# Online platform challenges – developing a viable business model

**Masterarbeit**

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## Abstract

The goal of this paper is to develop a business model recommendation for the Rattler platform, an initiative as part of the OpenAdaptronik project by the Fraunhofer Institute, offering various services and software for analysis of vibration data. The literature review part of the paper examines the underlying theory of business models in general as well as the specific characteristics of online platforms and open source software, both being fundaments of the Rattler platform. The Lean Canvas captures key findings of interviews conducted with project stakeholders and company representatives from the industry in order to better understand the platform's offerings, user needs and the right direction to take in order to make the platform successful.

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# List of abbreviations

| | |
|---|---|
| B2C | Business-to-customer |
| B2B | Business-to-business |
| API | Application programming interface |
| BMI | Business model innovation |
| KPI | Key performance indicator |

# 1 Introduction

Developing a viable business model for a new product or service is a complex challenge. One has to consider many aspects not only related to the solution itself but the environment and market in which the product shall launch. Questions arise regarding key functionality, target user groups, marketing activities and maybe most importantly, costs and revenue sources. Various special characteristics, like being based on open-source software, can introduce further angles the business model has to be examined from.

The goal of this paper is to develop a business model recommendation for the Rattler platform, an initiative as part of the OpenAdaptronik project, offering various services and software for analysis of vibration data. The project, called to life by the Fraunhofer Institute for Structural Durability and System Reliability LBF, headquartered in Darmstadt, Germany, created a new online service hosting a number of analytical free-to-use and open-source tools for individuals and professionals to measure, analyze and evaluate vibration related data. In this paper, two business model recommendations are developed based on the key findings in the scientific literature and interviews conducted with different project stakeholders and industry representatives.

In the first chapter, the paper gives an overview of the research method used in the paper and the OpenAdaptronik project itself underlining its key characteristics which influence the business model creation process. This is followed by a systematic literature review with the aim of covering all important aspects of the state-of-the-art business model literature, with special focus on online platforms, their main attributes and considerations.

Furthermore, characteristics and opportunities of open source software are examined to gain a better understanding of underlying concepts and discover its opportunities for the OpenAdaptronik project. All three aforementioned topics build key pillars of the platform itself hence there is a strong need to combine findings from all the respective fields to find a fitting model for the platform.

Finally, business model recommendations are developed along the dimensions of the Lean Canvas, a one-page business model template tool. Five interviews are conducted with stakeholders and representatives from the industry to shed light onto customer needs, desired product characteristics as well as possible revenue streams. The paper also discusses further research opportunities and limitations and gives an outlook on potential managerial fields to explore in order to further specify the platform's offerings and the underlying operational and business models.

## 1.1 OpenAdaptronik and Rattler platform overview

OpenAdaptronik is a project with aim at the maker movement providing active systems for vibration reduction in the field of photonics. The goal is to increase the accessibility of tools for image stabilization and vibration isolation for a broader user base, as these tools are usually only available for professionals and larger companies for a high price on the market. The project therefore intends to provide solutions as an alternative to these pricy industrial tools.


Figure 1: Official logo of the OpenAdaptronik project

The project started in April 2016 with support of the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung) and the team grew to a total of 17 members not including makers and enthusiasts supporting the initiative from regional universities like the Technical University Darmstadt in the recent years. Regular meetings and events provide a forum for exchange and alignment of project goals, milestones and main direction for future actions. The project's homepage also hosts a blog delivering updates on the projects and interesting news from related fields.

The Rattler platform is part of the OpenAdaptronik project. It started as a brief idea answering the question of how to gather huge amount of real vibration-related data from different sources. It is currently evolving into a more complex set of software that enables users not only to upload and store their vibration-related data but also provides tools and analytical software to visualize and evaluate the information hidden in the data. The online tools help to understand the causes of the vibration-related problems and give actionable recommendations to reduce vibration.

The set of tools is provided under open-source license and is available for anyone registered on the platform for free. An open application programming interface (API) is being developed to ensure flexibility and modular expandability. Users can take advantage of the open-source nature of the tools as they can modify, improve and tailor the code to their own needs. The API also allows developers and enthusiasts to connect external services and analytical software to the platform further extending its capabilities. All these tools supposed to support

real-life scenarios including but not limited to physical image stabilization, fault detection in machines or even enabling predictive maintenance.

The experience and expertise gained through the project and the application of the software shall result in an extensive knowledge base, also available to professional, scientists, students as well as hobbyists, tinkerers and makers. This combined with the platform's capabilities has the potential to support exchange between Fraunhofer, potential clients and solution providers benefiting every group participating in the ecosystem.

## 1.2 Research method

First, in order to gain a fundamental understanding of business models and the underlying state-of-the-art theory, a literature analysis was conducted which forges the main part of this paper. A detailed overview of the review method and process is presented in Chapter 2.

Second, interviews were conducted in order to gain insight into the project itself as well as into the needs of companies active in related industries. The interview consisted of six questions described in Chapter 3.1.

Finally, the key findings from the interviews were captured using the building blocks of the Lean Canvas developed by Ash Maurya based on Alexander Osterwalder's Business Model Canvas. The purpose of the canvas and a detailed description can be found in Chapter 2.5.

# 2 Literature review

In the following chapter acting as the main part of this paper, a literature review is conducted. It builds on the key principles of a scientific literature review process highlighted by Vom Brocke et al (2009) and Webster et al (2002). A central coverage level was applied covering the literature related to the topics mentioned below. The review process is described in detail in Chapter 2.1.

## 2.1 Review process

The review follows a threefold purpose each derived from the characteristics of the Rattler platform in question. Goal is to understand the underlying scientific theory and gain a better understanding of tree main areas:

1. Business models in general
2. Online platforms
3. Open source software

In order to find relevant research papers related to the topics, six popular online scientific databases were accessed and searched, as following:

1. ScienceDirect
2. Elsevier
3. EBSCOhost
4. JSTOR
5. SpringerLink
6. Google Scholar

Each database was searched by using key phrases and search terms related to the three aforementioned topics. The exact list of keywords can be found in the following Table 1. A total of 14 search terms were used to identify as many relevant publications as possible.

Table 1: Search terms used in the literature review

| | Topic | Search terms |
|---|---|---|
| 1 | Business models | business model, business model generation, business model creation, business model attributes, business model development, online business model, business model innovation |
| 2 | Online platforms | online platform, platform business model, online platform business model |
| 3 | Open source software | open source software, open source business model, open source software model, open source revenue |

While sampling the search results, the keywords and abstracts of papers were manually scanned in order to filter the papers related to the aforementioned topics. Further connecting papers, reviews and book chapters were identified through scanning the reference lists of the search results.

Finally, the entire text of relevant papers and book chapters were read. Key findings and pieces of information were synthesized in the following chapters to gain an overview of the tree areas.

Figure 2 below gives a visual overview of the search, filter and knowledge synthesis process.

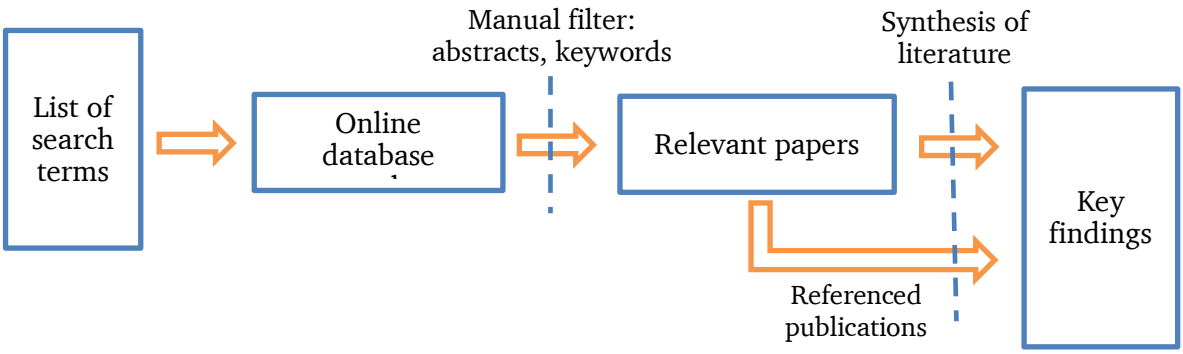


Figure 2: Overview of the literature review process (by the author)

## 2.2 Definitions of business models and their elements

In general, a business model refers to the process through which a company captures, creates and delivers value to its customers. (Teece, 2018) It is not limited to describing costs, revenues and profits but also includes the way of utilizing knowhow, assets and technology and interaction with the firm's environment and customers. All these elements have to be aligned with each other as well as with the internal organization of the company in order to be able to create real value for the customers. (Ritter, 2014)

We can find two main approaches on how to characterize a business model in the existing literature. The first discourse connected to the works of Drucker (1954) focuses on the operation of a business and how a company creates value for its customers. The author describes business models mainly by articulating their main elements and goals by answering questions like "Who is the customer?", "What is value to the customer?" and stating that "The purpose of a business is to create a customer" (Drucker 1954) (furthermore, see Figure 3). He summarizes the essential elements as customers, value propositions, product and service offerings, and mechanisms of value creation and appropriation stating that "a business is created when a firm matches its product/service offering to a set of customers." (Fjeldstad and Snow, 2018)

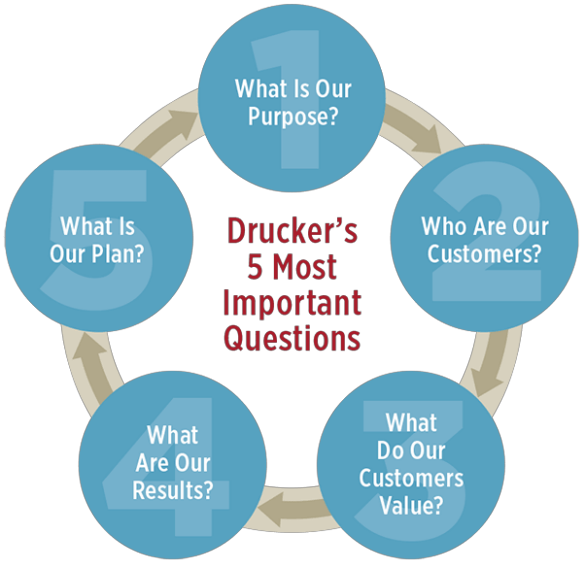


Figure 3: Drucker's five questions to characterize a business model

The second discourse based on Forrester's work (1958) describes a company model which is "a general theoretical statement linking the elements of a business model to organizational processes". (Fjeldstad and Snow, 2018) The theory also states that the company's success depends on its capabilities to dynamically adjust the operations and functions of the firm maximizing the value gained from their relationships.

### 2.2.1 Operational and dynamic dimensions

Another important attribute of business models can be reviewed along two further dimensions: the operational and dynamic dimensions. The first refers to value creation by maximizing efficiency in ways of transacting and exploiting lock-in effects from network externalities. (Amit and Zott, 2001) The theory aligns well with the main elements in Drucker's model such as customers, resources and internal relationship between the firm's activities.

The latter dynamic dimension describes, however, how a company changes and adapts over time. One of the main theoretical foundation is organizational adaptation depicted as an adaptive cycle (Miles and Snow 1978) of problem-solving regarding product positioning, activities and resource setup and administrative problems. The company changes the elements of its business model over time to overcome the challenges and problems it is facing due to changed external and internal variables. (Fjeldstad and Snow, 2018)

### 2.2.2 Value configuration

Value plays a central role in all of the theories described above. Prahalad (2014) emphasizes the importance of the value configuration in a firm as well. Value configurations outline the activities to deliver value and create competitive advantage.

However, there are different options for a company how to achieve this value. One of them is creating a value chain which transforms inputs into products. Classic examples are manufacturing firms where scale, capacity and utilization are important factors for efficiency. (Porter, 1985)

Another possibility is a "value shop" (Christensen et al., 2008, 2013) which focuses on customer problems on a case-by-case basis resulting in high customizability of products and services provided for the customer.

The third option is to set up value networks that link customers, things and places in order to provide the required service allowing exchange between the nodes of the network. Most well-known examples are various financial services, transportation solutions and numerous internet businesses.

Business model researchers Fjeldstad et al outline four key practical implications that should be considered when creating new or adjusting existing business models (Fjeldstad et al, 2017):

1. "Understand how value is created in your firm." Value configuration has an effect on every element of the company's business model therefore should be aligned with organizational design as well.
2. "Have a plan for changing your business model." Successful companies are capable of adjusting their business models according to the environmental changes.
3. "Know how collaboration fits into your firm's business model." The importance of collaboration within and across organizations is becoming more and more important when it comes to developing new business models.
4. "Anticipate the future of your firm's business model." Entrepreneurs and companies should keep an eye out on recent market trends identifying potential disruptors as early as possible in order to prepare required alignments in the organizational structure and business model setup.

Ries (2011) also articulates the importance of being able to pivot and change the elements of a business model in order to react to changes in the market environment. This particularly applies to internet-based business models where the channels provided by the network can rapidly deliver feedback about products and services. (Teece, 2018)

### 2.2.3 Business model innovation

Business model innovation (BMI) has been becoming more and more a central part in management theory in recent years (Geissdoerfer et al, 2018). The theory of business model innovation is concerned with the intersection of business models and new, innovative products. A new innovative idea alone does not necessary translate into a successful product on the market, it is the fitting business model behind that enables full potential and connects the product to the market. Therefore, new business model configurations might be necessary. (Massa and Tucci, 2013) Successful and innovative models can generate competitive advantages for the firm and is "seen as a source for superior organizational performance" (Geissdoerfer et al, 2018).

Business model innovation can support organizations to seize new opportunities (Johnson, 2010) by:

1. supporting the development of new value propositions for unmet customer needs
2. dealing with new customer segments that have been neglected before
3. enabling companies to enter new industries

Osterwalder and Pigneur (2010) also write about the opportunities of new business models that enables the serving of completely new customers. Products and services can be extended to those who had no access to similar solutions because of financial or even geographical reasons or found the products too complicated to use.

Massa and Tucci (2013) also emphasizes the importance of business model innovation in later phases of the market lifecycle. As shown in Figure 4, BMI can occur in stagnant stages giving an additional push to market development.

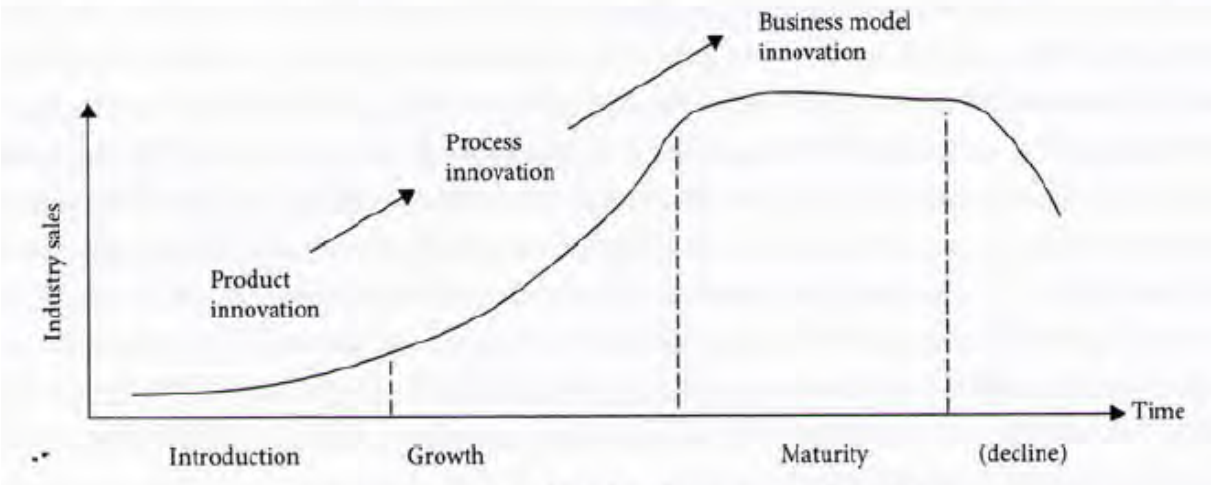


Figure 4: Market development and business model innovation (Massa and Tucci, 2013)

## 2.3 Business model considerations for online platforms

The second important aspect in the case of the OpenAdaptronik project is the fact that Rattler operates as an online platform.

A platform is a two-sided market to allow exchange between multiple groups. (Kim, 2016) The main goal hereby is to provide value to all participants that could be hard or impossible to achieve without the usage of the platform such as maintaining supplier-consumer relationships and other forms of transactions. This ecosystem evolves through the interaction of the participating parties. They also provide a core function as they offer a set of rules and technical functionality that set boundaries for user transactions (Boudreau & Hagiu, 2009). These components are mainly hardware, software and service modules including the architectural structure that connects the elements of the platform (Henderson & Clark, 1990).

Platforms have received growing attention in recent decades and a new research theory called "two-sided markets" emerged (Armstrong, 2006). Also, Kim (2016) states that "platform innovation has become the best strategy for achieving sustainable revenues" which is strongly supported by potential network effects that can be achieved via platforms businesses.

### 2.3.1 Platform quality management

To achieve and improve network effects providing growth opportunities, active platform quality management is necessary to gain the reliability of participants. (Kim, 2016)

Two effective quality management strategies are:

1. Platform regulation: determines whether to review the platform activities before or after they have happened (Boudreau & Hagiu, 2009). An example could be the review of products sold by a third-party distributor on the platform before making them visible to customers.
2. Platform quality certification: the theory relies on the idea of limiting the platform activity or participation based on certain "soft" or "hard" criteria (Hagiu, 2009). A hard criterion could be a block of certain activities if the participant does not provide proof of trust ex-ante whereas a soft method could mean providing product reviews and product satisfaction rating influencing buyer's behavior.

Both of these strategies can be implemented ex-ante (before the occurrence of an action on the platform) or ex-post (after the occurrence of a certain action).

### 2.3.2 Revenue models of platforms

Platforms usually connect the supplier side with the demand side, therefore they need to consider each group's price sensitivity while setting up the revenue models. It is of high importance to identify the money side (users who pay for the service with usually low price elasticity) and the subsidy side (users who benefit from the platform with high price elasticity) (Eisenmann et al., 2006). Customized price structures are needed as the two sides have different preferences and can lead to different network effects.

In general, we can therefore state that there are three models for possible revenue streams for online platform businesses according to the direction of revenue stream as shown in Figure 5. (Kim, 2016)

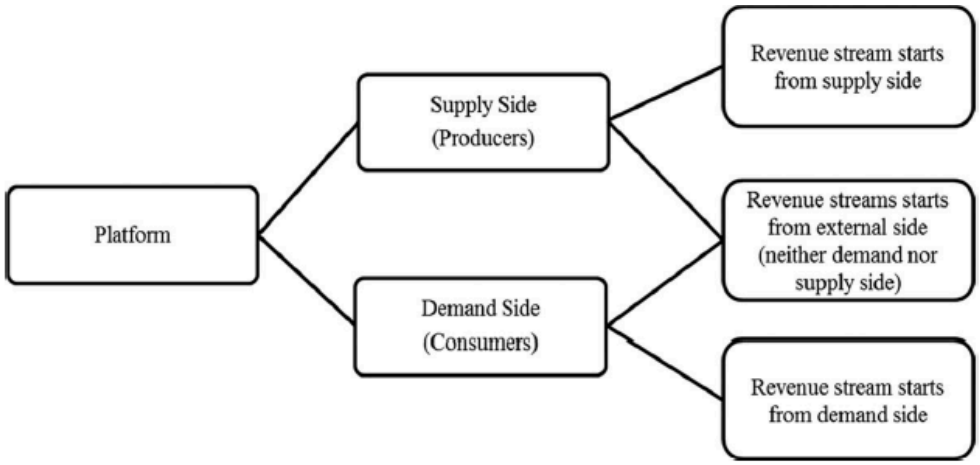


Figure 5: Possible revenue streams for platform businesses according to the direction of the revenue stream (Kim, 2016)

### 2.3.3 Network effects

An important characteristic of online platforms is that network effects emerge during their usage. Liebowitz and Margolis (1998) define network effects as "a change in the benefit, or surplus, that an agent derives from a good when the number of other agents consuming the same kind of good changes." A classic example here is from the telecommunication industry: as the first telephones emerged, the increase in the number of telephone subscribers increased the value of the network as more people could connect with others. The same scheme applies to modern platforms as well. One part of the value the consumer receives is the ownership or the right to use the product itself, the second part is the ability to connect to other users using the same platform.

The literature distinguishes two different type of network effects. Direct network effects created via direct physical connection of users. A new entrant increases the network value as users have an additional node to connect with. (Farrel and Klemperer, 2007)

In case of indirect network effects, additional benefits are not generated through direct connection of network parties but through complementary products. As the value of the network rises with the growing number of participants, the availability of complementary products increases while prices of these products decrease. (Liebowitz and Margolis, 1998)

## 2.4 Open source business models

The third pillar our business model will be built on is the open source characteristic of the tools hosted on the platform.

The original idea behind open source is the cooperative product development. The producers are usually group of developers or individuals that are interested in the further development and evolution of the product itself. There is no distinction between corporate or individual users and the contributors do not work for profit or monetary compensation. As a result, the product and the source code are available for free to anyone interested in trying or co-developing the product. (Krishnamurthy, 2003)

The Open Source Initiative gives a full definition and set of requirements for open source software. These include but are not limited to free distribution of the code in both compiled and uncompiled form, license allowing modifications and redistribution and also the obligation to retain the same licensing for derivative works (The Open Source Initiative, 2007).

### 2.4.1 Achieving profit with open source software

Today, the most common method of making revenue with software is to sell the right to use the software where actual ownerships is not transferred between the parties (Hecker, 2000). However, it's not uncommon to see companies make their software open-source or forge partnerships with open-source communities. This reduces the costs of software development and allows the company to shift focus and establish new revenue models. A typical example is service contracts becoming a strong revenue source for companies such as Red Hat, a distributor of Linux software. Another main advantage of leveraging open source besides the reduced costs is the huge gain in scalability and the opportunity to make a product global with ease. Companies can also adopt open-source software with a low product risk as these are available for free even if they decide not to deploy the solution in a productive environment in the end. Another important factor is the total cost of ownership which must

be evaluated on an individual product basis but chances are high that an open-source solution leaves the company with a lower total cost of ownership. (Krishnamurthy, 2003)

### 2.4.2 Product importance and customer applicability

Hecker (2003) argues that not all open source products have a high profit potential. The author uses two dimensions to examine the potentials of a certain product: customer applicability and relative product importance. Customer applicability describes the market segment that can take advantage of the software or the service. For example, designing a software for a very specific operating system that is not widely used will result in a low customer applicability.

Relative product importance refers to the importance of a software for the user in the functioning of a specific system. A controller software is, for example, is the most important part of a microcontroller software, otherwise the user wouldn't be able to take full advantage of all the functionality.

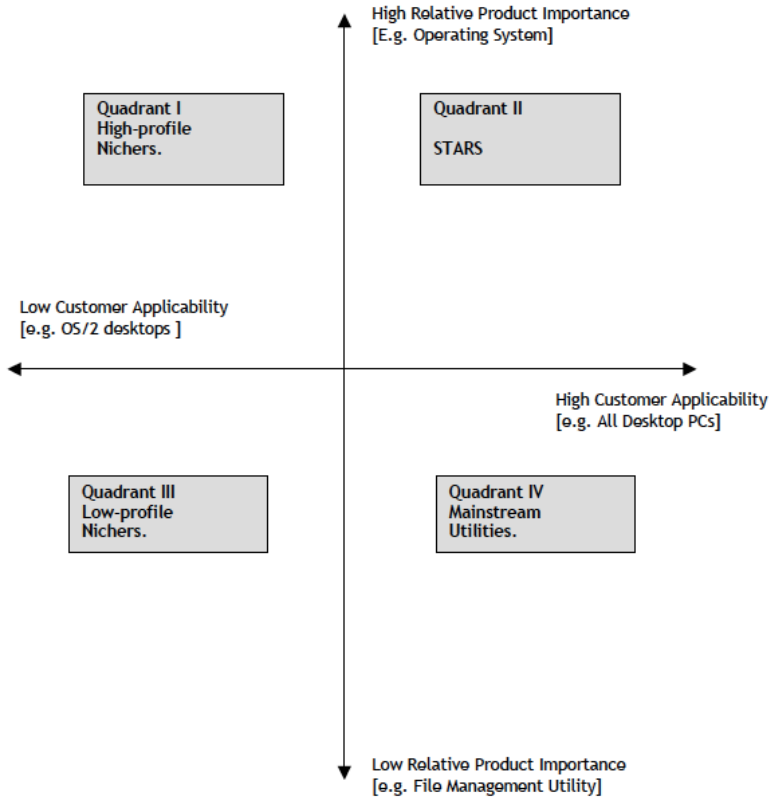


Figure 6: Relation between Customer Applicability and Relative Product Importance of a product (Khrisnamurthy, 2003)

Products performing well in both dimensions have the highest profit potential just like well-known desktop operating systems or office suits. However, solutions with both low customer applicability and low relative product importance are not necessarily doomed to fail. They can fill small niches effectively satisfying customer needs on which large software companies are unable to focus on with their solutions. These market players can achieve a profitable operation as well if supported with proper marketing activities. Companies and developers of software like that must evaluate and invest into the product category awareness, in this case, for example creative software suites. Furthermore, it is necessary to also invest into brand awareness of users – which would mean a specific company on the market in the category, like Adobe. (Khrisnamurthy, 2003)

### 2.4.3 Integrating open source attributes into business models

Although a company offering software as open-source will not be able to monetize the software through classical licensing models, it is still possible to place such software into business models and even utilize different methods in order to make money with the model. Many of these models are already proven to be effective, some are theoretically possible. Hecker (2000) gives an overview of these opportunities in his paper identifying several attractive possibilities:

1. Support Sellers: in this case, revenue comes from two categories: selling physical goods or services. Companies utilizing this model can sell the software on a physical data carrier or even provided copies of documentation. Another example is providing paid technical support for the software. These actions aim to improve the overall user experience with the product and offer convenience for users. An example from the industry is Red Hat Software.
2. Loss Leader: in this model, the open-source product does not provide direct revenue. The company gives the software away hoping that customers would buy other paid software or services offered by the company. Licensing schemes are of high importance if the open-source product shares code snippets with proprietary software commercialized by the same firm. This model can also effectively help building brand reputation and product awareness and even brand loyalty amongst customers. A known market player using this model is Sendmail Inc.
3. Widget Frosting: here, the model can be particularly compelling for hardware manufacturer companies producing any hardware from microcontrollers through peripheral devices to complete computer systems. In this case, the commercial physical products utilize the open-source software – such as drivers, interface tools or even operating systems – that come at no cost bound with the hardware. Amongst others, Corel is using this scheme.

4. Brand licensing: this model is more theoretical as not many companies use it to make revenue. A requirement for this model is the existence of an “official” trademarked software with the same functionality as the “unofficial” twin available for free. The company keeps the right for its trademark and intellectual property and charges other businesses to for the right to use the brand name and create derivative products. From a market perspective, the official and unofficial versions are perceived as two different products with different value despite of the identical functionality.

Furthermore, hybrid business models are also conceivable combining certain features of the schemes mentioned above or restricting some of the elements of the open-source definition. An example would be distinguishing user groups based on specified characteristics like commercial of non-commercial customers.

## 2.5 Lean Canvas

The Lean Canvas was developed by Ash Maurya (2012). It is based on Alexander Osterwalder’s Business Model Canvas which offers a strategic management tool for capturing key elements of a business model (Osterwalder, 2008). It visualizes main aspects in a 9-segment single reference model.

The Lean Canvas shifts the focus towards the customer and products rather than using a company-centric approach. It is designed to be easily understood applying a non-business terminology making it possible for non-business users to capture ideas using the canvas. Therefore, the Lean Canvas is particularly useful in the early stages of a company where details of the overall business model are not yet refined, although the canvas was proven to be helpful even from ideation to product-market fit evaluation phase with several startups (Maurya, 2018).

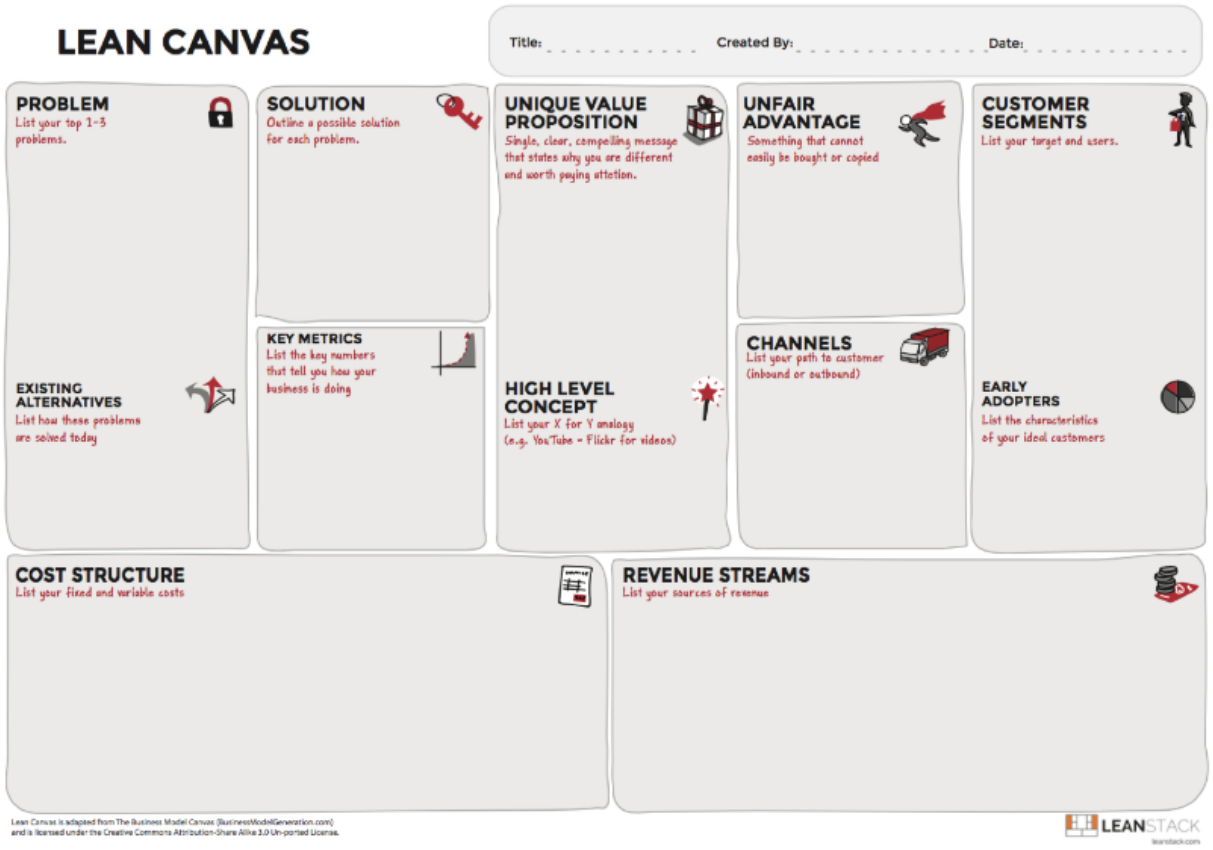


Figure 7: Lean Canvas by Ash Maurya (2010)

The 9 fields of the canvas are set and can be described as following:

1. Problem and existing alternatives: the customer segments, which the business model is aimed at, have distinct needs and problems they want to solve. This field describes these problems and needs that a product or service of the company can satisfy. “A product has value for customers to the extent that it helps them solve problems.” (Hecker, 2000) It also captures existing alternatives available on the market.
2. Solution: this segment describes how the company intends to address the customer’s needs and how they intend to solve their problems via the firm’s offerings. This may include products, services or even support related to the products marketed by the company.
3. Key metrics: indicators used for monitoring the company’s performance as well as the product’s performance itself. These key performance indicators (KPIs) have an important role in the evaluation of not only the products and services but the business model as well.
4. Unfair advantage: a distinctive characteristic of the company or its products that cannot be imitated easily or with low costs by competitors. These might include

knowhow, technologies or a unique set of human resources but also information no one else possesses on the market.

5. Channels: this describes the ways of reaching the customer segments. If more than one customer segments are defined, then multiple channels might be drafted here as well. Marketing activities are usually derived from and executed through these channels to create awareness and commercialize the product.
6. Customer segments and early adopters: one of the most important fields, heavily connected to the problem statement. It encompasses every target group the company is trying to reach with its products or services. The circle shall be expanded as the product portfolio grows and addresses new customer segments with new solutions.
7. Unique value proposition: a simple and compelling statement, a promise of value delivered by the company to the customers. Defines why the customers should consider paying for the company's solutions.
8. Cost structure: costs that eventually cover all the expenses i.e. market research, building the solution and costs of operational activities. These may vary heavily depending on the products nature and key characteristics.
9. Revenue stream: this field describes how the company earns money with its offerings. As products and services change, the revenue streams might have to be redefined.

# 3 Interview evaluation

There were five interviews conducted with various OpenAdaptronik project members as well as representatives working for different companies in the industry. In the following chapter, the most important findings of the interviews are described an evaluated. Key aspects are captured in the Lean Canvas model to give an overview of the most important outcomes. The answers can be found in the appendix where additional findings from the emerging loose discussions are also noted and allocated to the questions.

## 3.1 Interview questions

Following six questions were asked each interview candidate in face-to-face interviews to discuss key aspects of a possible business model for the Rattler platform, including but not limited to potential user groups, open source software characteristics and advantages, marketing channels and possible revenue sources. The questions were developed based on the findings in the scientific literature reviewed in the previous chapters and on the building blocks of the Lean Canvas. The interviews led to discussions ranging between 45 and 90

minutes. The notes taken during the interviews detailing the participant's answers can be found in the appendix at the end of the paper.

1. For which user groups could OpenAdaptronik offer potential services and solutions through the Rattler platform?
2. Which problems and pain points do you think these users or user groups have?
3. Which channels are the most relevant for OpenAdaptronik and the Rattler platform for reaching out and addressing their customers?
4. What advantages do you think Open Source software could offer for the Rattler platform?
5. What revenue streams do you think are possible in an Open Source business model?
6. How should the project measure success? What are the key metrics and key performance indicators that could help evaluate the performance of the platform and the project?

The interviews outlined two main relevant user groups for the Rattler platform. Both of them have distinct needs and pain points, therefore there is a strong need to address them via different channels with different solutions in mind. These lead to different aspects regarding cost structure and revenue streams as well. In order to examine the main characteristics of each group, two canvases were created to capture all the relevant aspects focusing on each group of potential customers separately.

First, a B2C (business-to-consumer) approach offers a possible model for addressing private individuals, hobbyists, tinkerers and makers.

Second, a B2B (business-to-business) canvas highlights the key characteristics of a business model targeted at small and medium-sized enterprises and start-ups active in the field of machinery and microelectronics.

## 3.2 Business to consumer

The Lean Canvas in Table 2 shows the applicable findings related to the possible business-to-consumer business model for the Rattler platform. Potential customers in this scenario include private individuals regardless of level of knowledge in regard to mechatronics as well as hobbyists and makers creating handcrafted products and solutions that aim to improve their daily life. They face a challenge with a faulty or misbehaving domestic appliance, mostly related to noise and loudness. This involves appliances of a higher value, for example washing machines, dishwashers, loudspeakers or microwave ovens. Little to no experience in the field of adaptronic and vibration reduction characterizes these user groups which makes it difficult

to find or develop a proper tool for analysis and evaluation of their problems. Even cheaper sensors and measurement software (e.g. mobile phone applications) require expertise to ensure the gathering of relevant data about the machines. An important aspect of the products is therefore that the learning curve necessary to be able to handle and operate the analytical tools should be limited. The main motivation of these groups is personal, without commercial interests. In accordance with that, the willingness to invest into these solutions is limited, ruling out pricy existing industrial solutions. No interview candidate could report about similarly powerful solutions provided for free on the market.

The main goal of reaching out to these customers in the first step is to create awareness. They need to be aware of the existence of the platform which could ease several of their pain points. Derived from the nature of the machines in question, online forums for domestic appliances and social media channels seem to be an appropriate channel to address these individuals. Some of the interviewees underlined the importance and potentials of content marketing. In this case, quality content is published in relevant journals and magazines summarizing the functionality offered by the platform emphasizing the relevant capabilities sought after by hobbyists and makers. Possible early enthusiasm could be awakened amongst university students as well, with slightly more understanding of the technology. Also, in order to gain further exposure, maker summits and events offer a proper environment to represent the platform's compelling features and offerings. Scientific publications, whitepapers and dissertations could grab attention of scientific communities clustered around universities and research institutions.

The open-source nature of the analytical tools enables users to not only upload and analyse their data, but also to tailor the code and with that, the software itself to their personal needs gaining a deeper and more accurate insight into their vibration-related problem. Furthermore, the expansion of the platform via user-created software fosters the development of the community around the platform which may lead to increased awareness and may be difficult to imitate by competitors.

Providing software under open-source license poses the challenge, how the company could make revenue with the software. One of the popular approaches is advertisement. After reaching a certain amount of data stored on the platform, computer algorithms can automatically evaluate the user's problem and target him with tailored advertisement offering commercial solutions for the identified need. Extending the free open-source portfolio with paid subscription offerings is also conceivable. Complex analytical tools, extra storage space and bandwidth or even personalized statistical model creation can be part of a paid service, software either sold as separate components or as a subscription model. These products do not necessarily have to be restricted to software: simple physical components usable for gathering data can be sold separately complementing the software side of the analytical process.

For more complex problems that cannot be solved by automated tools, a consulting service from Fraunhofer could offer more detailed and professional insights as well as support with the development of a proper solution.

On the other side, costs naturally arise while providing these solutions. One part of these are the infrastructural costs including server and hosting fees for code and software, maintenance and the eventual expansion of the capacities. As the core functionality including the platform and several analytical tools are developed by Fraunhofer, the development and maintenance costs should be calculated as well, also regarding further extension of the core base.

The interviewees seem to agree on key metrics that can be used to measure success and growth of the platform. Website metrics such as number of visitors, number of new registrations and returning visitors build a fundament for evaluating awareness for the platform. Advanced performance indicators include but are not limited to the number of new services connected by the users, frequency of utilization of particular modules. These KPIs (key performance indicators) also give a base for measuring the effectivity of marketing activities conducted to increase the awareness for the platform.

The following Canvas in Table 2 captures all the relevant findings in the business-to-consumer context.

Table 2: Lean Canvas capturing a business-to-consumer model recommendation (by the author)

<table>
<tr>
<td rowspan="2">Problem / Need<ul><li>Household appliance faulty/misbehaving</li><li>Little to no technical knowledge about vibration reduction</li><li>Do-it-yourself solutions not performing properly due to vibrational problems</li><li>No financial resources for professional solutions</li></ul>Existing Alternatives<ul><li>Pricey professional services aimed at companies</li><li>No other online platform offering open source tools</li></ul></td>
<td>Solution<ul><li>Set of open source tools for analysis and simulation of vibrational issues</li><li>Modular platform extendable by users</li><li>Consulting services for more complex needs</li></ul></td>
<td rowspan="2">Unique Value Proposition<ul><li>A unique set of open source tools provide analytical functionality in for of an online platform for hobby users and makers in order to find a solution to their vibration-related problems. The provided software can be customized, improved and tailored by the users as per need</li></ul></td>
<td>Unfair Advantage<ul><li>Unique set of tools built by a strong open-source community available for free</li><li>Efficient extendable platform by users</li></ul></td>
<td rowspan="2">Customer Segments<ul><li>Private individuals with any level of knowledge</li><li>Makers, hobbyists, tinkerers</li></ul>Early Adopters<ul><li>University groups (engineering students)</li><li>Enthusiastic engineers with sufficient knowledge and understanding</li></ul></td>
</tr>
<tr>
<td>Key Metrics<ul><li>Number of platform visitors</li><li>Registrations and conversion rate</li><li>Frequency of module utilization</li><li>New services connected by users</li></ul></td>
<td>Channels (Marketing and Communication)<ul><li>Social media</li><li>Content marketing in relevant journals</li><li>Maker groups, summits and events</li><li>Online forums for domestic appliances</li></ul></td>
</tr>
<tr>
<td colspan="3">Cost Structure<ul><li>Infrastructural: website hosting, hosting of code and development tools</li><li>Human resources related to the development of the software and consulting services</li><li>Marketing costs related to the activities described in the “Channels” block</li></ul></td>
<td colspan="2">Revenue Streams<ul><li>Consulting services for more complex user problems and needs</li><li>Tailored advertisement offering solutions based on identified problems and uploaded data by users</li><li>Selling physical components for measurement</li><li>Extended functionality and more complex analytical tools as paid service</li></ul></td>
</tr>
</table>

## 3.3 Business to business

The second identified user group is formed by small and medium-sized enterprises (SMEs) and start-ups developing products using moving parts and microelectronics or utilizing similar machinery in the production process. The main problem these companies face is that the products (light structures) have to be stabilized in order to function properly. Their needs are shaped by the lack of expertise in this area. Financial resources are limited for these solutions hence the companies are forced to look for alternatives to the pricey industrial solutions available on the market. Some argue that vibration reduction is performed on a per-machine basis individually if there is an actual need, although these processes are far from convenient and cannot scale easily. Even though cheaper sensory might enable data collection and processing, the thorough analysis of the data remains tied to expert knowledge.

A set of compelling software and hardware products offered by OpenAdaptronik and the Rattler platform could offer an alternative to the industrial solutions for these companies, integrated into one ecosystem. On one hand, physical components designed and sold by the platform provider can be integrated directly into the products. These measure, collect and transmit data automatically which can be stored and analysed by the platform software online, enabling predictive maintenance, evaluation of product usage and pattern recognition. On the other hand, similar advantages can be gained in the product manufacturing phases by enhancing the production line and machinery with sensors which continuously report valuable maintenance data. Furthermore, the agility of smaller sized and start-up companies enables the fast-paced integration of such solutions speeding up the growth of the Rattler platform and business.

Consulting services from Fraunhofer could complete the service offering with professional support regarding tool usage and product development, tailored recommendation of solutions and even initiation of complete project setups.

Just like in the case of the B2C model, the first step is to create awareness of the platform itself. Similarly, content marketing placed in the relevant journals, e.g. mechatronics papers, is able to reach out to broad audiences. Cooperation with manufacturers and service providers for domestic appliances can be fostered by presence at prominent events and exhibitions. The platform is available in German language at the moment but further expansion to wider markets is possible in the future.

Although many companies think in a negative way about using open source software or even making the code of their own products available, open source can offer numerous advantages not only to the customers but to the companies as well. The costs of software development are reduced due to external influence and at the same time, the meantime between discovering a bug or faulty functionality and implementing a fix is reduced due to the increased number of developers working on the code. The community-building nature of open source creates trust

between the participating parties. It establishes a discussion between users and developers which can lead to better understanding of user needs and to better feature sets.

We find similar suggested KPIs in the B2B context to the B2C model. Beside the classic website analytics figures, the number of established partnerships with manufacturers combined with their service usage data could offer a proper indicator for the strength of the relationship and uncover potential growth opportunities, e.g. a further set of domestic products or machinery that the measurement tools can be integrated into. Revenue gained through these partnerships could measure financial success. In regard to the consulting services offered to solve more complex issues with machinery, the number of initiated projects could not only act as an additional KPI but also shed light onto trends and what issues companies are dealing with on the market in general.

The following Canvas in Table 3 captures all the relevant findings in the business-to-business context.

Table 3: Lean Canvas capturing a business-to-business model recommendation (by the author)

<table>
<tr>
<td rowspan="2">Problem / Need<ul><li>Light structures have to be stabilized in order to function properly</li><li>Little or no expertise in this area at SMEs</li><li>No financial resources for industrial solutions</li></ul>Existing Alternatives<ul><li>Pricey professional services aimed at larger companies</li><li>Tailored solutions for individual business needs</li></ul></td>
<td>Solution<ul><li>Set of open source tools for analysis and simulation of vibrational issues</li><li>Ability to collect valuable machine data for evaluation</li><li>Consulting services for more complex needs and problems</li></ul></td>
<td rowspan="2">Unique Value Proposition<ul><li>The platform offers a compelling set of analytical and data collection tools for companies, all integrated into a single platform</li><li>It enables a wide range of operations including ad-hoc analyses, data collection and storage</li></ul></td>
<td>Unfair Advantage<ul><li>Unique partnerships with numerous manufacturers of domestic appliances; trust fostered by open-source nature of tools</li><li>Wide range of attractive tools available for companies supported by open source developer community</li></ul></td>
<td rowspan="2">Customer Segments<ul><li>Small and medium-sized businesses</li><li>Start-ups developing products using moving parts or microelectronics</li></ul>Early Adopters<ul><li>Start-ups that act fast and agile</li></ul></td>
</tr>
<tr>
<td>Key Metrics<ul><li>Number of consumers who provide valuable data</li><li>Number of partnerships</li><li>Utilization of platform modules</li><li>Data upload amount</li></ul></td>
<td>Channels (Marketing and Communication)<ul><li>Cooperation with appliance manufacturers and repair service providers</li><li>Content marketing in relevant journals</li><li>Professional events and exhibitions</li></ul></td>
</tr>
<tr>
<td colspan="3">Cost Structure<ul><li>Infrastructural: website hosting, hosting of code and development tools</li><li>Human resources related to the development of the software and consulting services</li><li>Marketing costs related to the activities in the “Channels” block</li></ul></td>
<td colspan="2">Revenue Streams<ul><li>Manufacturers: integration fee of physical measurement components</li><li>Paid extended functionality (e.g. based on data throughput; more complex analysis tools)</li><li>Consulting services for more complex problems and needs</li></ul></td>
</tr>
</table>

# 4 Practical implications and limitations

As the paper outlined in Chapter 2, business models are multidimensional and highly complex structures. One has to consider many aspects to find the best market fit in order to deliver real value to the customers while creating a profitable business.

The two articulated recommendations cover many aspects of possible business model directions. The main difference between these is rooted in the target customer segment. Both groups – private individuals and small or medium-sized businesses – have distinct needs that need different ways of addressing. The decision, which path to follow, lies in the hand of the platform operators. Focusing on the implementation of only one model might pose less challenges and bind less resources of Fraunhofer in the end allowing the company to easily launch the product. Although it might lead to a successful business, it is considerable to target both segments at the same time. This can further support the fast development of the platform by not restricting the sources of contributors to one group. Both groups – despite having different needs – might profit from each other's advancements and developments while creating extensive network effects.

## 4.1 Opportunities in further user and market research

The interviews – due to the limitations of this paper – could not include all of the aspects and different perspectives of a business model identified in Chapter 3. A valuable portion was covered though, giving valuable recommendations for the Rattler platform operators and developers how to approach the market with the new products and services.

Further research might be conducted to shed light onto the price elasticity of the customers, i.e. the willingness to pay for premium services offered by the platform. An optimal price point for every paid offer has to be determined once the products and services are ready to launch preceded by user research.

As the interviews clarified, the platform shall not be restricted to the German market in the long term. The paper focused on the requirements of the German market, however, further research can be done to discover the differences compared to other countries and continents. The adaptation of the platform on a wider market can be sped up by making the user interface available in other languages. This should also not be limited to English as users – especially those without extensive knowledge of technical terminology in English – can benefit from their native language available on the platform.

## 4.2 Technical implications

From a product perspective, it is recommended to achieve a solid base of core functionality on the platform including a stable API. There are several reasons for that. Attractive solutions offered free in an open-source framework can establish a strong user base. This can lead to natural and automatic identification of desired functionality and might uncover previously unknown needs. Furthermore, the core functionality can act as a base for user content, extending the platform with additional software components and analytical tools. This can be done by enthusiasts as well as companies taking advantage of the platform's capabilities.

It is also important to mention the role of quality gates. Due to the modular nature of the platform, every user can attach new analytical tools that typically come in different quality. Therefore, it is advisable to establish quality gates in order to maintain a consistently positive user experience even with third party modules. One possibility is to moderate the new services manually by dedicated personnel which might ensure the highest level of quality control but is naturally tied to additional costs. Another option is setting up a user feedback system where user can rate the analytical tools based on different criteria. Incentives – monetary and non-monetary equally – can be established to motivate developers towards delivering quality code and services even with long-term support for their own creations. Abandoned services can be also deleted or archived on the platform.

Also, out of scope of this paper, nevertheless, an important aspect to consider is the licensing of the open-source software as protecting the intellectual property is key for a company. There are several already established open-source licences available for anyone to use for the own software. These differ mostly in the rights given to the end-user of the product, even though providing free access to the software itself. Some allow anyone to modify, redistribute or even commercially sell the modified software under certain circumstances. Similar questions arise regarding the core functionality of the platform developed by Fraunhofer as well as in regard to the third-party modules integrated into the ecosystem.

## 4.3 Further prospects of scientific literature research

The literature review inevitably underlies limitations; therefore, the findings should be interpreted within the context of these constraints described in this chapter. The extensive managerial literature offers further opportunities synthesizing valuable knowledge connected to the three fields explored in this study.

First, six popular online databases were accessed in order to synthesize scientific knowledge related to business models, online platforms and open-source software. Further research can be conducted incorporating additional databases and journals including online and offline as well. The search was limited to literature in English language, however, additional publication languages other than English can be considered delivering valuable results.

Second, the set of search terms used in this study might act as a limiting factor as well. Broader topics could be explored in future research, e.g. thorough analysis of business model innovation theory or capturing business models in different conceptual frameworks like the resource-based view of a firm or frameworks focusing on dynamic capabilities of a company. Also, further aspects of open source software can be examined as there is an extensive coverage in the scientific literature. Topics like principles of licensing, technical challenges and their effect on open source business models or even theoretical implications of source code treatment can be considered.

# 5 Conclusion

This paper aimed to identify key aspects of developing a business model. Important aspects of OpenAdaptronik Rattler platform were considered with special focus, that is, being an online platform and offering open source solutions to the customers.

In the first part of the paper, an overview of the recent scientific literature was given, synthesizing scientific theories related to business models, online platforms and open-source software.

In the second part, interviews were conducted with different stakeholders of the OpenAdaptronik project as well as industry representatives. The key aspects were captured using the Lean Canvas methodology, a framework for outlining the main parts of a business model. Two canvases were developed based on two different identified user segments: business-to-customer and business-to-business. The various needs, potentials and financial attributes were characterised based on the respective user group.

The canvases shall serve as guidance for Fraunhofer, how to further expand the Rattler platform and how to establish market presence leading to a profitable business. The findings should be interpreted within the context of this paper's limitations, though the recommendations shall create a fundament for further research and further considerations related to the products and services offered through the platform.

# Appendix

## Interview answers

In the following, answers received from interview candidates are noted down and consolidated along the six questions. Each question is marked with the respective question number described in detail in the Chapter 3.1. The answers represent personal views based on professional expertise, experience and previous scientific work. Additional findings from the emerging loose discussion are also noted and allocated to the questions.

### Interviewee I.

Employee working for a manufacturer of professional electric tools with around 1.000 employees worldwide; the company is still discovering the possibilities of monitoring vibrations of tools and evaluating related data.

1.
   - private individuals who aim to monitor their more valuable domestic appliances
   - small and medium-sized companies usually inspect the machinery precisely on an individual basis

2.
   - limited technical affinity should be required in general → easy-to-use measurement tools
   - if small or medium-sized companies need vibrational measurement, they usually have it from the beginning
   - most companies already use built-in solutions for predictive maintenance and fault detection as well as analysis of usage

3.
   - distribution of measurement sensors and related technology in cooperation with the manufacturers of domestic appliances; without the need for education of end consumers
   - provide information about possibilities and advantages of using the measurement devices and analytical platform via classic internet channels

4.
   - many developers and consumers can participate as well
   - way of thinking in a lot of companies: they lose income, prestige and opportunities if they offer their solutions as open source

- platform tools would be available for every manufacturer regardless size and market position

5.
- no direct revenue through the platform itself
- manufacturers who integrate the solution (platform tools and analytical offerings) could save maintenance and service costs which could be shared with the platform operator (Fraunhofer)
    - practical example: raw data available to manufacturers can lead to impoved predictive maintenance solutions
- value of these solutions increases in the digital era

6.
- number of consumers who provide valuable data
- website metrics: number of visitors etc.

## Interviewee II.

Project member of a research organization focusing on applied science.

1.
- smaller companies with limited financial resources
- founders, tinkerers, hobbyists, maker
- customers who cannot afford other (mostly expensive) solutions available on the market
- large companies are no target group: they want to have tailored solutions for their problems

2.
- potential customers would want to build light structures
- vibrational and oscillational problems occur with light structures that have to be reduced in order to ensure the proper functionality
- main goals when designing these structures: maximising conformity, lifespan, precision
- there are two types of vibration reduction: active and passive
- most of the target groups do not have expertise nor experience with vibration reduction and measurement
- first: German market; potential expansion later

3.
- reaching out to potential customers via social media
- contacting maker movements and groups
- business and start-up incubators
- content marketing in relevant magazines (e.g. Make: Magazine)
- mechatronics journals (e.g. MECHATRONIK magazine in Germany)
- there are no known relevant journals specialized in adaptronic

4.
- cost advantage: tools available for free; compared to tools valued over €10.000 on the market
- source code available → the code can be modified, tailored for own needs, improved by everyone
- fosters trust between the parties
- establishes a discussion between the platform operator and users

5.
- offering consulting services related to the platform tools and products
- full version of certain tools are available only paid
- sale of physical components used for measurement of vibration data
- offering tailored solutions and services
- Fraunhofer would not develop all the software; could offer knowledge and expertise-based services complementing the analysis results from the platform
- differentiating between a free and a pro (paid) suite of platform tools and services

6.
- number of visits on the online platform
- download rates
- citation

## Interviewee III.

Project member of a research organization focusing on applied science.

1.
- hobby users, non-commercial usage

- smaller businesses with limited knowledge about vibration reduction and measurement
- little to no resources for such solutions

2.
- vibration or oscillation problem: machine faulty, too loud or has structural dynamical problems
- motivation: own interest
- basic knowledge about mechanics
- many industrial solutions on the market, but these are costly
- also, cheaper devices and software available for measurement → high knowledge required to analyze the data and draw useful and applicable conclusions
- ease-of-use important: “user sticks sensor to the machine, no calibration etc.”

3.
- standard channels at Fraunhofer: scientific approach: publishing whitepaper, dissertations, professional journals: could leverage visibility in scientific groups
- not yet utilized:
  - dedicated blog posts
  - presence on forums for domestic appliances and maker forums
  - content marketing has a huge potential
- market should not be restricted to Germany
- platform is available in German at the moment though
- no marketing or information campaign was conducted yet

4.
- core functionality developed by Fraunhofer, available free of charge at first
  - data upload
  - data storage
  - basic analyses and graphical representation
- extendable by users with additional modules and software tools for analysis e.g.
- open source supports the formation of developer communities as well
- users can tailor the code to their own needs
- question emerges: which functionality should be seen as core? Which components should be part of the paid offering?

5.

- advertisement based on the uploaded data: ads about the potential solutions for the user's problem
- services with added value in paid models → required resources for such models are available at Fraunhofer
    - charging for extra storage space
    - more complex analyses
    - tailored model creation for the current problem
    - even project recommendations → similar to a consulting service
- selling physical components for measurements
    - prototyping capabilities and resources at Fraunhofer available
    - no mass production capacities at the moment though
- data-based business models
    - predictive maintenance, eventually in cooperation with manufacturers as well
    - lot of data needed!
    - prediction tools for manufacturers based on data uploaded by users
    - pattern recognition
- problem: not many users on the platform at the moment
- integration in existing products to gather more data automatically
- compensation for the developers of the most popular modules as an incentive
- questions arise: B2C or B2B? both? Product integration: who collects and stores the data? Manufacturer or Fraunhofer?

6.

- no key performance indicators defined for the platform at the moment
- only measurement: can we operate the service from a technical point of view at all?
- possible KPIs though:
    - number of visitors; returning visitors
    - log-ins and new registrations
    - number of users who use the analytical tools
    - usage of platform services

        - number of connected modules and services that are not part of the core functionality
    - currently there is no quality check regarding modules and data
    - user feedback system could help
    - measuring the input and output of the modules in order to estimate quality (e.g. if a system throws only errors as output → probably low quality)

## Interviewee IV.

Project member of a research organization focusing on applied science.

1.
    - individuals and end-consumers interested in getting an insight into vibration related problems with household appliances (mostly related to noise and loudness)
    - maker scene
    - small and medium-sized businesses producing electrical or mechanical parts
    - background knowledge required
2.
    - for individuals: pure personal interest in improving domestic appliances
    - for small businesses: how to collect data after-sales?
    - Larger companies probably use existing industrial methods
3.
    - activities in university and core engineering student groups
    - short educational YouTube videos showcasing the potentials of vibration analysis and the platform
4.
    - no other similar platform exists
    - similar systems are expensive
    - open source enables users with limited financial resources to utilize the analytical software
    - users can write their own software, also based on previous works
    - changing and improving the code requires developer knowledge → not necessarily the case with every user

5.
- partial solutions offered for free (e.g. pre-analysis), more complex methods offered for a fee
- consulting services for more advanced solutions and complex analysis
- small and medium-sized businesses could be a paying target group
- private individuals and enthusiasts probably will not want to pay for the services
- act as a middle man between consumers and manufacturers for commission

6.
- revenue through the platform
- website analytics and goals, e.g. conversion rate
- data upload amount
- new service connections

## Interviewee V.

Employee of a multinational professional services network. Project lead of a local makerspace.

0.
- the Makerspace is part of the PwC Experience Center Frankfurt
- Internal usage by PwC employees and clients working on projects
- Idea: rapid physical prototyping for projects
- Utilizing machinery (like 3D printer, laser cutter etc), tools and microelectronics

1.
- makers and start-ups developing products using moving parts or microelectronics
- individuals requiring a quick analysis with no learning curve
    - simple and easy-to-use software for measurement; one-click analysis with clear results
- bigger companies probably already utilize measurement hardware and analytical software to evaluate their products

2.
- no resources for these kinds of tools, no willingness to invest higher sums as the need is probably ad-hoc
- individuals:
    - no previous technical knowledge or technical affinity
    - want a quick solution if problems arise

3.
   - presence in maker communities, fablabs, online forums, startup hubs and events
   - content marketing possible to increase awareness
   - cooperation with manufacturers and repair service providers

4.
   - code available for free → relevant for makers and startups with proper knowledge
   - possibility to improve the code without binding internal developer resources
   - community-forming attribute of open source can further increase visibility amongst potential user groups
   - even larger companies are able to use the code and software → generating traffic and publicity for the platform, OpenAdaptronik and Fraunhofer

5.
   - Professional user support regarding usage of the tools
   - Professional consulting services for startup and small sized company projects
   - Pre-manufactured standard physical components incl. embedded software

6.
   - number of visitors → level of awareness
   - number of registered users
   - contribution and attached modules by users
   - if consulting service: number of projects started in cooperation with Fraunhofer

## References


**Amit, Raphael; Zott, Christoph (2001):** Value creation in E-business. In: Strategic Management Journal, 22 (6-7), S. 493-520.

**Boudreau, Kevin J., and Andrei Hagiu (2009):** Platform Rules: Multi-Sided Platforms As Regulators. In: (Hrsg.): Platforms, Markets and Innovation. Edward Elgar Publishing.

**Broekhuizen, Thijs L. J.; Bakker, Tom; Postma, Theo J. B. M. (2018):** Implementing new business models: What challenges lie ahead? In: Business Horizons.

**da Silva Piñeiro, Fabio; Mendes de Oliveira, Janaina; Cougo da Cruz, Anderson; Zardin Patias, Tiago (2017):** BUSINESS MODELS ON STARTUPS: A MULTICASE STUDY. In: MODELOS DE NEGÓCIO EM STARTUPS: UM ESTUDO MULTICASO., 10 (5), S. 792-807.

**Drucker, Peter (1965):** The practice of management. Harper Brothers, New York.

**Farrel, Joseph; Klemperer, Paul (2007):** Coordination and lock-in: Competition with switching costs and network effects. In.

**Fjeldstad, Øystein D.; Snow, Charles C. (2018):** Business models and organization design. In: Long Range Planning, 51 (1), S. 32-39.

**Forrester, J.W. (1958):** Industrial dynamics: a major breakthrough for decision makers. In: Harvard Business Review, 36.

**Gatautis, Rimantas (2017):** The Rise of the Platforms: Business Model Innovation Perspectives. In: Engineering Economics, 28 (5), S. 585-591.

**Geissdoerfer, Martin; Vladimirova, Doroteya; Fossen, Kirsten Van; Evans, Steve (2018):** Product, service, and business model innovation: A discussion. In: Procedia Manufacturing, 21, S. 165-172.

**Hagiu, Andrei (2006):** Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies. In.

**Hecker, Frank (2000):** Setting Up Shop: The Business of Open-Source Software. In.

**Initiative, Open Source (2007):** The Open Source Definition. Abruf am 12.09.2018.

**Johnson, Mark W. (2010):** The time has come for business model innovation. In: Leader to Leader, 2010 (57), S. 6-10.

**Katz, Michael L.; Shapiro, Carl (1994):** Systems Competition and Network Effects. In.

**Kim, Junic (2016):** The platform business model and business ecosystem: quality management and revenue structures. In: European Planning Studies, 24 (12), S. 2113-2132.

**Liebowitz, S. J.; Margolis, Stephen E. (1998):** Network Externalities (Effects). In.

**Massa, Lorenzo; Tucci, Christopher L. (2013):** Business Model Innovation. In: (Hrsg.).

**Maurya, Ash (2010):** Lean Canvas.

**Maurya, Ash (2018):** Create a 1-page business plan using a Lean Canvas - LEANSTACK. Abruf am 18.08.2018.

**Osterwalder, Alexander (2008):** Business Model Canvas.

**Osterwalder, Alexander; Pigneur, Yves (2003):** An ontology for e-business models. In.

**Porter, Michael (1985):** Competitive Advantage: Creating and sustaining superior performance.

**Ries, Eric (2011):** The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Publishing Group.

**Ritter, Thomas (2014):** Alignment² [Alignment Squared]. The CBS Competitiveness Platform.

**Täuscher, Karl; Laudien, Sven M. (2018):** Understanding platform business models: A mixed methods study of marketplaces. In: European Management Journal, 36 (3), S. 319-329.

**Teece, David J. (2018):** Business models and dynamic capabilities. In: Long Range Planning, 51 (1), S. 40-49.

**Vom Brocke, Jan, et al. (2009):** Reconstructing the giant: On the importance of rigour in documenting the literature search process. In: ECIS, 9.

**Webster, Jane; Watson, Richard T. (2002):** Analyzing the Past to Prepare for the Future: Writing a Literature Review. In: MIS Quarterly, 26 (2), S. xiii-xxiii.

# Index