these roles included up to eight different types, which tried to give a more detailed insight into the dynamics of the communities:

- **Project Leader** – Responsible for the vision and direction of the project
- **Core Member** – Coordination of the development as experienced longtime member
- **Active Developer** – Major development of features and bugfixing through regular contribution
- **Peripheral Developer** – Short time developer with irregular contribution to the project
- **Bug Fixer** – Fixing bugs as developer with limited scope on the concerned module

- **Bug Reporter** – Testing the system, without any development tasks
- **Reader** – Active users of the systems with interest in the project but without contribution
- **Passive User** – The actual user of the system

(Nakakoji, Yamamoto, Nishinaka, Kishida, & Ye, 2002, p. 79)

These various roles within the community may also be considered as different actors within the Value Network of the FOSS project, hence a detailed separation of roles, as it has been done by Nakakoji et al., allows a more detailed analysis of the relationships, motivations and benefits of their created value within the community. Each of these listed types has its own transfers within the network, so that different values and revenues are exchanged throughout the project. However, as it can be concluded from the organization of Catrobat in Figure 6, there can also be identified further or different individual actors, depending on a certain project. In relation to the defined roles by Nakakoji et al., Catrobat can get summarized to the following roles:

- **Catrobat** (Project Leader) – Project lead, project management and overall infrastructure provision
- **Coordinator** (Core Member) – Coordination of a certain field of development and management of a specific part of the project
- **Senior Member** (Core Member) – Experienced longtime members with influence on other contributors and the competence of approving code as well as advising the further development
- **Developing Member** (Active Developer)- Contributors that are working on a regular basis on new features and improvements
- **External Contributor** (Peripheral Developer) – Short term contributors without any closer relation to the overall project (GSoC Students, interested developers, etc.)
- **Expert User** (Reader) – Perform additional community tasks such as teaching or event activities, that are organized and executed individually without any help of the overall project
- Passive User

However, as the example of Catrobat shows, there can also be other roles, that can be part of the community, as it has been defined previously. Especially since the contributors are not the primary users of Catrobat, the connection between project and users on a usability, marketing and educational viewpoint are essential. The lack of missing active users in contribution, which can be reasoned by the education character of the project, has to be compromised by further communication and interaction with the target user groups. Furthermore, the character of the project also appeals external institutions that, in different ways, have influence on Catrobat. Thus, following additional roles also must be considered within the network, since their created value can be seen as crucial for the network and its value transformation processes:

- **Member** – "Non-coding" contributor to the project. Provides additional services such as usability evaluations, translations, support to users, local networking and representation of the project. This entity represents the major contact to the user and has a (regional) network that is used to perform its services. It closes the gap between contributors and the users.
- **Partner** – Another project which exchanges services or products to create a benefit for both involved projects. This interaction can either be with other FOSS or also commercial projects. Both involved entities create due to their partnership together an additional value for the users.
- **Sponsor** – Provide monetary, tangible or intangible values to support the project for different intangible reasons. This may either be sponsorships as well as hardware, licenses or also the provision of access to a business network (e.g. presentation or conference participation), as well as similar external promotion activities (reports, awards, et cetera). However, this relation does not rely on an adequate revenue stream that is created through the project itself.
- **Advisor** – An advisory board supports the project with knowledge and field specific expertise. Although their role has no direct influence on the project, their opinion can flow into the overall strategy and future development of the project.

This diversity of roles and motivations shows the complexity when different types of contributors, or respectively community members, with different benefits get considered within a Value Network. Whereas Allees approach to analyze Value Networks can be constructed proportionally simple on a visual

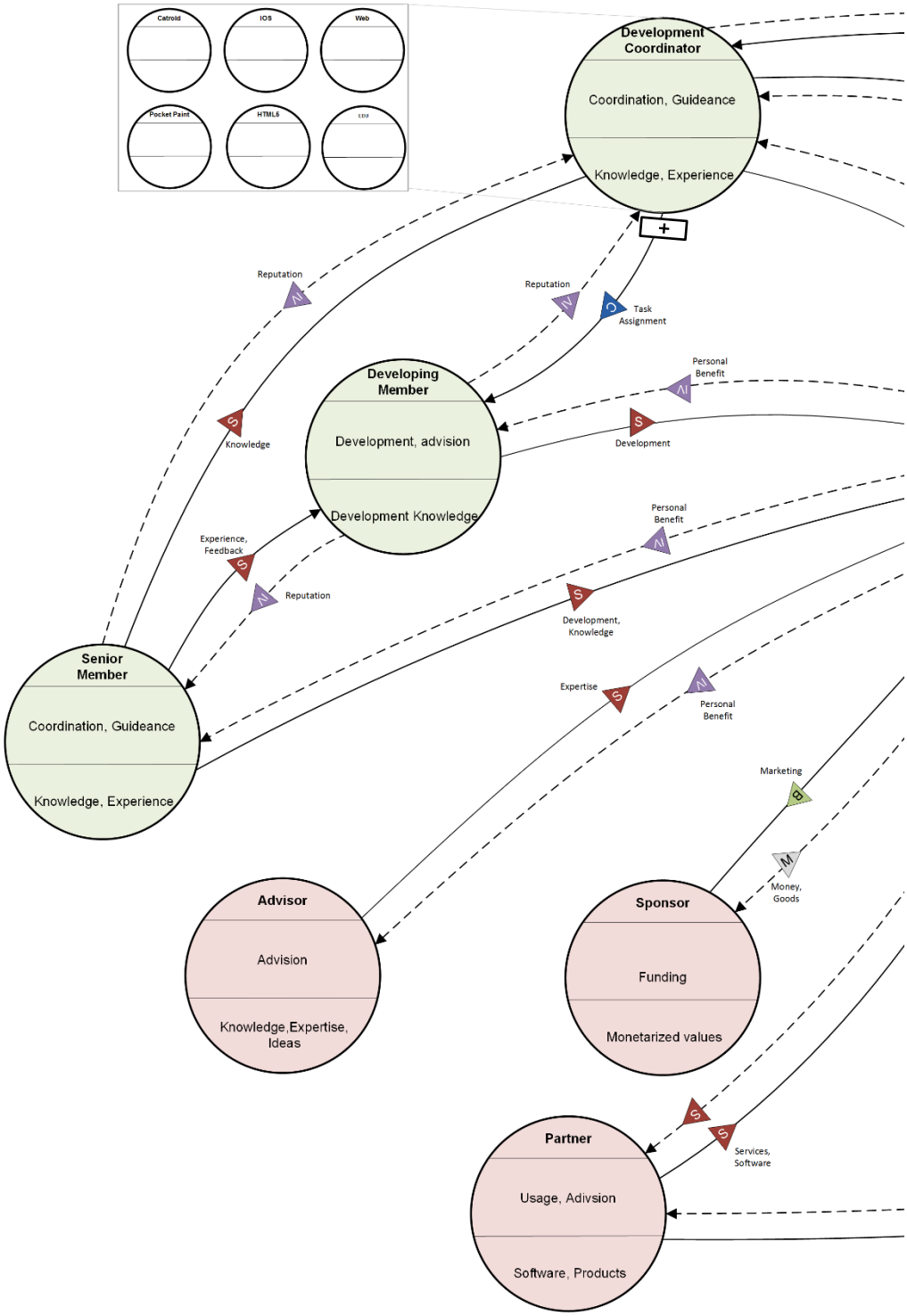
basis, other models consider more aspects and thus provide a framework that also can be used to draw and analyze the actors, relations and dependencies of more complex environments. Biem and Caswell focus with their approach on the end-consumer as main valuator and furthermore want to oppose the limits of Allee's analysis potential (Biem & Caswell, 2008, p. 3).

Biem and Caswell describe a set of economic entities, which are defined as any economic agents, with a visible process of transferring value, of which each consists of capabilities and assets. Whereas the capabilities include all relevant activities, processes and dynamics of a specific entity, the assets are defined by all of the entity's tangible and intangible resources, such as material, capital or knowledge. The transferred objects between the entities are described as offerings, which can be manufactured products, information or a service, that are visualized through unidirectional links. Thus, there is the need of a differentiation between in- and out-offerings, whereas in-offerings refer to supplies that are transformed to a specific out-offering through a value creation process. For a more detailed analysis of that, Biem and Caswell distinct between five different types of offerings:

- **Product** – Any transferable where the ownership is also transferred with it
- **Service** – Any offering where the corresponding supply is provided by the recipient
- **Brand –** The prior awareness of potentially generated value by the economic entity
- **Coordination –** Value creation by managing the network of economic entities and offerings
- **Information –** Common definition of information

(Biem & Caswell, 2008, p. 3f)

Although this framework provides an innovative tool to analyze and capture the Value Network, an enhancement to it, provided by Vorraber, even considers additional aspects and effects of the value creation process. Besides the already mentioned transfer process between entities, the so called V^2-notation also describes the endogenous motivation and exogenous influence of entities to detect weak points within the network (Vorraber, 2012, p. 54). This notation enables the detection and analysis of potential dangers as well as potential additional value that can arise in the future of the network.


Catroid
iOS
Web
Pocket Paint
HTML5
Development Coordinator
Coordination, Guideance
Knowledge, Experience
Reputation
Reputation
Task Assignment
Developing Member
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Development
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Experience, Feedback
Reputation
Development, Knowledge
Senior Member
Coordination, Guideance
Knowledge, Experience
Expertise
Personal Benefit
Marketing
Money, Goods
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Usage, Adivsion
Software, Products
Services, Software

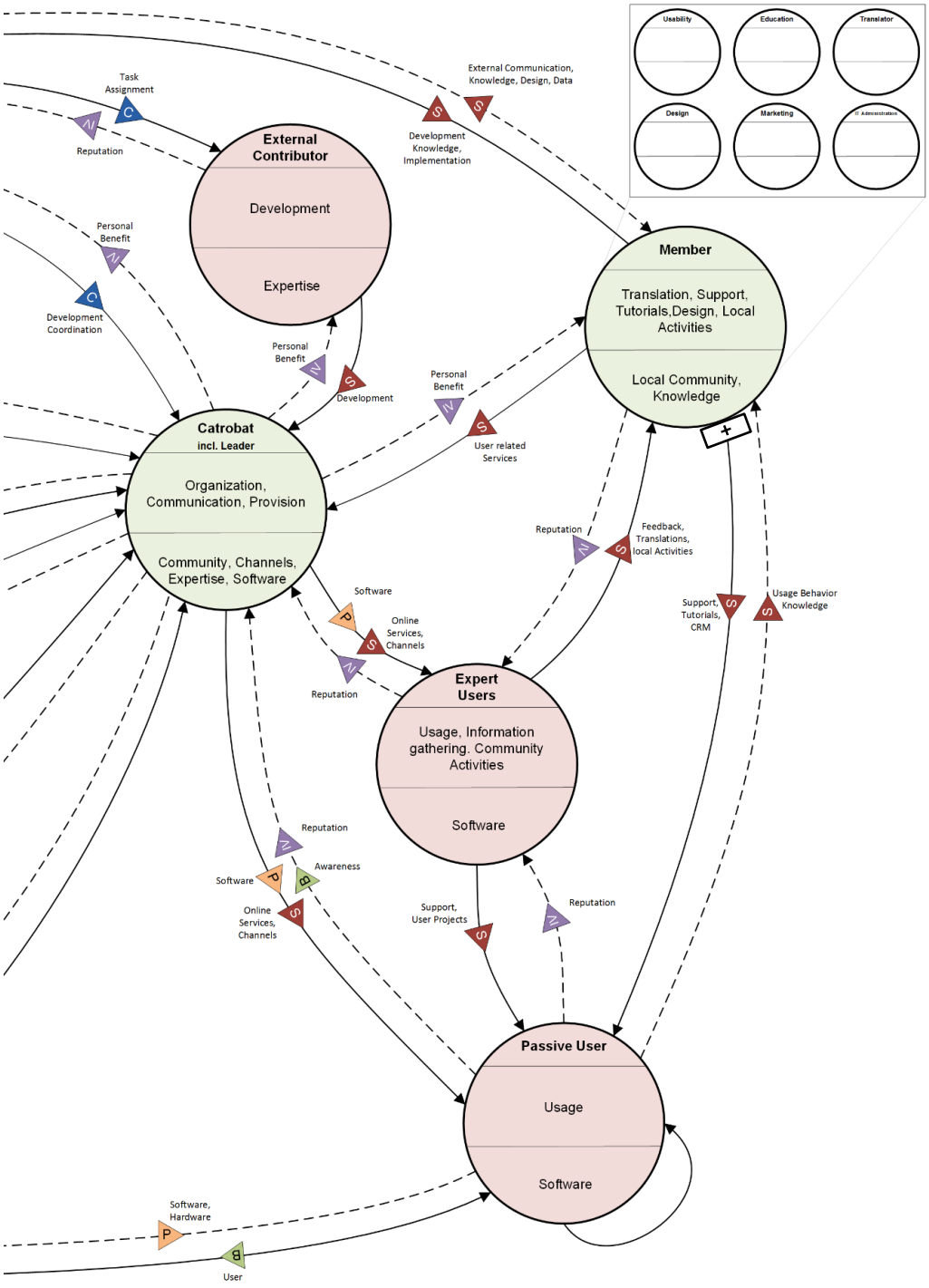


Figure 9 V² Value Network of the Catrobat Project, considering motivations and roles within the community, as well as TU Graz related (green) and external entities (red)

This extended notation allows to analyze these, motivation and influence based entity related, effects on the network. Since, as already mentioned before, the contribution to FOSS projects is driven by the motivation of contributors, this described analysis is an important part of the Value Network. Thus, this notation is preferable to be used on Open Source Projects and the different roles within the community.

The V^2 notation also takes use of the differentiation of provision and revenue links in the visualization of the network (Vorraber, 2012, p. 58). This distinction of provision and revenue, as already used by Allee, gives the possibility to understand the exchange processes and the direct impacts of a transfer on both entities, such as if the supplier receives an equivalent return for his offering. Especially at analyzing value conversion within a network, it is important to determine all potential value conversion opportunities that arise through the inputs and outputs of each role (Allee, 2008, p. 9). Although for these transfers Biem & Caswell have already identified five different types of offerings, Vorraber deduced two additional types from previous research:

- **Monetary Value –** The flow of monetary values through payment transactions
- **Intangible Value –** Used to model consumer experience as value

(Vorraber, 2012, p. 59f)

As the general Value Network reflected by Allee's Model in Figure 8 has shown, all transfers and entities can be assigned to one of these seven types. The additional elements of capabilities and assets of each entity, moreover enable a distinction between the different but similar roles within Open Source projects. The mentioned motivation factors as well as the influence on the entities can furthermore be illustrated by the listed extensions of Biems and Caswells notation through the V^2 Network. Thus, all these specified roles and relations can be represented within this network notation, as demonstrated in Figure 9.

As the organization of the project has shown, Catrobat on the one hand manages different internal roles, which are somehow related to the Graz Unviersity of Technology (TU Graz), and on the other hand is also connected to different external stakeholders. To distinguish between these different types of entities, the V^2-notation can be further extented by a color notation. Especially for communication purposes and due to the complexity of this network, the colored background layers of the entities help to orientate and to

gain a faster understanding of the different entities and their classification defined by their colored background. Therefore entities that are linked to the TU Graz are marked green, whereas external roles are labeled red. Combined in this represented visualisation, the structure and value processes within the project can quickly be represented and explained, without the need of a previous deep understanding of the organization and its actors.

4.1.2 Methods to Analyze Value Networks

Analyzing Value Networks allows a deeper insight into the dynamics of the relations, the concrete importance of a certain entity and information about the health of the network. Different analysis methods based on Social Network Analysis (SNA) are powerful tools to understand such complex networks and their dynamics (Schiffer & Hauck, 2010, p. 239). As Allee defines it as impact analysis, the analysis of individual roles and if these roles of a Value Network realize value out of the input they receive, can help to gain a deeper understanding of the overall value flow and creation process (Allee, 2008, p. 16). However, the complexity of such structures goes along with some questions and fears, especially when it comes to relations, the level of detail or the consideration of qualitative instead of quantitative data (Vester, 2015, p. 16ff). As Vorraber has already pointed out, current frameworks lack in considering these existing dynamics of such a network when it comes to an analysis (Vorraber, 2012, p. 71). But especially the development of ICT has fostered the usage of network algorithms and provides tools to analyze, aggregate and visualize these complex and dynamic structures.

SNA provides a variety of algorithms, such as centrality, density or cliques, that can be performed on different types of networks. But, previous literature on Value Networks hasn't yet provided any explicit research of such algorithms on Value Networks. Although Allee or Biem and Caswell dealt with the analysis of Value Networks and provided guidance, as well as research questions to do so, there is currently no explicit proposal for an ICT-supported analysis of them (Allee, 2008, p. 14ff) (Biem & Caswell, 2008, p. 5ff). These analyses are based on the actual visualization and the individually interpreted dynamics of the Value Network, without considering additional information that results from the network structure of these models. But, as it is illustrated in Figure 9, the analysis of larger networks, such as the one of Catrobat, requires more considerations due to the complex dynamics within them. Furthermore, FOSS projects mainly rely on technical contributors, who can also be interested in a

strategic analysis of the Value Network, since their personal interest in the project, through their contribution, is high. Thus, additional defined values and calculations may help to analyze these networks and to understand their outcomes without the explicit need of a manual analysis that requires deep background knowledge in this field. In contrast to the mentioned previous models, Net-Map is intended to perform SNA algorithms after a network has been constructed (Schiffer & Hauck, 2010, p. 239). But, due to the variety of different networks and fields of usage, there are also no precise recommendations for Net-Map which algorithms or values may be used as benchmark or respectively are recommended for an analysis.

Considering Value Networks, there are some characteristics which need to be taken into account to perform an algorithm based analysis. Whereas many structures are build up on equivalent links between the entities, Value Networks consist of relations which rest upon a certain influence and quality. As Vester notes, soft, or equivalent qualitative, data is often not considered in complex systems, although the importance of these relations is often crucial for the system (Vester, 2015, p. 20f). Whereas, as an example, Allees notation or the network by Biem & Caswell do not explicitly weight the relations between the entities, at Net-Map networks the relations and entities differ in their power and influence, which meets the requirements of a qualitative and quantitative analysis. This qualitative and numeric capable data can help to use more precise algorithms, that considers these individual conditions. By introducing so called influence towers, that are related to the entities, Schiffer and Hauck were able to add a new dimension for the analysis, which not only relies on pure network indicators (Schiffer & Hauck, 2010, p. 241). Another singularity of Value Networks is the dynamic flow of values between the entities. Whereas many common SNA methods just follow the static construction of the network, the analysis of Value Networks can gain further information from iterative algorithms, which pay attention to this flow of values on a qualitative basis.

One of the algorithms that is based on such an iterative approach and hasn't yet been considered for Value Network analysis, is the PageRank Algorithm, that has its roots in the beginnings of the Google Search Engine. PageRank by Page, Brin et al. was defined as an algorithm to rank webpages by their in- and outgoing links, aiming to assign them a certain "importance" solely based on these relations (Page, Brin, Motwani, & Winograd, 1999, p. 14). Although this algorithm is designed as measurement of links, or consequently references, between websites, it can also easily be performed on common networks of nodes and directed links. To calculate the PageRank of a node, an initial value

is equally distributed from each node to each other one, that is connected via an outgoing link. This procedure is repeated till the values of each node converge or a given number of iterations is reached. This explained calculation of a Page Rank can be defined as (Page, Brin, Motwani, & Winograd, 1999, p. 3ff):

$$PR(n) = c \sum_{u \in B_n} \frac{PR(u)}{N_u}$$

Formula 1 Simple definition of the PageRank algorithm (Page, Brin, Motwani, & Winograd, 1999, p. 3ff)

By the original definition used in Formula 1, *PR(n)* represents the PageRank of a node n, B_n a set of nodes that point to n, N_u the number of outgoing Links of u and c is a scaling factor used for the normalization of the values (Page, Brin, Motwani, & Winograd, 1999, p. 3). An enhancement of this algorithm was published by Brin and Page later on, which also considers a damping value, defined as d. This damping factor prevents that the total PageRank gets stuck in a node without any outgoing links and hence results that the PageRank in the other nodes tends to zero, as shown in Formula 2 (Brin & Page, 1998, p. 109f).

$$PR(n) = (1 - \mathrm{d}) + d \sum_{u \in B_n} \frac{PR(u)}{N_u}$$

Formula 2 Enhanced PageRank algorithm (Brin & Page, 1998, p. 109f)

When it comes to Value Networks this algorithm in its given form only considers quantitative aspects, in detail the number of relations, that define the importance of a node. As explained before, there is also the need of taking the power, influence and motivation of both, entities and relations, into account. Although there has already been research on weighted PageRank variants, these primarily focused on the document and web search aspects, whereas Value Networks for the given reasons could also profit from these approaches. To do so this thesis describes two simple modifications of the PageRank algorithm, that allow a more detailed analysis of Value Networks and could give new insights into the value transfers within such a network.

To add this described qualitative aspects, the nodes of the networks get weighted by a special scaling factor that is performed on the damping value. This change enables the algorithm to consider the weight of a node in each iteration, which results in a slightly scaled PageRank based on the weight, but, doesn't change the overall behavior of the algorithm. Additionally, to also consider different weights of links, the PageRank of a node does not get equally distributed to each neighbor when it comes to the calculation of an iteration. Instead of this equal distribution, the user rates each link within the network in respect to its outgoing node, what represents the proportion of value that is transferred from the node to another. These changes can be summed up as function as it is shown in Formula 3 and be used for an example implementation as represented in Code 1.

$PR(n)$ …. $PageRank\ of\ Node\ n$
d ….. …. …. $Damping\ Factor$
$SF(n)$ …. . $Scaling\ Factor\ of\ Node\ n, where\ SF(n) = \frac{\#\text{nodes}}{\Sigma v}\ v_n$
B_n …. …. . . $Nodes\ that\ point\ to\ n$
C_n …. …. . . $Nodes\ n\ points\ to$
v_n …. …. …. $qualitative\ Value\ of\ a\ Node\ n$
$w_{u,v}$ …. …. $qualitative\ Weight\ of\ Link\ from\ Node\ u\ to\ v$

$$PR(n) = (1-d)\ SF(n) \quad + d \sum_{u\ \epsilon B_n} \frac{PR(u)\ w_{u,n}}{\sum_{v\ \epsilon\ C_u} w_{u,v}}$$

Formula 3 Entity and relation weighted definition of the PageRank

To analyze the Value Network through this approach, the V^2 notation already provides the necessary network structure and is furthermore capable of representing qualitative data through its enhancements. Additionally, the visualization used for the Value Network can easily be adopted to add and represent ratings. To introduce these necessary ratings, there is the need of defining a qualitative scale that can be used for the SNA analysis. A practical attempt to do so and to analyze the outcomes will subsequently be performed on the Catrobat project, which will deliver a preliminary assumption of the effectiveness of this new approach.

```
While (iterations < maxiterations) and NOT(converges(pagerank))
   For each entity
      newpagerank[entity] = (1 - damping) * scalingfactor[entity]

      If outdegree(entity) = =  0 Then
         newpagerank [entity]  +=  damping * pagerank [entity]
      Fi

      For each neighbor from neighbors(entity)
         relationvalue = (relationweight[neighbor,entity]/
                              totaloutvalue(neighbor)) * pagerank [neighbor]
         newpagerank [entity] += (relationvalue * damping)
      Next neighbor
   Next entity

   pagerank = newpagerank
   iterations++
Loop
```

Code 1 Pseudocode notation of the weighted PageRank algorithm for Value Networks

The benefit of using such networks is, that on the one side they can easily being visualized, so that an understanding of it can be achieved with limited previous knowledge about the used methods, and on the other side they also enable a algorithm based analysis on quantitative and, depending on the available relevant data, on qualitative aspects. By adding different SNA methods, including variants of the PageRank algorithm, a further constant analysis is possible, which does not only rely on an individual analyst. Furthermore, the change of a network or the similarity to other networks can be defined by the outcomes of such algorithms, providing additional benefits for strategic discussions or long term studies.

4.1.3 Practical application of a weighted PageRank Algorithm

As the previous chapters have already shown, the Catrobat Project is situated in a complex network of users, contributors and stakeholders, in which primarily intangible values are transferred. In such a represented information system, all involved actors should get a return for their value input (Vorraber, et al., 2016). To measure this return value, the defined weighted PageRank enables the responsible persons to analyze the return of every entity in relation to its presented input. However, it's important to note that especially at FOSS or other user centered projects the main part of the value will be transferred to the users and contributors, since these roles are keeping the project alive, whereas other entities are performing supportive tasks which will result in a lower PageRank. This results in the fact that the PageRank will usually not be equally distributed over all entities, furthermore, some entities will stand out in either one way. Hence, when it comes to the analysis of such a network, the persons involved should think about the different roles and if they get enough value in return, in comparison to other entities and in terms of keeping a certain health in the network.

As basis for the weighted PageRank, or for any other SNA algorithms, a basic V^2 Value Network of the organization should be prepared, as it has been done for Catrobat in Figure 9, and be provided in a printed format to the people who rate the actors and relations. Since the V^2 notation is build up on previous research, there already exist several methods and principles for building such a network. Hence, this part will focus on the rating aspects. These ratings have also been discussed by Schiffer and Hauck, who accomplish the rating by interviewing different people who define the network by their own experiences, whereas in the end all these networks are summed up in a final, rated Value Network (Schiffer & Hauck, 2010, p. 235ff). Although interviews are a common tool for such an analysis, also other methods can be used and may even fit better for this purpose. As Stickdorn has shown, Co-Creation is one of the principles of Service Design, that involves different stakeholders in the design processes, which leads to a smoother interaction between the involved parties (Stickdorn & Schneider, 2015, p. 38f). This interaction can also help in the creation of Value Networks to create a common understanding of the value creation and furthermore to benefit from different viewpoints in the rating process.

To apply this principle to the Catrobat project, the prepared Value Network has been handed out as a printed copy to five different long-term members,

who were asked to rate the individual entities by their impact on the overall project. One important factor was to choose these members from different fields, so that there has been a larger diversity of background and knowledge. As Business Model creation has shown, this approach of team work helps to bring in new ideas and to identify links that else would have been unidentified (Osterwalder & Pigneur, 2010, p. 143). To evaluate the position of each entity, a simple scale, as represented in Appendix A, consisting of the following elements, loosely based on Schiffer and Hauck's influence towers, has been used:

- Not mandatory
- Good to have, but no big impact
- Undecided
- Important, but replaceable
- Essential for the project

Although this rating has only been done by five people, there has been a large deviation, especially when it came to external entities. This variance hasn't made it possible to conclude a final rating from this method and showed that the rating process of such a network is still challenging. Similar outcomes were achieved by Schiffer and Hauck, when they faced a large variation of different actor definitions that have been generated through the individual interviews of their approach (Schiffer & Hauck, 2010, p. 240).

Another fact that was highlighted through this rating process was, that according to whether these people had been directly in touch with the outlined entities, the rating differed. This fact reinforced the assumption that there is currently no common understanding of the impact of the different entities within the Value Network of the project. Till now, no tools or frameworks, such as Value Networks or Business Models have been used, instead most connections and dependencies on stakeholders or users have been discussed orally just in specific teams. Thus, it can be reasoned that using tools such Value Networks can lead to benefits, in the meaning of a common understanding of the project and its environment. As Osterwalder has shown for Business Models, a shared understanding helps to improve an organization, since people can easily contribute their own ideas and furthermore align their work with the strategic direction (Osterwalder & Pigneur, 2010, p. 155). Especially technological projects such as Catrobat can profit from that approach. Engineers tend to take themselves as reference for

the software they produce, hence they're often missing the real problem they need to solve and are consequently missing the needs of the users (Cooper, 2004, p. 14ff). Part of understanding a user's problem, and in a next step to understand the connected needs, is to have a clear view on the overall project and all involved entities, that help to solve this problem, as well as the people to whom the solution for this problem is delivered to. The research of Schiffer and Hauck already pointed out that it is crucial to create a clear understanding of the involved actors, their influence and relations (Schiffer & Hauck, 2010, p. 241). Hence, the Catrobat project can benefit from the visual approach used by V^2 models to spread this understanding beyond its contributors. Nevertheless, since the rating process has outlined this problem, the Value Network was discussed in an informal meeting by the project leads, who followed the principle of co-creation and concluded together on a rating based on their experiences and knowledge about the project.

	Value	Scaled Value	Closeness Centrality	Pagerank	Relation-Weighted Pagerank	Entity-Weighted Pagerank	Weighted Pagerank
Catrobat	5	0,83333	0,1111	2,7204	3,5198	2,6805	3,5135
Member	7	1,16667	0,0368	1,0741	0,5452	1,0971	0,5703
Development Coordinator	9	1,50000	0,0348	1,3525	0,3952	1,4409	0,4759
Senior Member	8	1,33333	0,0262	0,8528	0,3483	0,9311	0,4047
Developing Member	7	1,16667	0,0265	0,8528	0,3756	0,9116	0,4133
External Contributor	3	0,50000	0,0301	0,6112	0,2565	0,5478	0,1848
Advisor	4	0,66667	0,0092	0,3812	0,2398	0,3278	0,1896
Sponsor	8	1,33333	0,0092	0,3812	0,2697	0,4278	0,3195
Partner	4	0,66667	0,0214	0,6074	0,7366	0,5431	0,6831
Expert User	6	1,00000	0,0315	0,8357	1,0704	0,8262	1,0660
Passive User	5	0,83333	0,0581	1,3306	3,2430	1,2661	3,1793

Table 2 Applying the (weighted) PageRank on Catrobat

To put this algorithm into praxis, a version of Code 1 has been implemented in Excel and VBA, that uses an easy representation of the Value Network as matrix, as can be seen in Appendix B. For Catrobat, the algorithm has been iterated 100 times over the specified network and showed convergence in the weighted PageRank. To point out the differences in weighting the nodes and links, in addition to the definition in Formula 3 also versions that just consider

the link weighting and the entity weighting have been added. As it can be seen in Table 2 in relation to other SNA algorithms, such as the calculated Closeness Centrality, the therewith calculated PageRank and weighted PageRank refer to a much more dynamic result influenced by the ratings. Especially the results of the weighted PageRank, in comparison between the individual entities, shows that there are large differences within their actual computed role in the Value Network. Notably external entities, such as sponsors, partners or advisors, achieve a relatively low weighted PageRank, which can be concluded that they just have a minor role within the exchange process of the Value Network. Sponsors, which have a relatively high rating assigned by the project lead, receive a well below average weighted PageRank, what can promptly be identified even without extensive experience in Value Network analysis.

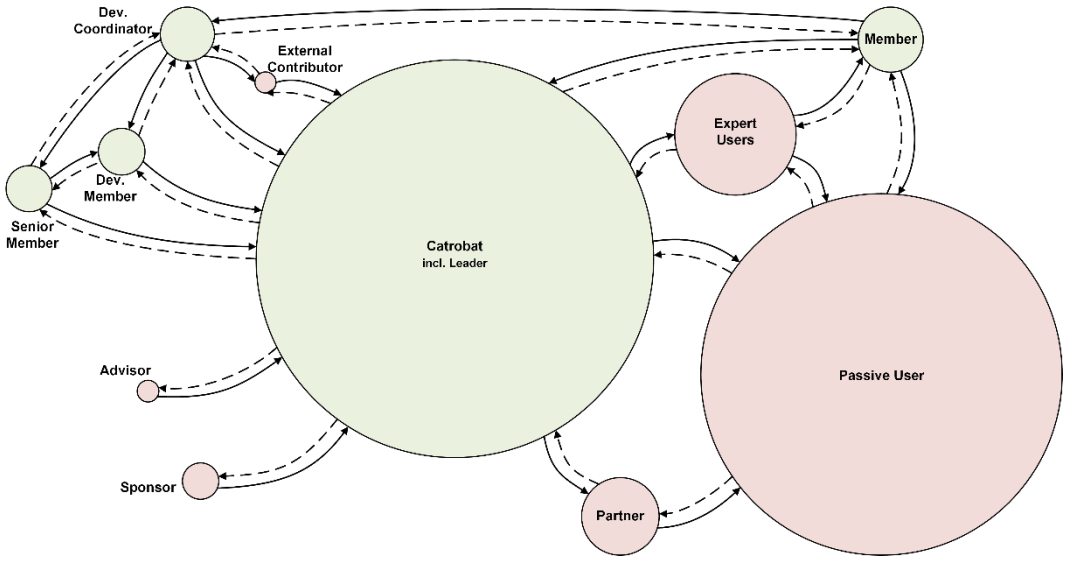


Figure 10 Scaled representation of the network entities that have been weighted with the adapted PageRank algorithm

But as expected, the weighted PageRank also proves the importance of the project as organizational unit that distributes values to all involved entities. In addition to that, the user can, as supposed, be highlighted as main external receiver of value, as it can clearly be spotted in a scaled representation of the network in Figure 10. This importance of the user confirms the need of special consideration of this specific role with Service Design tools. However, these two entities can be seen as outliers, whereas especially the contributor roles represent calculated weighted PageRanks relatively close to the average. Thus, it also can be reasoned that these actors are essential for the viability of the

network, whereas entities with a comparable extremely low rank, such as the advisor, could be easily be replaced or disregarded, without significant effects on the overall network. But, this identification of relative low ranks could also be used as opportunity to evaluate if these actors could take a stronger role within the network and add more value in future or if such a low influence is intended by the project, as it is the case for the advisor in the current state of the Catrobat Project.

This weighted PageRank algorithm adapted on Value Networks can be seen as first approach to continue Schiffer and Hauck's SNA usage on Value Networks. Though, it can only be seen as supportive tool for a manual analysis and can't replace the human process of analysis, since not all characteristics of a dynamic example can get respected properly. As an example, the sponsor role within Catrobat receives a low weighted Page Rank, although it is of importance through its nature as only revenue stream for the project. But since the sponsor isn't requesting an equivalent return for its sponsoring, just a small amount of value is returned to this entity, which ends up in this relatively low weighted PageRank, despite the fact that the rating of it was accordingly high. Hence, the weighted PageRank offers a new algorithm to stronger include the value flow in the analysis process, but can't describe all effects of a network.

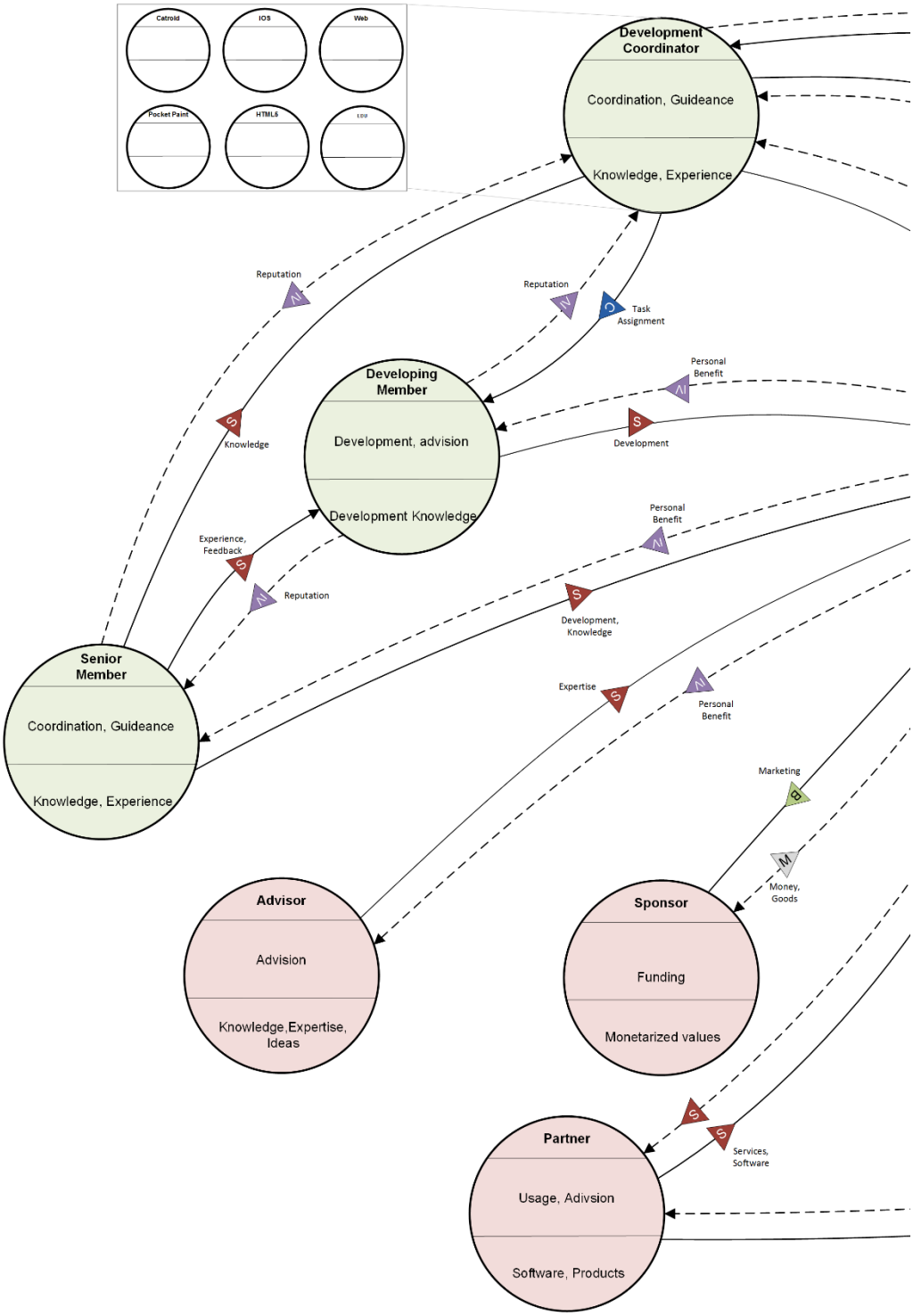
As an interesting side effect the co-creative way of doing the rating process, also pointed out room for improvement within the Value Network. By analyzing and discussing the specific entities of the network, it came to light that some important capabilities or assets, which would have benefits for the project, are currently not matched by any present stakeholder or entity. Including such potential entities in the Value Network can help the project lead, or respectively management, to improve the networks performance, in the meaning of value exchanges, and to plan future strategies. Exchanging minds on a common understanding of a Value Network hence can also help to extend the network and to decide future steps towards these enhancements.

In this example, discussing the Catrobat Value Network for the rating process, outlined the need of a multiplier role within the network. The current limits of the already existing entities showed that an additional entity is needed that takes over promotion and reputation activities directly on a user basis. Thus, this entity which is connected to the project, just acts as communicator to the passive users. Based on this information, this new defined entity has already a rough definition of the capabilities and assets needed, although the exact values that are exchanged can't be defined at this state, since the motivation of the actual desired entity can't get determined without further analysis.

By advancing the V^2 notation by Vorraber with a simple dotted line-style and greyed entities, these potential missing entities can also be taken into the graphical consideration of Value Networks, as illustrated in Figure 11. This approach of visualization can also help to include future activities, or respectively plans, of the project in the actual communication process, which now not only allows to describe the current status quo, but also to give a clear understanding of the desired network development. Hence, since these environments are subject of steady change, Value Networks do not have to just represent a current state of an environment. Rearranging entities within it or also modifying existing entities can lead to total different relations and value flows. For this reason, the advancement of considering possible entities can be a basis for further examination of the Value Network and help to further develop and influence the value creation and capturing process.

4.2 Specifying the User-Entities

Since the Value Network has outlined the different entities and persons involved within the project, the next step towards analyzing the project, is to further define the actors, in particular users, to whom value is delivered. To be able to create a unique experience for them, what should be desired as main goal of the whole value process, it is important to continue considering the outside-in perspective, as it has already been done for the Value Networks (Reason, Løvlie, & Flue, 2016, p. 57f). As previously shown, there is a variety of user segments, representing either pure consumers or contributors of any kind, who need to be considered therefore. For a detailed analysis, it is necessary to gain a deep understanding about the related entities by identifying their needs, wants and fears. The therefore regarded user centered approach, as it has been described as a main aspect of Service Design, highly depends on the available user data. Nevertheless, different common Service Design tools help to gather this information about the users and show how to take advantage of them. But, these tools can also be used to identify the characteristics and motivations of contributors, since fulfilling their needs and encountering their pains is also of potential interest, since their existence and work is essential for the viability of a FOSS project.


Catroid
IOS
Web
Pocket Paint
HTML5
Development Coordinator
Coordination, Guideance
Knowledge, Experience
Reputation
Reputation
Task Assignment
Developing Member
Development, advision
Development Knowledge
Personal Benefit
Knowledge
Development
Experience, Feedback
Reputation
Personal Benefit
Development, Knowledge
Senior Member
Coordination, Guideance
Knowledge, Experience
Expertise
Personal Benefit
Marketing
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Funding
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Services, Software

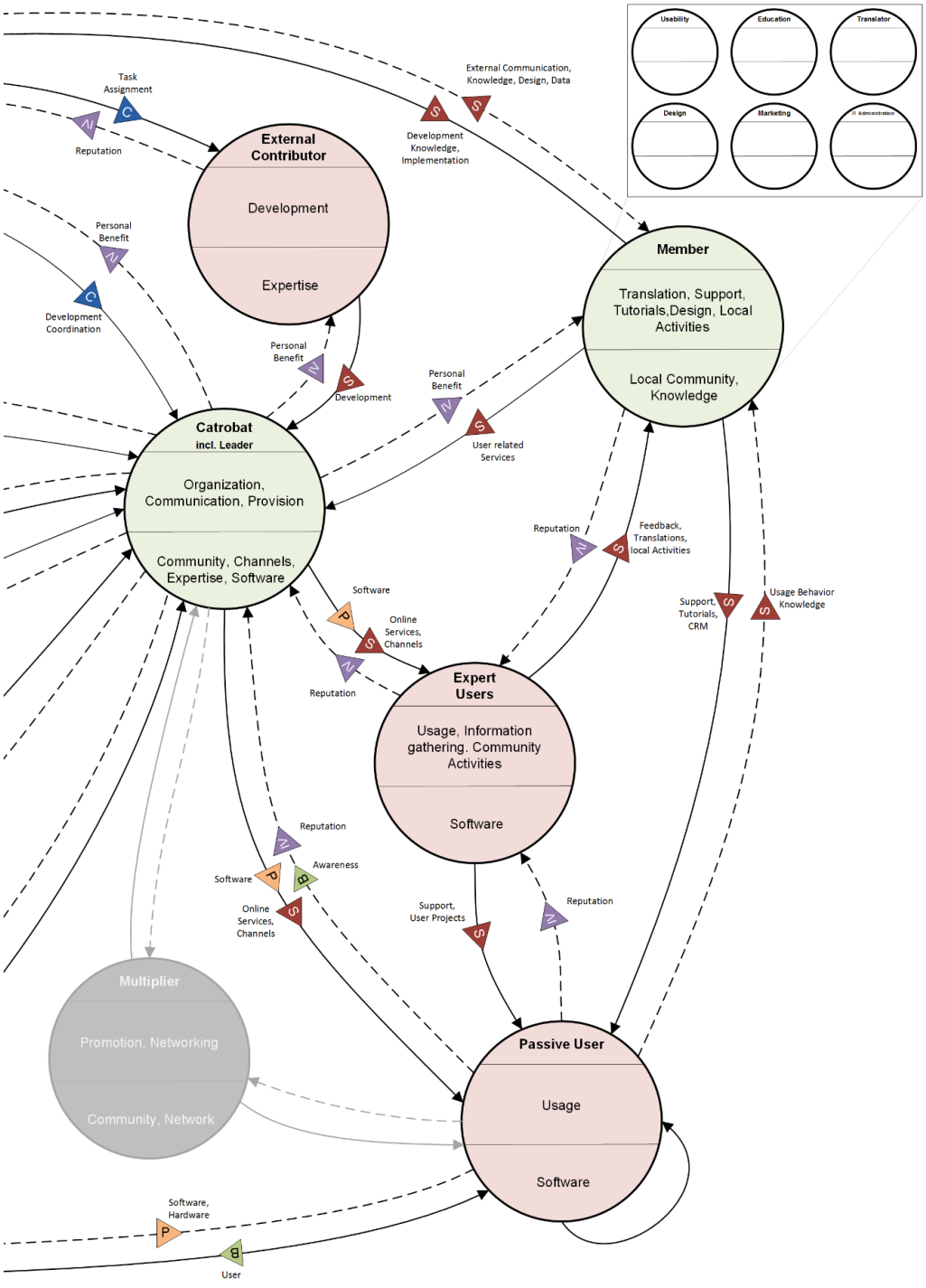

Figure 11 Modified version of the Catrobat V² network by considering desired entities

4.2.1 Understanding the users

One of the most challenging parts of a software project is to gain a clear understanding of the different users, or from a more commercial view, customers to whom the service is provided. As the launch of the Apple iPhone 3G in Japan has shown in 2008, misunderstanding a single customer group can cause that an important market isn't reached as successful as similar other ones and consequently potential success isn't reached (Revella, 2015, p. 3f). Many different software projects have shown in the past that especially developers unintentionally focus on the program design, which is inspired by their personal preferences and the coding style, instead of designing for the end-users and their needs (Cooper, 2004, p. 22f). As already mentioned, particularly Catrobat is faced with this issue since the contributors differ from the actual target user group. In addition to that, there is a rising demand of interaction and furthermore experience within services, since the users request steady improvement and change, what is also driven by the fast development of new technologies within the mobile industry.

However, notably ICT projects have the advantage of having access to several different ways to understand their users und encounter these challenges. Whereas common methods such as interviews, personas or A day in Life can be easily used, also new online platforms can help to gain knowledge about the users. This common approach of using already available data to get a first insight, Osterwalder et al. describe as "Data Detective" methodology (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 108). Rating websites as well as different analytics tools give the possibility to get direct feedback from the users, which can be summed up to general conclusions. Thus, creating special channels on which users can intentionally express their ideas and desires can even foster innovation and provide a fast way to get an insight into their needs and jobs (Løvlie, Downs, & Reason, 2008, p. 11). In the case of the Catrobat project, many users already reviewed the app with detailed information about their goals and wishes on Google Play. Furthermore, different communication channels are frequently used by the user community to request support, which reveals also a deep insight into the users' behavior and needs. Taking a closer look on them pointed out some recurring, qualitative facts that are important for at least some users and should flow into the application of these tools.

As a Service Design workshop within the Catrobat Project has shown, the main challenge is to collect this user related data, communicate it to the responsible contributors and furthermore to represent the outcomes in a way that can be

used immediately for implementation. As a starting point for this workshop, whose materials can be found in Appendix C and in which six long-term Catrobat members with different background participated, the reviews on Google Play have been used to gain an insight into the user perspective. As Figure 12 illustrates, selected recurring statements have been presented to the participants of the workshop to gain a better understanding of the real users of the project's services. By going through these comments, the participants recognized that the users have a detailed vision of what they expect. These findings align with the assumption that customers are usually aware of how their needs could be solved (Reason, Løvlie, & Flue, 2016, p. 11). In addition to that, it turned out that some of the mentioned issues have already been solved or are currently in development, which hasn't been communicated to the users properly. Pointing out this specific feedback of users, immediately helped the participants to put themselves into the position of these actual users and to see their mentioned problems.

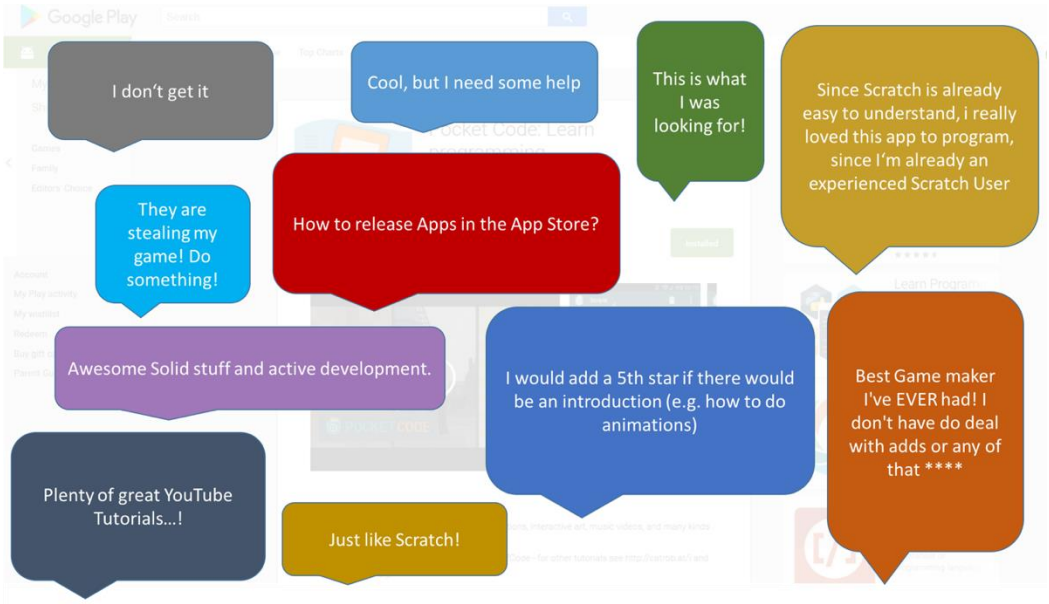

Figure 12 Selected user reviews from Pocket Code's Google Play profile used for the Catrobat Service Design workshop

In addition to these reviews, the workshop lead also visited a school, that is currently using Pocket Code, to observe the pupils during using the app and also to interview one of the teachers. The answers and findings have also been handed out to all participants, so that these outcomes could have also been

used for Service Design tools. This observation proved that the users exactly know what they want to achieve and that they have a clear picture of what they do expect as outcome. So, the assumptions about the users' problems that have already been made by the participants on basis of the reviews, got backed by the results of these observations. Thus, it can be concluded that collecting data by the mentioned data detective approach, without direct contact to the user, can in certain circumstances lead to the same outcomes as collecting data directly at the user. Nevertheless, especially the interview also pointed out that it is important to respect every user segment. The requirements of the teacher, as well as the issues she encountered in class, differed widely from those of the pupils. As an example, the participants have been astonished when they found out that the teacher created the teaching resources for the Pocket Code classes by herself, although the project provides different websites and materials that are freely available. The reason therefore was that the teacher didn't know about them since they haven't been linked within the services, what quickly got identified by the participants. Pointing out these two different perspectives, made clear that it is crucial to examine different views for the development process.

Figure 13 Visual outcomes of a Catrobat Service Design workshop using customer journeys on a given scenario

As practical part, to gain further insights, all workshop participants discussed together different scenarios and went through various customer journeys, based on the gained insights before. As basis therefore, the toolbox provided by Marc Stickdorn in "This is Service Design Thinking" has been used. These introduced tools do not require following any rules of application or guidelines that need to be considered, since every project should find a suitable combination of the introduced tools, that fits their needs best (Stickdorn & Schneider, 2015, p. 148). But, an important factor that has been used for all tools, was the principle of visualization. As Reason et al point out, the key to make ideas understandable and to communicate them, is to visualize them e.g. with simple drawings or post-its (Reason, Løvlie, & Flue, 2016, p. 10). As Figure 13 shows, an ordinary whiteboard with clear illustrations on it has been sufficient enough to interactively go through a customer journey and to add the ideas of the participants. The scenario used for this specific case has been a trivial walkthrough of the process of how a teacher gets to visual programming with Pocket Code. As this approach has shown, a short, written explanation of this plausible situation as scenario, using a real persona, is an effective way to get into a discussion about the main driving factors of the underlying service experience that needs to be considered for the development (Stickdorn & Schneider, 2015, p. 184) (Cooper, 2004, p. 179f). Going through this scenario by building a customer journey also helped to reproduce the experience with all its ups and lows. To avoid to only consider the service provision process and thus to loose important insights into the users' motivations and feelings, as it is often done, the journey has been split up into four stages - before the service (pre-service period), beginning of the service , during the service (actual service period) and after the service (post-service period) (Reason, Løvlie, & Flue, 2016, p. 18ff) (Stickdorn & Schneider, 2015, p. 40f). This methodology enabled the participants to examine the whole service process, as well as the motivations and corresponding reasons for starting or finishing it.

It turned out that these insights helped to identify various potential issues that real users are facing. Furthermore, the used tools instantly provided the chance to create proper solutions to encounter these identified issues. Looking onto the services from this user sight also opened new possibilities by highlighting potential new features that would create additional value for the customers. However, it also outlined that there is the need of retaining this gained information and to communicate it to the developers who are developing the regarded services. Thus, it is important to provide a clear definition of the needs in addition to the well specified implementation tasks. This helps to encounter the already mentioned problems by Cooper, such as

not well defined goals or a lack of understanding of the user. A special usability team within Catrobat describes these tasks in respect to the users and common development guidelines. Regular beta tests and additional field tests also support this user centered approach by avoiding capsulation from the actual users. But, the regular use of the presented multiple available Service Design tools would help to create an extended knowledge about the users, which if communicated consequently to all contributors, would lead to an even more user and experience oriented focus in the future.

4.2.2 Describing Roles and User Types for the Catrobat project

Although, Catrobat mainly focuses on teenagers, many more different user roles have a significant influence on the project and need consideration. Different backgrounds, education and experiences make it necessary to split these roles into more detailed ones. In addition to this, a role can be fulfilled by different types of persons, such as developers, teenagers or teachers. This approach of separating the actors into roles and types, allows to gain further information about the motivation and expectations of the different detailed entities. As the Value Network has already outlined, the most important roles from this point of user related view, are the passive users, expert users and the different kinds of contributors.

Currently no analytical user data is collected by the organization that could be used for such a detailed analysis of different user types. Now, there are just the existing reports from Google Play that represent downloads, active users and meta information such as language, used software and hardware. Despite the fact that there are tools that could collect such individual user data, there are also ethical and legal aspects, especially due to the young target group of the Catrobat services, that would need to be considered in detail before applying them. However, more relevant information from the users can already now be collected by the introduced data detective approach, that can use various public and internal channels such as support requests, community channels or published user reviews.

Taking a closer look on these resources of Catrobat demonstrates that there are different user types, which can be identified by their type of request, the background information they provide or their goal they describe to achieve. Summarizing this data from Google Play, social media platforms, mailing lists

and e-mail requests, points out five main user types on which should be taken a closer look. Each of these user types can engage in different roles, depending on the individual person fulfilling it. Although this data is not based on quantitative research or continuous analysis, listing these roles and types, as it has been done in Table 3, can be a useful supportive tool for Service Design workshops, since different aspects of the users can be taken into consideration.

		Role		
		Passive User	Expert User	Contributor
Type	Teenager	●		
	University Student	●	●	●
	Teacher	●	●	●
	ICT Enthusiast		●	●
	Adult Coding Beginner	●		

Table 3 Roles and user types within Catrobat

Identifying these different combinations can help at applying the Service Design toolset in the development process. Having a clear vision of possible user segments that can occur, is essential to generate a useful and valid output of these tools (Stickdorn & Schneider, 2015, p. 36f). As the workshop within the Catrobat project has shown, it is not necessary to apply each tool on each of these segments, furthermore the participants were able to understand the impact of the existence of these rolls and thus discussed different user views during applying each tool. Often there just showed up insignificant differences between these combinations, however, examples such as the distinction between technophilic teachers, that act as expert users, and teachers with little ICT background, representing a passive user, also proved that identifying and considering these roles and types can help to pinpoint potential issues that can occur in a certain segment.

One issue that challenges the development of Catrobat's services in a different way, and can't get considered through this types and roles perspective, is the global distribution of the users. Although these roles and types already give a good insight in the structure of the user base, there are also demographical and cultural aspects that are much harder to evaluate and identify. As it is illustrated in Figure 14, the main app of Catrobat, Pocket Code, got already

installed by users from almost all countries of the world, as internal download statistics prove. Nevertheless, this makes it also necessary to take this global distribution of the app into account to meet the needs of every user worldwide. One important step therefore is the provision of different languages, that Catrobat achieves through using Crowdin[14] as online platform for volunteer translators. By doing it that way, the app gets currently translated into 48 languages by volunteers from all over the world. The analysis of qualitative data, particularly reviews, has pointed out that especially young users request these translations, since their proficiency in a foreign language is often not sufficient enough to take advantage of all features that the Catrobat's services provide. That demonstrates that these regional differences are also a differentiator when it comes to specifying the different existing user groups. But, representing these language barriers, or other similar cultural differences, as a separate segment for each language or region, would overrun the requested level of detail that is necessary to apply the tools. However, it must be kept in mind that regional differences, such as language barriers or technical issues due to the usage of regional device brands, are an important pain mentioned by a significant number of users.

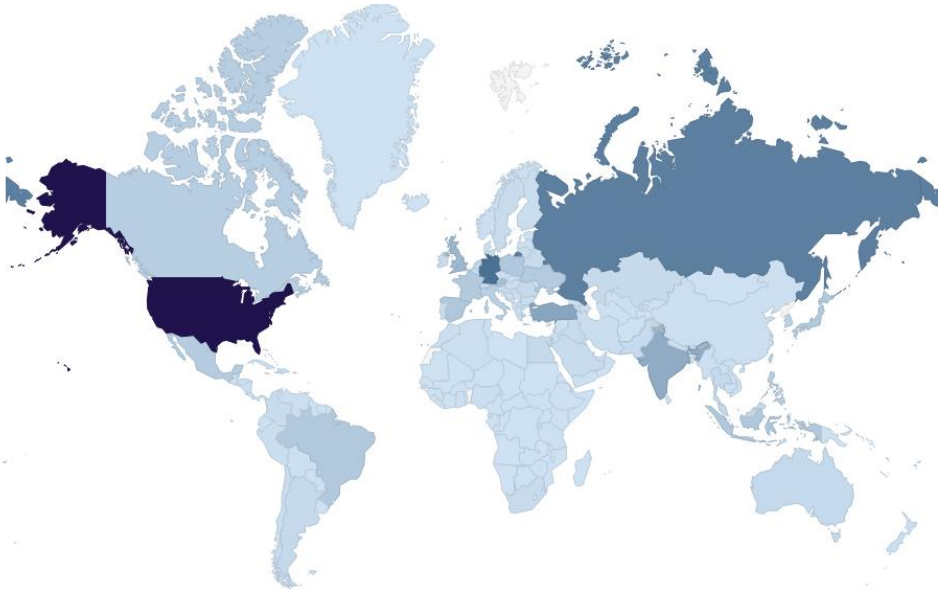

Figure 14 Worldwide distribution of Pocket Code unique total user installs at the end of 2016

[14] http://translate.catrobat.org

As already brought up in Table 3 also the different contributors represent a group that needs attention. The analysis of FOSS projects for the creation of Value Networks already outlined the different motivations and fulfilling contribution roles of these actors. Nevertheless, all these motivations are individual and represent an actual need that gets addressed by the project, its community and processes. But currently no personal data or statistics, that could give a valid representation of these needs, are collected by the project. Nevertheless, although the workshop at Catrobat focused on user-related issues, Service Design methods could also give access to this specific view if relevant data would be collected and prepared for these specific purposes. Thus, special workshops that just focus on this contributor related viewpoint are imaginable in the future, since their outcomes would probably have an as similar positive impact on the overall project's goals, as already have been achieved through the user-oriented workshop.

4.3 Ways to display the created Value

Whereas the Value Network has outlined the different actors that are involved within the value creation process, it is also important to identify the benefits that are created through this processes for the different individual entities. Hence, by the already given definition, a Value Proposition can get used to describe this generated benefit that actually is provided by the offered products and services (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 6) (Chesbrough, 2006, p. 64f). Thus, it can be concluded that different entities, as well as customer segments, will respectively have different Value Propositions that need to be considered.

A Value Proposition illustrates the jobs that a specific segment needs to get done and the offerings that support them on fulfilling these jobs, which, if done correctly, will be the key for success (Johnson, Christensen, & Kagermann, 2008, p. 60). Especially from a strategic point, a Value Proposition is an important development step for a company since it represents the essential customer perspective of a business strategy (Kaplan & Norton, 2000, p. 53f). Thus, a Value Proposition connects the provided offerings with the targeted consumers. Hence, to design a proper Value Proposition, it's crucial to understand the users' goals and to outline how the offerings help to achieve these goals, because only then the user will also be willing to help to reach the business' overall goals that lead to success (Cooper, 2004, p. 149f). But, the expectations of the customers on the offerings nowadays not only rely on

quality and costs, furthermore aspects such as convenience, after-sale service and more play an important role (Treacy & Wiersema, 1993, p. 84). Thus, defining value in respect to the customer got an essential discipline for businesses and determines whether an organization is going to be successful or not. Since companies can gain such a great advantage from using Value Propositions, also Free Open Source projects can apply these methods on their services and products. Identifying and mapping the various offered services to the jobs and needs of the different potential user-segments can especially help to analyze the prejudice of FOSS missing the users' expectations and needs.

4.3.1 Mapping the User to the Offering

Although there exist many different theories about Value Propositions, there are currently more definitions than practical tools that could easily communicate a certain Value Proposition. The already discussed aspect of creating a shared user and value definition could get backed by such a visualized approach and could also help to align services to the actual consumers. Creating a clear Value Proposition is crucial for an organization, but, there is often still no consensus about it in businesses (Kaplan & Norton, 2000, p. 53). An approach to create such a needed common understanding on a visual basis, is provided by the Value Proposition canvas (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 3ff).

When it comes to Value Propositions it's fundamental to answer the question what problems of the customers are going to be solved with the business' products and services (Chesbrough, 2006, p. 65). As already described, the Value Proposition canvas by Osterwalder describes the customer and the offering in a useful, and detailed way to answer this specific question. By differentiating between the Value Map, describing the offering provided by the organization, and the Customer Profile, shaped by the characteristics of an actual customer segment, the canvas can be analyzed as fit of these two sections (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 8f). This fitting of the Value Proposition is especially important for Business Models, since it describes the created value and benefit for the users or respectively customers (Chesbrough, 2006, p. 64) (Osterwalder & Pigneur, 2010, p. 22ff). Hence, on the one side knowledge about the offerings of the services and products is necessary, on the other side the customer segments with all their jobs to be done, occurring needs, and furthermore pains must be identified.

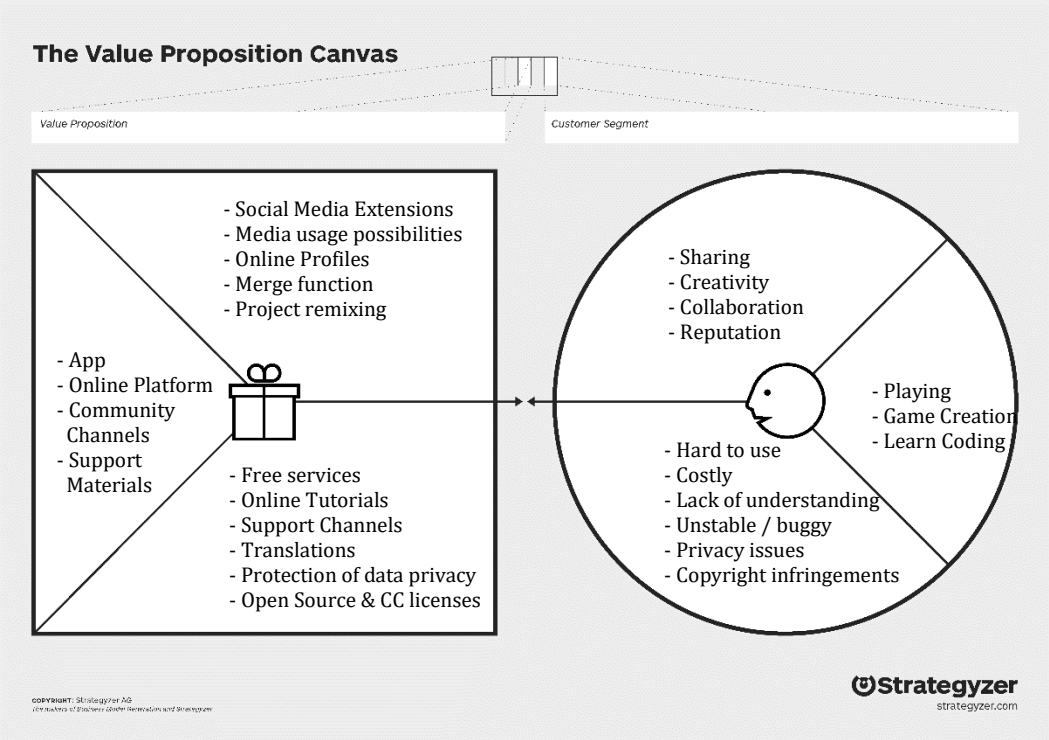

Figure 15 Value Proposition canvas used on the Catrobat – passive user relationship [15]

Recapitulating the previous sections of this thesis, this needed Customer Profile can simply be reasoned from the outcomes of the applied Service Design tools. Nevertheless, also Osterwalder et al. suggest different methods to support to gain a deeper understanding of the customers for the canvas creation, such as interviewing ("The Journalist") or observation ("The Anthropologist") (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 106f). However, since these methods follow the same principles as used within Service Design methodologies, also other tools, as example the explained scenarios in the Catrobat workshop, can be used as initial point for the creation of a Value Proposition. As the canvas in Figure 15 shows, the therefore deducted Customer Profile for Catrobat, reflects the expectations and issues that have been identified during the Service Design workshop. Thus, to analyze the necessary fit, the services provided by Catrobat, including the according pain relievers and gain creators on the Value Map side, get opposed to the Customer Profile of a specified segment. Although such a proposition can be easily created, the same issues as already identified for the definition of roles and types occur. Since one Value Proposition just represents one

[15] Canvas provided for non-commercial use by Strategyzer AG – http://strategyzer.com

individual customer segment, there is the need of having a clear vision of which segments exist and of their unique customer profiles. Hence, to use this tool efficiently, it's essential to identify the different user groups, and their individual characteristics, in different propositions.

4.3.2 Considering the internal Value of Contributors

Whereas the foregoing section showed how to deal with the customer related Value Side, especially FOSS projects have also to take the contributors into account. As already highlighted before, contributors do have a particular motivation for their contribution to the organization. Hence, this motivation can be seen as part of their individual Customer Profile. Since they face certain needs, resulting in pains and gains, during their contribution, is it crucial to also consider their unique benefit that is created through working within the organization. As pointed out in the Value Network, contributors are indispensable for the value creation and capturing process of a FOSS project, Thus, the organization needs to offer appropriate pain relievers and gain creators that lead to this necessary benefit for these actors.

Taking a closer look on the contributors will also foster the holistic view onto the overall organization of the project. As it will get pointed out later, this perspective can also be used as important component for detailed, holistic Business Models. Based on the Value Network and the already made considerations about the contributors' motivation, the Value Proposition canvas can smoothly be applied on the available research data of general FOSS projects. Figure 16 represents these simple assumptions about the motivations within the Value Proposition canvas for contributors. Although this information already allows a rough insight into this specific viewpoint, for a detailed analysis of the contributors, as it has been done for the users of Catrobat, more specific data would be needed to construct a reliable model. The proposed Service Design workshops would unveil this needed information to create such a valid model. Even though research within Catrobat already considered the role of the contributors, this data solely focused on the general working and development aspects, without considering the community aspects or deeper facets about the reasons and motivations for their contribution. Nevertheless, already such a general representation highlights the various aspects that need to be considered for a successful contribution of developers and other members. Unique motivators and needs will depend on the different FOSS projects and on the environment these

projects are situated in. Hence, it can be reasoned that depending on the provided services and offers, also the contributors and their individual jobs, needs and gain creators will vary. But, simple research within that field can lead to a deeper insight of these entities and could create additional benefits for all involved parties.

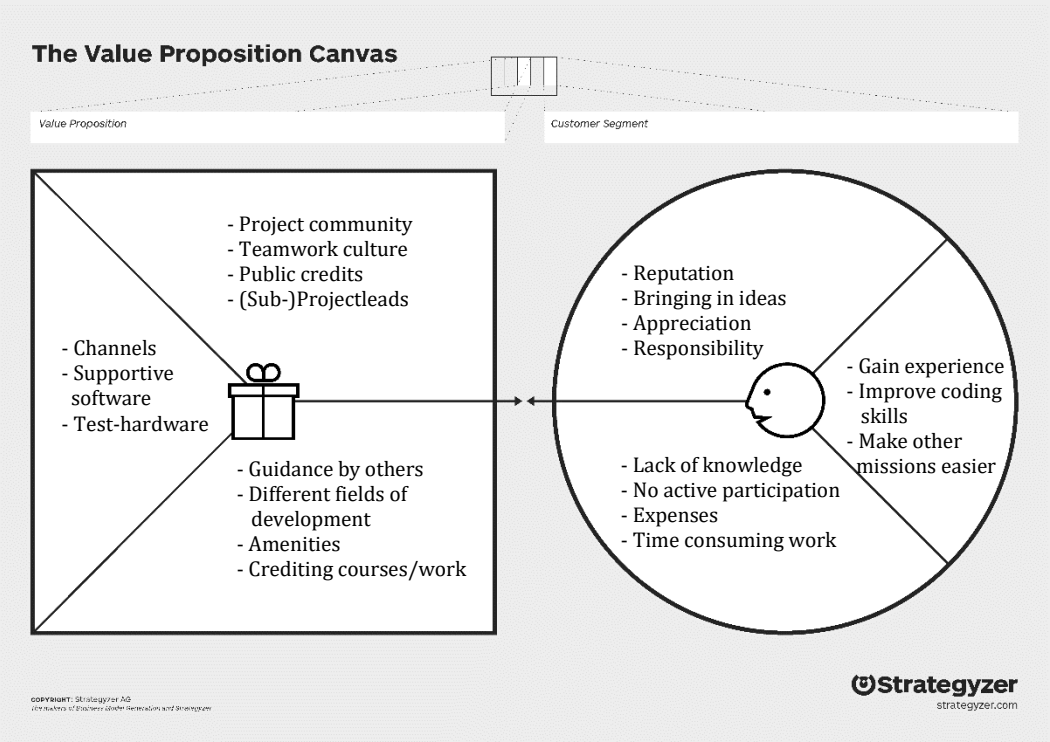

Figure 16 Value Creation process for contributors represented by the Value Proposition canvas

4.4 Generating a Business Model

As the Value Networks have already shown, there is especially at FOSS projects a large amount of interactions and transfers within such an organization, what makes it important to specify and represent the value processes within them. Since the previous chapters have already highlighted the different actors that need consideration, it is now important to get to a more detailed level that combines the achieved findings of value creation and value capturing from the previously applied tools. Exactly this representation of the process related created and captured values by the entities, is performed by a Business Model

(Chesbrough, 2006, p. 2). Hence, it is the logical last step on to creating a common understanding of FOSS projects, to consider them from a Business Model view, that reveals the last missing links that need to be taken care of, and that additionally represents all major findings within one easy, understandable model.

Although many Free Open Source Software services are distributed by nonprofit organizations, which are financed through fundraising, there also exist common strategies to gain profit out of such software. Successful business strategies in the past, beyond others, were value-added service-enabling, as it was realized by Red Hat, or versioning models, that provide free basic and costly extended versions, such as it happened at MySQL (Chesbrough, 2006, p. 45) (Fitzgerald, 2006, p. 590) (Osterwalder & Pigneur, 2010, p. 97) (Fink, 2003, p. 175f). Today there exist several different Business Models that are built up on or around Open Source projects. Nevertheless, as Chesbrough and also Fink outline in their research, Open Source projects are courage not to profit out of their work and thus these commercial strategies are not common within the movement (Chesbrough, 2006, p. 44) (Fink, 2003, p. 176). Nevertheless, a Business Model can also be a useful tool for non-profit FOSS projects to identify and define the creating, distribution and exchange of value that is needed to keep the project alive. As it is also described by Osterwalder and Pigneur, Business Models are not limited only to for-profit corporations, furthermore, they may be used as a tool to describe a non-commercial mission and how the occurring costs are covered (Osterwalder & Pigneur, 2010, p. 264). This fact also makes it interesting for non-profit projects, which haven't shown efforts in business disciplines yet, to engage with Business Models to analyze and improve their cost structure as well as their relations to the users, contributors and partners.

4.4.1 Choosing the right Model

Due to evolving markets the research on Business Models is an ongoing process and subject of change, thus there currently exist different ways and applied models to describe a certain Business Model. Gordijn et al. describe this process of development as an evolution of Business Model research, which has been categorized through five phases, as it is illustrated in Figure 17 (Gordijn, Osterwalder, & Pigneur, 2005, p. 2). Although the concepts and fields of research have been changing in the last years, the core components and elements from early stages are still essential parts of modern Business Models,

since currently common models, ontologies and tools are built up on them. Furthermore, many users of these models, adapted them to their very own needs and to new trends in development, technology and customer behavior, which consequently leads to the constant emergence of new ways to represent and describe Business Models. A further aspect that arose within the last years, is the transformation from product oriented Business Models, to service oriented Business Models (Zolnowski & Böhmann, 2011, p. 1). Hence, it can be conducted that this evolution is still an ongoing process, with more different models to come, that will differ in their field of application and complexity.

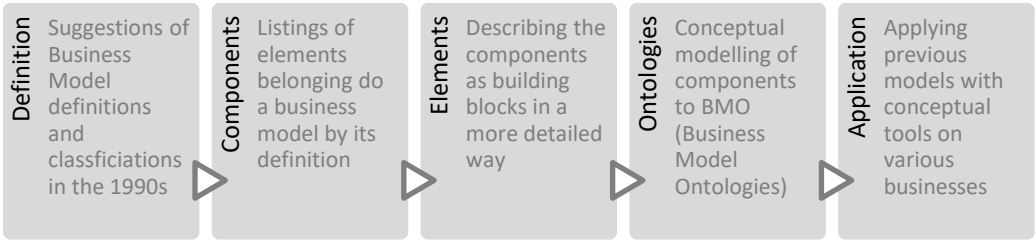

Figure 17 The evolution of Business Model concepts during the past years. Adapted from (Gordijn, Osterwalder, & Pigneur, 2005, p. 3)

Due to this large amount of definitions and structures that have been published within the last years, Table 4 gives an overview of common, different definitions of the elements and accordingly components of Business Models. Although most of the regarded models have been created for a special purpose, which has been labeled, they can be adapted for ICT projects, since these can be characterized to the fields of technology, innovation and competition, which are also of importance when FOSS organizations get considered. As it can be seen in the table, the models differ in various ways, particularly in their level of detail and their number of elements. Even though in modern literature there is no general valid definition for Business Models, many constructs be alike in their characteristics (Nenonen & Storbacka, 2009, p. 5). Notable differences occur in the structure of the defined models and in the ways to describe them. As an example, Osterwalder describes nine building blocks of a Business Model (Osterwalder & Pigneur, 2010), Johnson, Christensen and Kagerman define just four interlocking elements (Johnson, Christensen, & Kagermann, 2008) and Nenonen an Storbacka even minimized it to three components of four dimensions each (Nenonen & Storbacka, 2009). Nevertheless, all of these models are able to represent a certain business from a slightly different view.

Author	*Purpose*	Elements
(Petrovic, Kittl, & Teksten, 2001, p. 3)	*eBusiness*	Value Model Resource Model Production Model Customer Relations Model - Distribution Model - Marketing Model - Service Model Revenue Model Capital Model Market Model
(Chesbrough & Rosenbloom, 2002, p. 533f)	*Innovation*	Value Proposition Market Segment Value Chain Cost Structure and Profit Potential Value Network Competitive Strategy
(Voelpel, Leibold, Tekie, & Von Krogh, 2005, p. 40)	*Competition*	Customer Value Proposition(s) Value Network Configuration (value creation) Sustainable returns
(Johnson, Christensen, & Kagermann, 2008, p. 60f)	*Innovation*	Customer Value Proposition - Target Customer - Jobs to be done - Offerings Profit Formula - Revenue Model - Cost Structure - Margin Model - Resource Velocity Key Resources - Needed to deliver the CVP profitably - e.g. People, Technology, Channels, Partners Key Processes - Make the profitable delivery of the CVP repeat- & scalable - e.g. development, IT, Rules, Norms

(Nenonen & Storbacka, 2009, p. 7)	*Value Co-Creation*	Market - Market & Customer Definition (Design) - Customers & Brands (Resource) - Market & Customer Management (Capability) Offering - Offering Design & Earnings Logic (Design) - Technology (Resource) - Offering Management & R&D (Capability) Operations - Operations Design (Design) - Infrastructure, Suppliers & Partners (Resource) - Sourcing, Production & Delivery (Capability) Management - Management System (Design) - Human & Financial Resources (Resource) - Management & Leadership (Capability)
(Osterwalder A. , 2004, p. 15ff)	*Innovation*	Customer Segments Customer Relationships Channels Value Propositions Key Activities Key Resources Key Partners Cost Structure Revenue Streams
(Zolnowski, Weiß, & Tilo, 2014, p. 720f)	*Services with Co-Creation*	Customers Key Partners For each perspective: - Cost Structure - Key Resources - Key Activities - Value Proposition - Relationship - Channels - Revenue Streams

Table 4 Comparison of included (sub-)elements/components in different Business Models

To find a suitable model for FOSS projects this thesis will try to identify common elements from these listed different approaches by analyzing them in a FOSS context. As mentioned before these models have similarities within their structure, but distinguish in their elements, representation or interpretation. This wide diversity arose from researchers that preferred to create alternative models instead of evolving existing ones (Zolnowski, Weiß, & Tilo, 2014, p. 718). To analyze these differences the findings from the previous sections will get taken into consideration, especially the facts of value co-creation within a highly connected multi actor network and of a comparatively large amount of intangible values that is transferred between the individual actors. Whereas, as an example, Chesbrough and Rosenbloom define the Value Network as a fundamental element of their Business Model, this thesis will provide the Value Network as a pre-stage to the creation of the Business Model. Especially since Value Networks are a central point of analysis due to its consideration of different aspects (Vorraber, 2012, p. 41). The results from constructing and analyzing a Value Network, before drawing a Business Model, can be useful to identify certain elements and helps to gain further knowledge about the involved entities, as the following analysis will show.

Nonetheless there are different components and elements which literate through the various models. Worth mentioning at this point is the characterization of (target-) customers, since their influence on a Business Model is crucial. To be profitable any business must define the customers it wants to reach and therefore decide which segments of customers shall be served and which ones ignored (Osterwalder & Pigneur, 2010, p. 20). The customer component of a Business Model can either be one belonging directly into the Business Model or one indirectly specified by the Value Proposition or market segment. However, it has to be taken care of the fact that different customers may have different reasons why a certain product creates value for them, like reducing costs or creating new possibilities and solutions (Chesbrough & Rosenbloom, 2002, p. 534). Thus, a Business Model must reflect the different customer segments and groups it serves (Osterwalder & Pigneur, 2010, p. 20). In the field of FOSS this is of importance when different actors are identified within the community, such as developer or supporters, as it is the case in the Catrobat Project. Hence a major task is to portray the users (customers) and to gain detailed knowledge about them, as it has been highlighted in the previous chapters. In addition to that, there can occur some key partners or stakeholders, that carry different important roles for the Value Network and thus the Business Model. So, it can be reasoned, that the creation and analysis of the Value Network, its entities and the captured value creation process they're involved in, has benefits when it comes to modeling a business.

This benefit can also be related to the common definition of external connections within a Business Model. As already identified by Nenonen and Storbacka in their research, Business Models should examine an external view, that represents connections to entities within the network (Nenonen & Storbacka, 2009, p. 4). Already early definitions, such as from Petrovic, Kittl and Teksten, mention the inclusion of the relevant environment in which the business operates (Petrovic, Kittl, & Teksten, 2001, p. 3). Whether as market, stakeholders or partners, most Business Model constructs represent these external connections within their definition for a Business Model. The analysis of Value Networks in the forgoing chapters has already laid out the complex connections that can occur through the value creation and capturing process, which indeed is relevant for a Business Model. Hence, it is especially important when it comes to co-creation and the representation of services, that these multiple actors get illustrated by a Business Model definition (Zolnowski, Semmann, & Böhmann, 2011, p. 10). In particular, due to the dynamic and manifold composition of the Value Networks of FOSS projects this characteristic is an essential point that has to be included in the representation of a FOSS project through a Business Model.

Another aspect that appears at FOSS, and respectively non-profit organizations, is the equivalent small amount of costs and revenues. Whereas some models, such as from Johnson, Christensen and Kagermann, provide detailed formulas and explanations for the representation of the revenues and costs, for projects driven by technicians and volunteers, who haven't considered these aspects in detail till now, more simplified approaches are recommendable. Especially the graphical canvas approach by Osterwalder and Pigneur allows a simple representation of these streams, irrespective of a detailed knowledge of it in advance (Osterwalder & Pigneur, 2010, p. 15ff).

Besides the consideration of the elements, the mentioned representation of a Business Model can also be named as criteria for the selection of a model. Whereas many, especially early, models get along with ordinary written descriptions, currently arising models are also focusing on the visualization of them. The already mentioned and introduced Business Model Canvas (BMC) is a good example of this trend. In addition to this advantage, it also pays attention to the specified common elements, based on a strong customer focus. Hence, this approach allows a simple, but also significant, view on the organization of FOSS projects. Although this concept seems to perfectly fit the characteristics of FOSS projects, the next section will show how a modified version of it, in detail the Service Business Model Canvas (SBMC), can even create a deeper insight into the mentioned aspects of FOSS Business Models.

4.4.2 Combining different aspects within a Business Model

Whereas the benefits of using different Service Design tools for modelling a business, on basis of its value processes, have already been shown, several of the listed Business Models can partly be derived from these existing outcomes. As already mentioned, this section will especially point out the benefits of the SBMC in comparison to the BMC when it comes to complex multi-actor networks, since these had an essential impact on this thesis.

Since the created overall value of a Business Model can be described as sum of value that is created for all business stakeholders (customers, suppliers and partners) (Zott & Amit, 2007, p. 183), there exists a notable overlap to the Value Network, which represents the influence of these third parties on the corresponding value creation and capturing process (Chesbrough, 2006, p. 68). Whereas most models just pay attention to a small number of roles that are fundamental for the value creation and capturing, the Service Business Model Canvas by Zolnowski, Weiß and Böhmann splits the Business Model into three perspectives, which are each divisible by itself. The problem that led to this construct, is that current models don't respect the connections each involved actor has to the single elements of the Business Model. That results in a miss of representing the contribution of the various actors to a Business Model (Zolnowski & Böhmann, 2011, p. 6). As Zott and Amit highlight, a Business Model shows the linkage to the stakeholders and especially how value is created for all these partners (Zott & Amit, 2007, p. 181f). Hence there originates the need of designing the Business Model in a way that represents these transactions between the involved stakeholders. The commonly used Business Model Canvas by Osterwalder and Pigneur already describes the occurrence of several different customer segments that interact with each other, that create value through these interactions, and are interdependent from one another, as so called multi-sided platforms, just as visualized in Figure 18 (Osterwalder & Pigneur, 2010, p. 75ff). However, this co-created value creation and furthermore the dependencies between the actors, beside the customer – business relation, currently can neither be represented properly with the BMC nor through other common models (Zolnowski, Semmann, & Böhmann, 2011, p. 5). As pointed out in the illustrated multi-sided platform pattern of the BMC, the actual value contribution of partners, as well as the value created by the customer segments itself, are unconsidered since the left, so called efficiency related, side of the canvas is just dealing with attributes that serve the value creation for the actual customers by the business itself.

<table>
<tr><td rowspan="6">KP</td><td rowspan="3">KA</td><td rowspan="2">VP 1</td><td>CR 1</td><td rowspan="2">CS 1</td></tr>
<tr><td>CR 2</td></tr>
<tr><td rowspan="2">VP 2</td><td>CR 3</td><td rowspan="2">CS 2</td></tr>
<tr><td>CR ..</td></tr>
<tr><td rowspan="3">KR</td><td rowspan="2">VP 2</td><td>CH 1</td><td rowspan="2">CS 3</td></tr>
<tr><td>CH2</td></tr>
<tr><td rowspan="2">VP ..</td><td>CH 3</td><td rowspan="2">CS ..</td></tr>
<tr><td>CH ..</td></tr>
<tr><td colspan="3" rowspan="4">C$</td><td colspan="2">R$ 1</td></tr>
<tr><td colspan="2">R$ 2</td></tr>
<tr><td colspan="2">R$ 3</td></tr>
<tr><td colspan="2">R$ ..</td></tr>
</table>

Figure 18 Multi-sided platform of the Business Model Canvas, representing several different customer segments

A Business Model defined by the BMC is capable to illustrate the comparable easy relation to the customers, but further Business Models presented by this canvas could also be used to present all occurring value creation and capturing processes within a Value Network. Therefore, for each relation within the Value Network, a BMC would have to be used to describe the business from these points of view. Nevertheless, as the upcoming representation of Catrobat as Business Model will prove, one BMC can't cover the complete value creation and capturing happing in such a complex connected network. In contrast to the BMC, the Service Business Model Canvas pays attention to these multiple connected actors within the Value Network. Instead of evoking a total new construct, Zolnowski et al. reuse the advantages of the BMC by using its nine building blocks, what preserves the ease of use as well as a clear and intuitive representation of the BMC (Zolnowski, Weiß, & Tilo, 2014, p. 726). Nevertheless, the described disadvantages of the BMC regarding multi-sided platforms, get encountered by adding three different perspectives, in detail a customer, a company and a partner perspective, that are capable to clarify the whole value processes within the business. The illustrated SBMC in Figure 19 points out the differences to the BMC, especially when a Value Network is taken into consideration as initial point for the different perspectives of the Business Model.

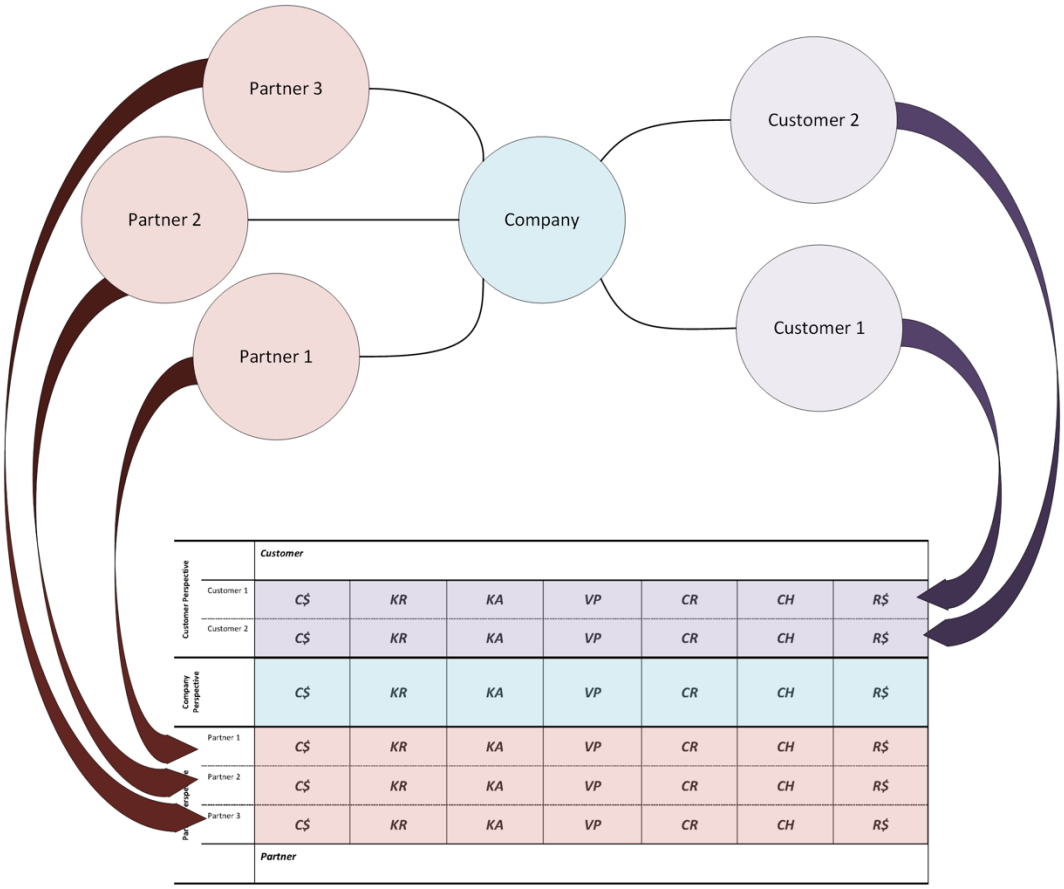

Figure 19 Representing all main actors of a Value Network within one SBMC

As already described in the chapter "Specifying the User-Entities", each of these considered actors has unique characteristics and attributes. Thus, also the related building blocks of a Business Model are varying by the viewpoint that is used. As shown in the figure, for a holistic examination of the Business Model, this circumstance demands that the building blocks are considered for each actor individually. The perspectives of the SBMC can simply be split up into several views that get respected, which consequently pays attention to the characteristics of this highly connected, complex and co-creative network.

Whereas the actors (partner and customer segments) involved in the Business Model are clearly identifiable by the already applied tools, there is just a rough specification of them in the header and footer of this canvas. Although more information is probably available to describe them, it is not captured in the SBMC. Nevertheless, the original building blocks of the BMC, which are used to

describe each actor individually, take use of this available data in a certain aspect. Especially the Value Proposition is considered for each actor independently, representing each actor's unique created value and benefit. Hence, it is necessary to create a Value Proposition for each identified segment, to spot this benefit in respect to its individual jobs, needs and gains. This is of importance, since some Business Models need a combination of different Value Propositions to gain a working Business Model that captures an overall value (Osterwalder A. , Pigneur, Bernarda, & Smith, 2014, p. 52f). Important to point out here is the aspect of co-creation through the users. So called prosumers are not only consuming services, they're also producing a certain input to them. Recapturing the possible floating shifting of users to developers in Open Source projects, this can be seen as a fundamental attribute that a Business Model for FOSS projects needs to capture. Especially Catrobat can benefit from this approach, since even the users are engaged within the services by contributing their own projects, created through Pocket Code, to the community and share their knowledge with other users, what backs the principles of fostering learning and open data.

4.4.3 Modelling Catrobat as FOSS project

One of the most common approaches to illustrate a Business Model is currently the BMC. But, as explicated before, this construct is not able to represent all value processes, especially when co-creation is involved. To draw a comparison, Figure 20 shows the BMC applied on the Catrobat Project. As it can be seen, this customer, or respectively user, oriented view of the Business Model is neither capturing the revenue streams of the project, which are mostly created through key partners without a direct relation to the user segments, nor the prosumer aspects of the users. The value that is created by these producing user segments, in the meaning of building an open community and user base, which is indeed essential for this FOSS project, isn't also picked up by the represented BMC at all. This practical example aligns with the theoretical findings of the sections above. The BMC allows an easy and fast possibility to represent simple business structures, however, it weakens when it comes to multi-sided networks as they can be found in modern ICT organizations that rely on value that is created, transformed and delivered by several actors.

<table>
<tr>
<td rowspan="2">Key Partners
- TU Graz
- Partners
- Sponsors</td>
<td>Key Activities
- Coordination (PL, CO)
- Service Provision (PL)
- Management (PL)
- Promotion (PL)
- Development (CO)</td>
<td rowspan="2">Value Proposition
- Personal Games (PU, EU)
- Fun Factor (PU)
- Exchange with others (PU)
- Reputation/Good Will (EU)
- Personal Benefit (EU)</td>
<td>Customer Relationships
- Co-Creation (PU, EU)
- Community (PU, EU)
- Self-service (PU, EU)
- Personal assistance (PU, EU)</td>
<td rowspan="2">Customer Segments
- Passive Users (PU)
- Expert Users (EU)</td>
</tr>
<tr>
<td>Key Resources
- User Base (PL)
- Infrastructure (PL, CO)
- Partner Network (PL)
- Dev. Environment (CO)</td>
<td>Customer Channels
- App (PU, EU)
- Online Platform (PU, EU)
- Social Media (PU, EU)
- Mailing Lists (PU, EU)
- E-Mail (EU)</td>
</tr>
<tr>
<td colspan="3">Cost Structure
- Development Hardware and Software
- Channels for community and service provision
- Infrastructure</td>
<td colspan="2">Revenue
/</td>
</tr>
</table>

Figure 20 Representing Catrobat's multi-sided Business Model by Osterwalder's BMC, presenting the project (PL), contirbutors (CO), passive users (PU), and expert users (EU)

As already described, FOSS projects are generally dependent on the existence of contributors, users and some organizational partners. Whereas most Business Models, as proved before, just represent one role in detail, the suggested Service Business Model Canvas (SBMC) by Zolnowski, Weiß and Böhmann makes it easily possible to combine these different roles within one clear and extendable model. Looking on the analysis of the Value Network and user groups, the perspectives needed to illustrate Catrobat with the SBMC can easily be extracted, as listed in Table 5. For this extraction, it is important to have identified the potential users and partners and declare which of them, or which aggregation of several of them, should get considered. Therefore, also new segments, whose needs haven't been met by yet, could be considered in the model, since new innovations and possibilities could arise from these potential entities (Osterwalder & Pigneur, 2010, p. 129).

Customer Perspective:	*Company Perspective:*	*Partner Perspective:*
• Passive User • Expert User	• Project Lead/Organization • Contributors	• TU Graz • Partners • Sponsors

Table 5 Catrobat's perspectives in meaning of the Service Business Model Canvas

Considering the provided perspectives for Catrobat, the results of the used methodologies for this thesis can now be summarized within one single model. Figure 21 concludes on this Service Business Model that shapes the Catrobat Project with all its facets. Although, compared to the presented BMC, it gained additional complexity through the three differentiated perspectives, it is still easily understandable and interpretable. As defined, this last step of the analysis of the Catrobat Projects, provides a clear overview of who is creating what value and why these values are actually creating a benefit for the entities. Nevertheless, this model can be easily used to communicate these value processes, but, it is not capable of representing all insights and aspects that have been achieved through the research and application of Service Design tools on this FOSS organization.

Depending on the level of detail that needs to be considered, the Service Business Model Canvas can provide a quick overview of the essential components of a business' value creation and capturing processes. But, when it comes to the actual development process of features and services, more detailed and specific views, as they have been the basis for this summary, need to be taken into account. Especially through the trivial representation of the SBMC it's not possible to display all the knowledge about the involved actors and its relationships that has previously been gained. However, to encounter the issues of a missing overall understanding of the project, this tool is perfectly suited to provide a simple, visual model which can even be interpreted without extended knowledge in the domain and the application of such tools.

Customer:

- PU – Passive Users who just use the app and create games
- EU – Expert Users who interact with the community and spread the services in their personal network/community

		Cost Structure	Key Resources	Key Activities	Value proposition	Relationship	Channels	Revenue
Customer Perspective	PU	- Mobile Device - Temporary internet access	- Mobile Device	- Gaming - Game creation - Sharing	- Personal games - fun factor - Exchange with others	- Co-Creation - Community - Self service	- Apps - Online Platform - Social Media - Mailing Lists	/
	EU	- Mobile Device - Internet access	- Tangibles (Mobile Device, Internet access) - Intangibles (Access to community, network)	- Gaming - Game Creation - Community Support/ Exchange - Giving Feedback	- Personal games - Reputation/Good Will - Experience/Expertise - Personal benefit	- Co-Creation - Community - Self service - Personal assistance	- App - Online Platform - Social Media - Mailing Lists - E-Mail	/
Company Perspective	Project Lead	- Dev. Hardware & Software - Channels	- Tangibles (infrastructure) - Intangibles (User Base, Partner Network, Code Base)	- Service Provision - Management - Decision Making - Coordination - Promotion	- Reputation - Identification FOSS movement - Good Will	- Community - Personal assistance	- Confluence - Jira - IRC - E-Mail - Personal meetings - Social Media - Mailing Lists	- public/ private Funding - Awards
	Contributor	- Dev. Hardware & Software	Tangibles (Dev. Environment, Infrastructure)	- Coordination - Development - Support - Service Provision - Community services - Research -Testing	- Personal benefit - Experience/expertise - Personal benefit - Community Identification - Delayed rewards	- Co-Creation - Self-service - Community - Personal assistance	- Confluence - Jira - IRC - E-Mail - Personal meetings - Social Media - Mailing Lists	- non monetary (progress in studies by projects and theses)
Partner Perspective	TU	- Space - Equipment	-Tangibles (Infrastructure, Workforce, students) - Intangibles (Knowledge, Research)	- Promotion - Research	- Support of ICT EDU - Int. Reputation - Research - Innovation	- Personal assistance	- E-Mail - Newsgroups - Lectures - Personal meetings	- public/ private Funding - Awards
	PA	- Workforce	- Tangibles (service, product) - Intangibles (user base, business network)	- connecting own services to Catrobat	- enlargement of potential market for own services/products	- Dedicated personal assistance	- E-Mail - Personal	- revenue through fostering own Business Model
	SP	- Funding - Awards	- Tangibles (Budget for Funding)	- Support of projects	- intangible, individual benefit - reputation	- Dedicated personal assistance	- E-Mail - Personal	/

Key Partners:
TU – Graz University of Technology
PA – Partners who have a benefit for their own services and products by working with Catrobat
SP – Sponsors decide on an intangible basis to support Catrobat without a direct return

Figure 21 Service Business Model Canvas applied on Catrobat

4.5 A summarized guideline to analyze FOSS projects

Although each of these tools can help to gain a deeper understanding of the organization and the structure of a FOSS project, putting them together provides a strong basis to communicate a shared understanding of the project and furthermore it enables the contributors to move together into a common, strategic direction. The co-creative and informal approach of the different tools fostered these aims and also brought up new insights into the users and stakeholders. Even though FOSS projects can be situated in complex and dynamic networks of stakeholders and contributors, visual frameworks and canvases provide a possibility to capture these findings and conclude on a common understanding in an easy to use way. Thus, the methods that have been used for Catrobat, could easily also be used to study other similar Open Source projects. Putting the findings of this analysis process together, Figure 22 portrays the approach that has successfully been used in this thesis for Catrobat Project.

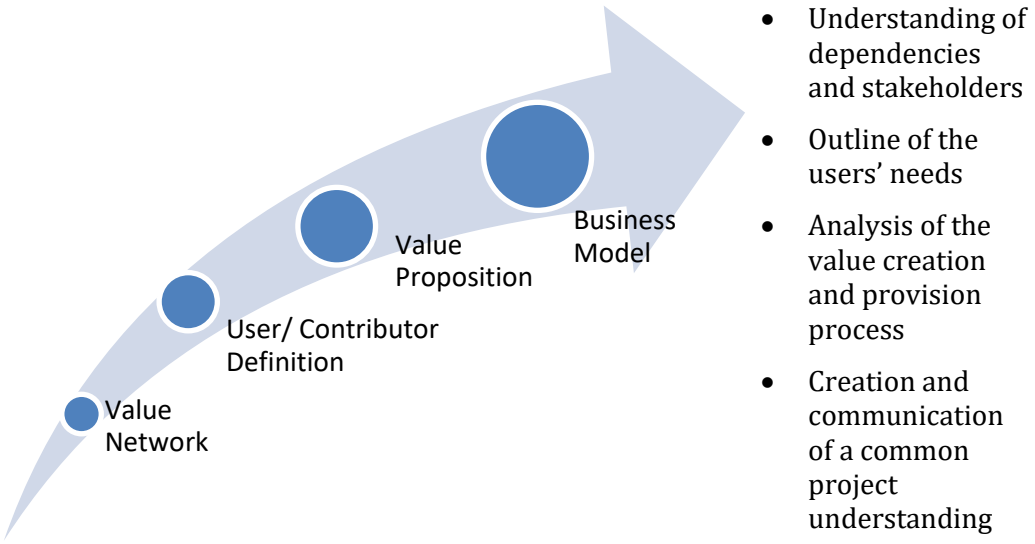

Figure 22 Analyzing Free Open Source projects and taking benefits from the outcomes

Nevertheless, other projects or corporations can also benefit from different models or adapting this rough guideline. As the still growing variety of Business Models shows, there are also different ways to conclude on these mentioned insights. The most important conclusion that can be made from the Catrobat example, is that the general usage of such tools, that consider an external, or respectively different view, on the organization and structure, can unveil facts that haven't been dealt with before at all. A lot of these facts arise from co-creation and the inclusion of different knowledge, backgrounds and experience in the analysis process. Hence, it is recommended to follow this holistic team-work approach and capture the outcomes with visual thinking methods, that can be easily communicated.

Depending on the tasks that need to be achieved and insights that are needed therefore, there is a wide range of tools that can easily be used. Whereas the Business Model created an overview that can get utilized as communication tool, methods such as scenarios, customer journeys or the data detective approach can particularly help to gain precise insights into a specific segment or actor. As it has been described by Stickdorn and proven by this thesis, Service Design provides a toolbox of various techniques that can be combined and used for numerous purposes. Although the previous chapters showed a way to systematically analyze a FOSS project, the tools do not require it to do use them that way. Hence, this referred toolbox approach is preferable, instead of a strict guideline, since different environments and situations will need different processes and methods to gain the information that is desired. As long as the principles of Service Design are followed, it ensures a holistic, actor oriented and meaningful outcome for the project.

5 Lessons learned by analyzing "Catrobat"

As already pointed out through the practical application of the various tools on this project, there has been a useful and innovative outcome from the appliance of Service Design principles on Catrobat. Gaining a deeper understanding of the environment, its special needs, and created values unveiled several potential possibilities to reshape the services of the project to even align better with the actual expectations of the users. As this recapitulation will show, even successful and proper aligned projects, or businesses, can benefit from this holistic approach by considering different perspectives and views.

5.1 Identifying room for improvement

The practical example of Catrobat has proven that these tools do have the power to highlight room for improvement even in already successful and accepted projects. Although the open character of the project already considers, either intentionally or unintentionally, many user related aspects, this consideration can get fostered by the systematic usage of corresponding methods in the future. The dynamic and manifold environment Catrobat is situated in, enables plenty of different possibilities to improve existing services or explore new, innovative offerings based on the individual users' jobs and needs.

Nevertheless, as this thesis has demonstrated, it is essential to share these jobs and needs with all people involved. Creating a common understanding of the served users and participating partners is a fundamental step towards a value and user oriented organization. As the workshop within the project has shown, there is currently a lack of this shared understanding in the project. Based on this existing missing linkage of the provided services to the users' pains and jobs they're encountering, certain important aspects for the users currently just get barley met. Nevertheless, the already existing organizational structure, that also considers the connection to external parties through special teams, is a good basis to communicate this understanding that can be derived from the outcomes of this thesis. Outlining the different roles, types and segments that

have been identified can lead to detect potential issues and bugs earlier, just by considering certain services from the view of the actual user (-segment).

But beside this service oriented aspect, also the important part of the contributors can get improved through the usage of certain Service Design tools. By defining their unique, individual motivations and jobs they try to get done through their contribution, the project can better react on these and thus influence it in a positive way. Especially the university character of the project allows a broad spectrum of possible engagements and ways to respond to their needs to achieve a sustainable long-term contribution of them, that in the end ensures the further success of the project. As this example shows, Catrobat can take advantage of these tools in several areas and enhance its created overall value by the continuous consideration of the previously defined principles of Service Design. Despite the already growing reputation and continuing great achievements of the project, adjusting the offerings, in respect to internal and external actors, can even help to reach the next step on the ladder to success. Creating a co-creative project setting and establishing holistic approaches in the different fields of Catrobat can be a driving factor on the way to innovation and excellence.

5.2 Suggestion of next steps

As the example of Catrobat has shown, recommendations for enhancements of the services can even be found in a successfully growing project. Considering new perspectives always provides new insights that will encourage to rethink certain services and gives the opportunity to react to maybe till now unseen changes in the environment. Hence, the outcomes provide a current viewpoint on the needs of the actors, without rating any existing services and offerings. Putting these already described outcomes of the applied methods together, following suggestions for the project could get considered in the future:

- Introduction of the Value Network to all members, to create a common understanding to whom value is delivered.
- Evaluation of collecting analytical data to gain further details about the different user segments.
- Treating the users as co-developers by engaging them to provide their needs and wants to the project through special channels.

- Communicate the detailed users' jobs and pains that need to get solved through the services, when an implementation task is described. Thus, helping to avoid losing the users' point of view in the development process.
- Analysis of the contributors' motivation and needs with the help of Service Design tools.
- Aligning the development of the different services of the project, with the user side of the Value Proposition.

As previous research, and the outcomes of the organized workshop, have shown, it is essential that all people in the project have a shared understanding who is exactly part of the value process, either as producer or consumer. This shared understanding supports a user-centered approach to create and deliver services the consumers can gain a benefit of. The presented tools provide a basis on that this communication can get funded, however, the introduction of the outcomes to the members is the currently most essential part that leads to services that meet the users' needs. Hence, most of these listed recommendations are connected to enhance the communication within the project, aiming to create a commonly shared holistic view on the network the project is placed in, and the members that are acting in it.

As described earlier, the introduced tools and principles do have a large range of application. Hence, even if this thesis maybe disregarded fields and areas of the project, Service Design can also be evaluated to those fields, to help to align the services and offerings to the users, contributors, and partners. Especially as answer to the continuously changing environment due to emerging technologies and innovations, Catrobat could be positively effected if considering these principles in its project culture. Furthermore, since through the Open Source character of the project already similar concepts are regarded, expanding them by these principles should be respectively simple. Although Catrobat, as well as probably most other FOSS projects, are not directly missing the needs of the users, considering the Service Design approaches could help to precisely meet them. Through the community driven character, Open Source projects are solely developing software that meets the needs, at least of a certain user segment, but considering this development in a wider sense, also taking other segments and actors into account, would even allow to reach a broader audience and enhance the experience the users are gaining.

6 Conclusion

The idea of Service Design Thinking, as new approach to regard services and its providers, represents an elemental new and innovative way to adjust the provided offerings to the actual recipients of these services. By considering a holistic point of view on the whole environment that shapes these services, helps to discover dependencies and also possibilities to make the most out of the underlying value process. Whereas this field brings up several different methods that can easily be adopted to a special situation, the practical part of this thesis showed that already internalizing the common principles of a user-centered, holistic and co-creative maxim helps to improve services and the connected value exchanges. Adopting the way of thinking, that is used for the development of services, by considering further aspects, insights, and furthermore complex dependencies, can be key role when it comes to being successful. Especially because of emerging new innovations and technologies, the way consumers are nowadays experiencing services and products changes tremendously. Whereas in previous times just the fulfillment of certain jobs had to be met, this thesis showed that further, subjective aspects nowadays need to get considered to successfully launch a service that customers want. Responding to their individual pains and gains, providing them a unique journey through the service, and particularly differentiating between them on base of their unique characteristics got fundamental tasks for every business.

Applying these principles on Catrobat showed that there are many currently undetected aspects that do have influence on the project and its success. The complex dependencies and especially the occurrence of many different entities, with individual characteristics, make it difficult to identify and react to the requirements that are implicitly made on the project. However, the relevant organized workshop and the proposed next steps show that Service Design potentially has the power to provide solutions therefore and highlight necessary changes that respond to these circumstances. Enhancing a culture of Service Design thinking supports all these processes and creates various benefits for the project. By promoting a consistent understanding of the project, its actors, and the value that is created, all involved people get the chance to actively participate in the value processes and to gain a net-benefit out of it. Especially users can, if their personal needs are met, contribute value to the project that in the long will support projects to grow and sustainably being successful. Thus, introducing the presented methods and principles allow to better understand the processes within an organization and how to design and control them to gain the most benefit out of it.

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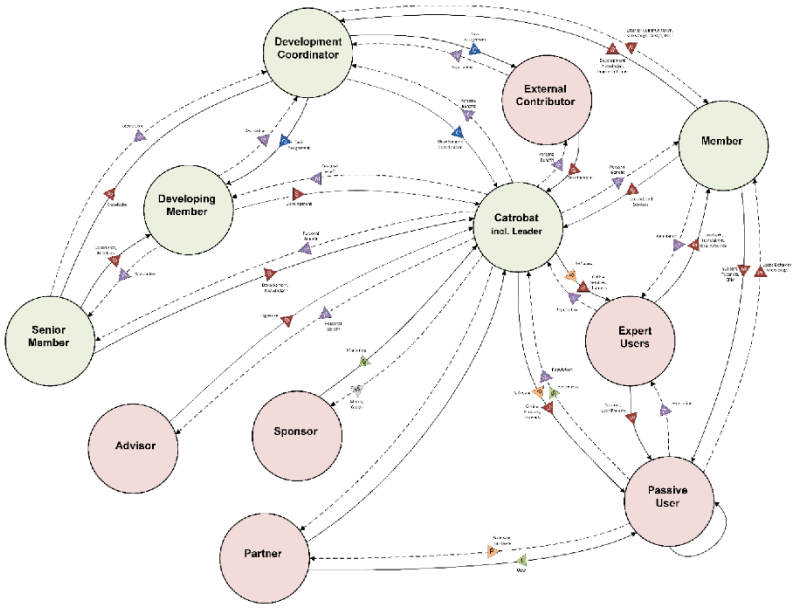
8 Appendix A

Survey that has been used for the rating of the Value Network:

Stakeholders involved in Catrobat



How would you rate the importance of the actors for the existence of Catrobat?

	Not mandatory	*Good to have but no big impact*	*undecided*	*Important, but replaceable*	*Essential for the project*
Catrobat (Project Structure = Project Head, Assistants,...)	○	○	○	○	○
Developing Coordinator (Catroid, iOS, Web,...)	○	○	○	○	○
Developing Members (TU-related, Teammembers)	○	○	○	○	○
Senior Developing Members (active Alumni)	○	○	○	○	○
Members (non-coding, TU-related: UX, EDU, Design,..)	○	○	○	○	○
External Contributors (e.g. external GSoC Students)	○	○	○	○	○
Expert Users (e.g. Teachers or coaches who do workshops)	○	○	○	○	○
Partners (also provide a benefit for users – e.g. Phiro or Samsung)	○	○	○	○	○
Sponsors (support the project without user contact – e.g. Google)	○	○	○	○	○
Advisors (people who advise the project in certain fields)	○	○	○	○	○
User	○	○	○	○	○

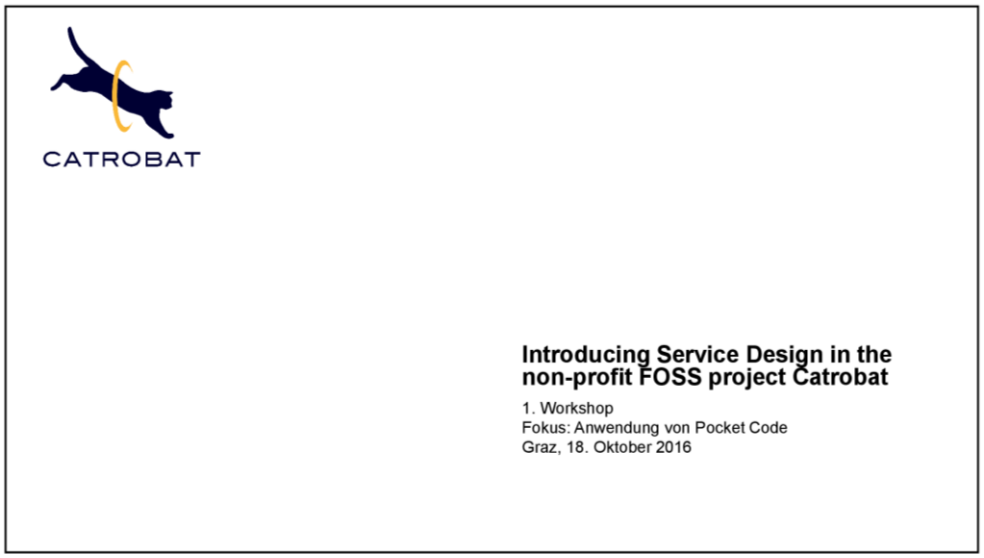
9 Appendix B

Rating Matrix used for the implementation of the weighted PageRank:

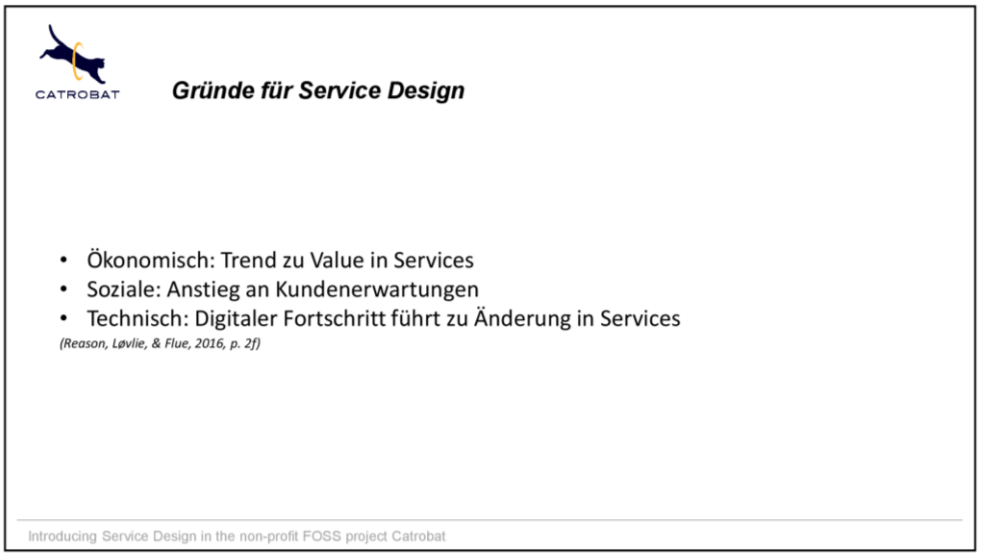
From/To	Catrobat	Member	Development Coordinator	Senior Member	Developing Member	External Contributor	Advisor	Sponsor	Partner	Expert User	Passive User
Catrobat		5		5	5		3	4	15	20	35
Member	60			5						10	25
Development Coordinator	80	5			5	5	5				
Senior Member	70			10		20					
Developing Member	80			10	10						
External Contributor	95			5							
Advisor	100										
Sponsor	100										
Partner	70										30
Expert User	50	10									40
Passive User	30	5							5	10	50

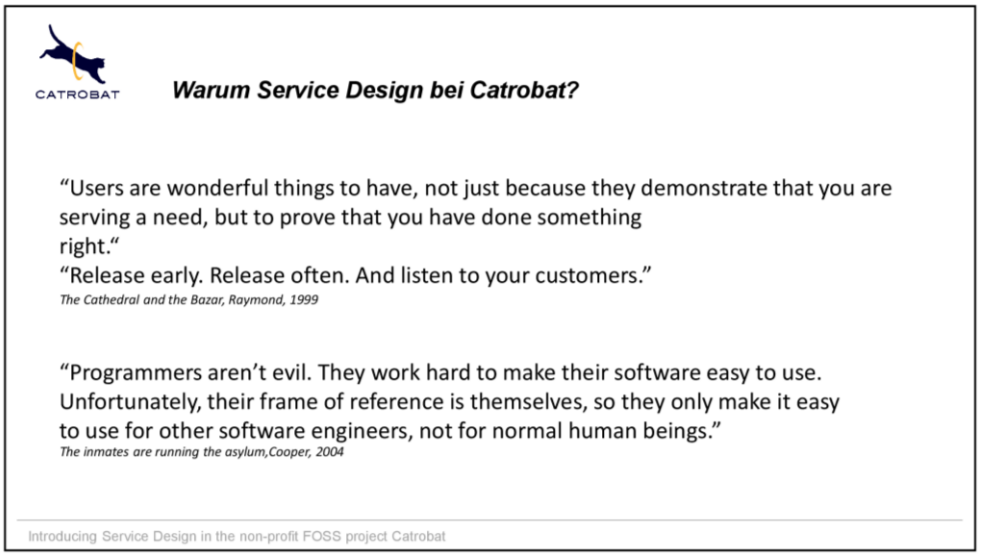
10 Appendix C

Service Design Workshop materials used for Catrobat (german):

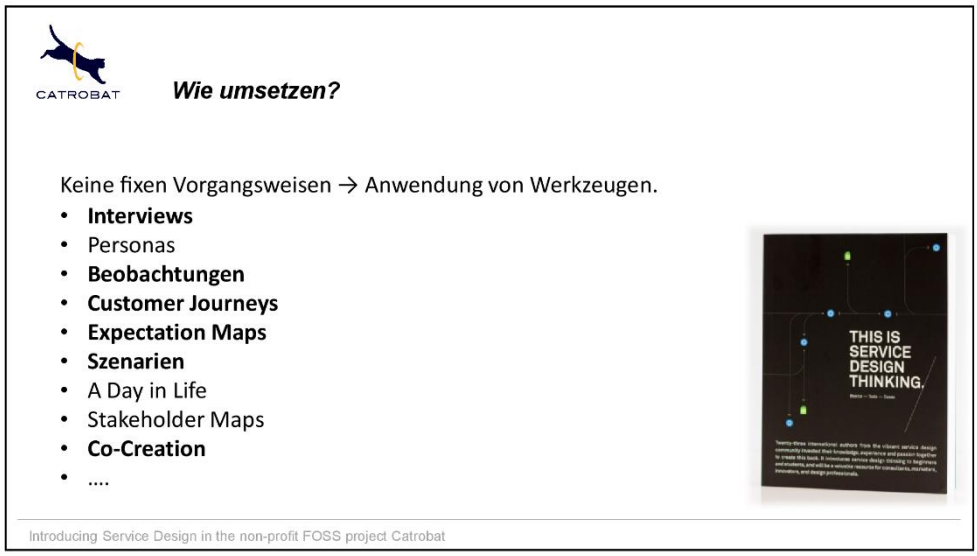


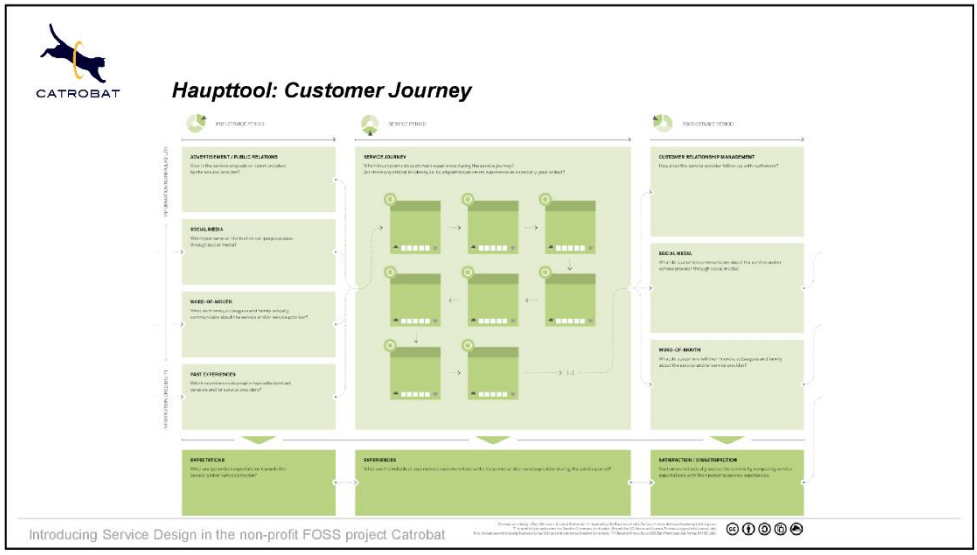
Appendix C


CATROBAT
Gründe für Service Design
• Ökonomisch: Trend zu Value in Services
• Soziale: Anstieg an Kundenerwartungen
• Technisch: Digitaler Fortschritt führt zu Änderung in Services
(Reason, Løvlie, & Flue, 2016, p. 2f)
Introducing Service Design in the non-profit FOSS project Catrobat

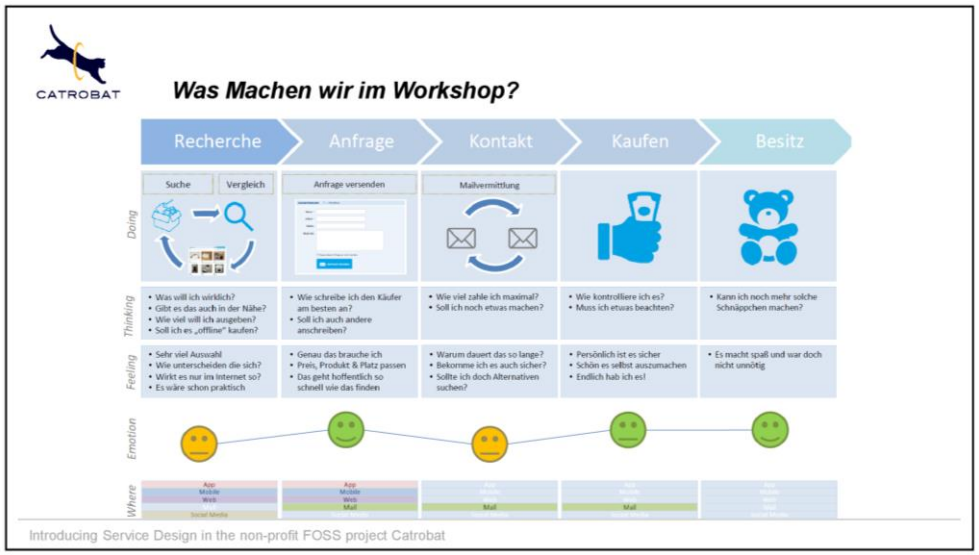

CATROBAT
Warum Service Design bei Catrobat?
"Users are wonderful things to have, not just because they demonstrate that you are serving a need, but to prove that you have done something right."
"Release early. Release often. And listen to your customers."
The Cathedral and the Bazar, Raymond, 1999
"Programmers aren't evil. They work hard to make their software easy to use. Unfortunately, their frame of reference is themselves, so they only make it easy to use for other software engineers, not for normal human beings."
The inmates are running the asylum,Cooper, 2004
Introducing Service Design in the non-profit FOSS project Catrobat

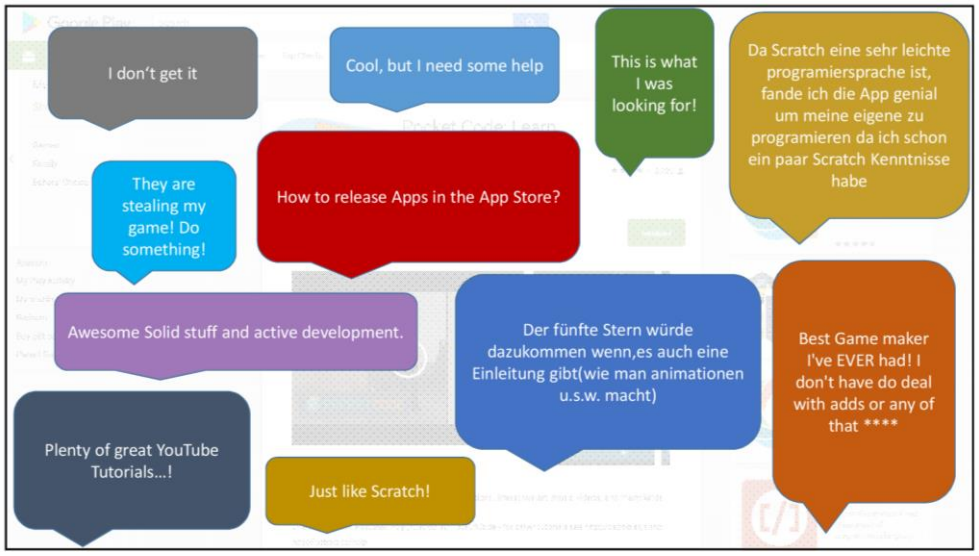
Appendix C


CATROBAT
Wie umsetzen?
Keine fixen Vorgangsweisen → Anwendung von Werkzeugen.
• Interviews
• Personas
• Beobachtungen
• Customer Journeys
• Expectation Maps
• Szenarien
• A Day in Life
• Stakeholder Maps
• Co-Creation
• ....
THIS IS SERVICE DESIGN THINKING.
Introducing Service Design in the non-profit FOSS project Catrobat

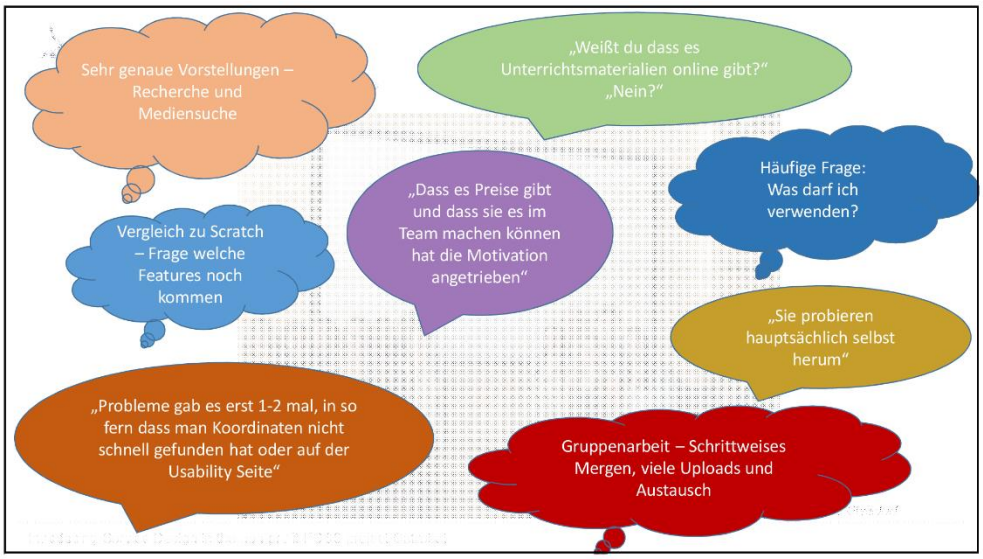

CATROBAT
Haupttool: Customer Journey
Introducing Service Design in the non-profit FOSS project Catrobat

Appendix C


CATROBAT
Was Machen wir im Workshop?
Recherche
Anfrage
Kontakt
Kaufen
Besitz
Suche
Vergleich
Anfrage versenden
Mailvermittlung
Doing
Thinking
Feeling
Emotion
Where
Introducing Service Design in the non-profit FOSS project Catrobat


I don't get it
Cool, but I need some help
This is what I was looking for!
Da Scratch eine sehr leichte programiersprache ist, fande ich die App genial um meine eigene zu programieren da ich schon ein paar Scratch Kenntnisse habe
They are stealing my game! Do something!
How to release Apps in the App Store?
Awesome Solid stuff and active development.
Der fünfte Stern würde dazukommen wenn,es auch eine Einleitung gibt(wie man animationen u.s.w. macht)
Best Game maker I've EVER had! I don't have do deal with adds or any of that ****
Plenty of great YouTube Tutorials...!
Just like Scratch!

Appendix C



CATROBAT

Szenarien:

Ein Lehrer der von Pocket Code in einem Zeitungsartikel gelesen hat und dieses in der Schule einsetzen möchte.

Ein Teenager-Mädchen das bereits Scratch programmiert hat und im Play Store nach Scratch am Smartphone sucht um ihre eigenen Animationen zu erstellen

Introducing Service Design in the non-profit FOSS project Catrobat