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STUDENT REPORT

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Creating a Business Model Using Data  
Collected from Smartwatches

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Abstract:

The semester project details our research into the topic of data collection from smartwatches. The primary purpose was to investigate how data can be extracted from smartwatches and what business models can be created from data collected from smartwatches.

The secondary purpose was to research the legal aspects such as the GDPR and anonymity techniques are explained, and other technological aspects and how they affect the creation of a business model

Furthermore, an extended market research is part of the project, that shows the markets situation and competitiveness.

The report is concluded with a discussion and conclusion on our findings on the problem formulation.

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# Creating a Business Model Using Data Collected from Smartwatches

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Semester Project Report  
Group 1.4

Innovative Communication Technologies and Entrepreneurship (*ICTE*)  
Aalborg University (*Copenhagen*)

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## **2 Background**

User data are becoming increasingly valuable for companies and organizations every day. Possessing user data allows companies and organizations to understand their customers better, thereby understanding their needs and thus adjust their products and services accordingly. Understanding the customer also allows companies and organizations to operate in a competitive market, by targeting the right customer in the right way, with the right product using the right platform. However, where user data can be used is limitless, it does not need to be restricted to goals such as financial growth for companies and organizations.

There are many ways to collect user data. However, this report will focus on the user data collected from smartwatches. Today's market has a vast variety of smartwatches that a consumer can choose from. To the consumer, the difference between the smartwatches consists of the shape, color, materials, features and operating systems. However, companies tend to have differences in their approach to add-ons for the watches as well as design, applications, API-s, and ways of collecting and handling the data generated by smartwatches. Some of the data the smartwatches collect are considered as personal data. These personal data require in many cases some form of processing such as anonymization or pseudonymization in order to meet the legal requirements set up by regulatory bodies such as the European Union. Legislations change continuously in order to adapt to changes in society, this also applies to personal data which has become high in demand due to the enormous development in technology. The most recent regulation, that sets up stricter requirements for how companies and governments handle, process, and collect user data is the General Data Protection Regulation, which took effect two years ago. The changes that came with the General Data Protection Regulation, significantly restrict how user data is used, when and what may be collected, the regulation sets clear boundaries when dealing with the user data of European residents compared to previous regulations.

## **3 Motivation**

Our motivation behind this project is to investigate how smartwatches collect user data and how these data are required to be treated as well as investigate whether there is a market to sell the user data to. This aligns with the semester theme and allows us to understand how companies can use the data collected from smartwatches we carry daily. The motivation is also to figure out what the company handling the data uses the data for, whether it is for development purposes or for selling the data to third parties. Therefore, it was decided to formulate a problem statement that focuses on the economic aspects of the collected data as well as how the collection, possessing, processing, and storing of data is regulated in the EU.

## 4 Problem Formulation

The project will focus on the technical and economic aspects of data collected from smartwatches. Therefore, the problem formulation is as followed:

*How can we extract data from smartwatches and what business models can be created from data collected from smartwatches?*

To specify the focus area the following sub-questions have been defined:

- How is data collected from a smartwatch and how is the collecting, possessing, processing, and storing of data regulated in the EU.
- Is there a market for selling the collected user data?

## 5 Delimitations

- To ease the readability of the report, the fictive company that is to sell the data collected by Garmin's Forerunner watches is referred to as 'XYZ'.
- This report focuses more on Garmin and the Forerunner 945, this choice was made because the Forerunner is one of the newest smartwatches in the market with the largest number of sensors that collect health data.
- The center of attention is Garmin and more specific its Forerunner 945. The data in question are extracted from their customers who use the Garmin Forerunner 945 smartwatch.

## 6 Limitations/Assumptions

- After research and an attempt to communicate with Garmin via email, the way Garmin handles or applies anonymity was not defined. Their response was that everything is mentioned in their website under their privacy policy sector, but nothing is referred about anonymity.
- For the purpose of the project, it is assumed that XYZ buys data collected by Garmin Forerunner 945 and does any necessary modulation and thereby format the data in such a way that they meet the format needed by the customer segment.
- Very little information related to Garmin Watch OS is available which is why it is not included.

- Pains and Gains in the Value proposition canvas were unfortunately assumed, as it was not possible to connect with the different customer segments.

## 7 Methodology

This chapter describes the methods used in the creation of the report. Firstly, a description of the process model used throughout the duration of the project is provided. Secondly, the methods used for data gathering are described thereafter is the general structure of the report illustrated. The methodology chapter continues with a description of the analysis method used and ends with a discussion on the business models used in the report.

### 7.1 Process Model

The process model is an important part of the project as it helps in defining the structure and workflow of the project. Because the project is of analytical nature, we began the process by deciding on the subject and then continue with planning, research, data gathering, and review as shown in Figure 1. The first phase was repeated when new information was available or obtained and thereafter, we continued with the second phase of the project which was the analysis part of the project.



*Figure 1 - First phase and the second phase*

The stages in the process model:

#### 1. Planning

The Planning stage began with setting the initial deadline goal. Then we continued with defining the motivation, background, and the problem formulation for the project.

#### 2. Research

The research stage includes researching necessary literature that is relevant to the scope of the report. This included but was not limited to, academic literature, articles, legislative acts, and regulations.

3. Data gathering

This part of the process included gathering data that were relevant to the project and were able to support in the analysis part of the project.

4. Review

The reviewing part of the process model included peer-reviewing each other as well as reviewing the used literature.

5. Analysis

The analysis part of the project initiated the second phase and the final stage of the project before the completion of the report. Here we tried to use the information gathered in the first phase of the process model and use it in the analysis and thus answering the problem formulation.

## 7.2 Data Gathering Methods

The data gathering is an essential part of the project and thus the analysis. In this section, we state why we primarily used a qualitative method in the data gathered. This is because this report examines how we can extract data from smartwatches and then examines the legislative regulations on possessing, processing, and storing of the data. Based on these findings we conduct a value proposition canvas, business model canvas, and SWOT analysis.

A qualitative data collection method is usually used for exploring, and as long as the report's data are non-numerical, it fits on it. It is used to understand the research reason and the distinction of **how** and **why** a specific phenomenon operates as it does. The primary purpose of collecting the data is for research and analysis. There will be no primary data presented or surveys or other types of questionnaires will be not carried out.

Thus, while trying to solve the problem formulation of the report, we used books and the internet for articles and papers as literature. However, for the legal part, the European and local regulations and legislation were used. Furthermore, for the technical part, an investigation of how the data are collected from the smartwatches and what API's and SDK's use is done, mostly from each brand's website. Finally, for the business part a Value Proposition Canvas, a Business Model Canvas, a SWOT analysis, and market research were used to create the analysis. All the data gathered from all the parts lead to the result of our report where they are merged into a conclusion of the results.

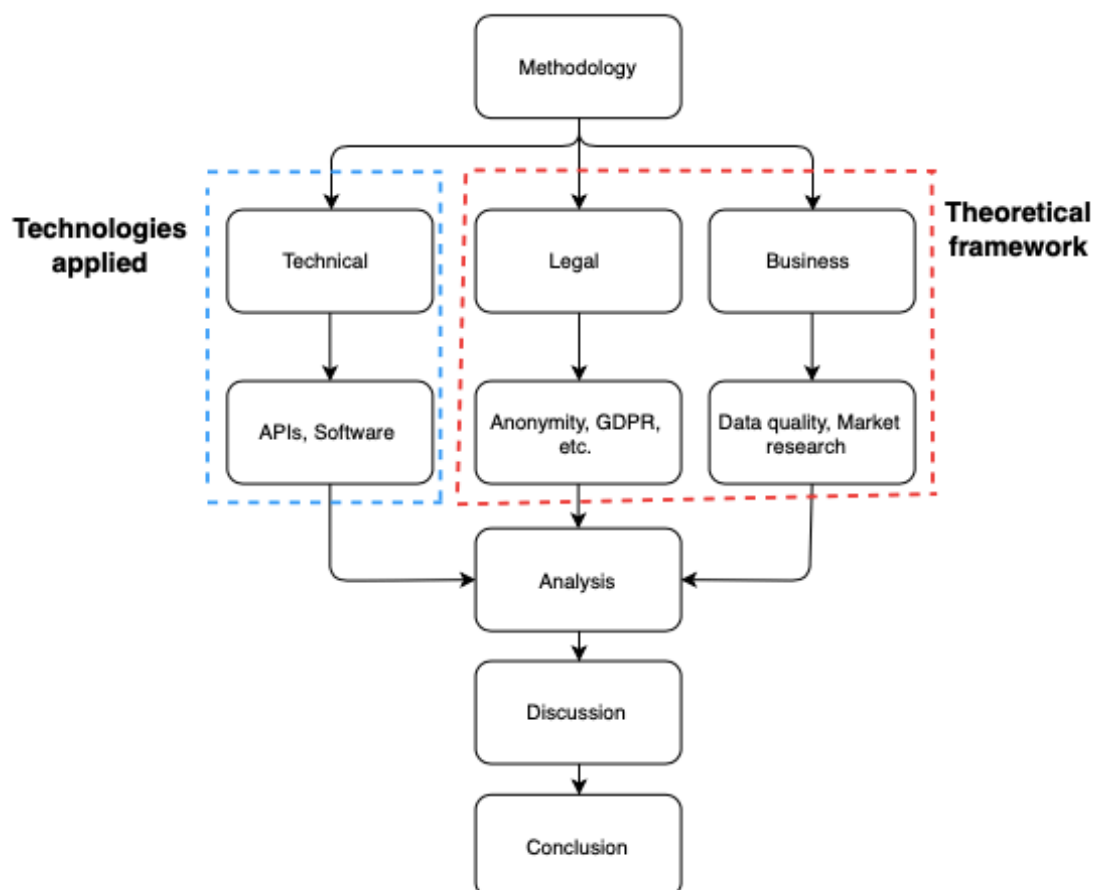


It is important to be revealed the type of knowledge of qualitative data collection is subjective, and because of the sensitivity of the data area, after asking Garmin to elaborate how they handle some of the processes, we received a generic answer and were referred to their webpage.

### 7.3 The General Structure of The Report

The structure of the report is as shown in Figure 2 where the technical, legal, and business areas of the project are researched separately and used in the analysis as each part is equally important and is associated with the problem formulation.

However, Figure 2 also depicts that the report includes three topic areas the Technical, Legal, and Business area, these areas have their specific and related subjects as indicated in Figure 2. The theories of each subject used in the legal and business area are defined in the theoretical framework chapter and used later in the analysis chapter and the rest of the report. The technical area includes specifications about the smartwatches that are described in the technologies applied chapter used and later in the discussion chapter of the report.



*Figure 2 - Structure of the report*

## 7.4 Analysis Method

The basis of the analysis involved the theories researched in the theoretical framework which allowed us to determine how we could utilize data collected from smartwatches and what business models could be created from that data.

The first step in the analysis was to assess whether there was a legal base. After evaluating carefully, the legislation, and the regulations related to the General Data Protection Regulation and different methods of protecting individuals and their personal data, we came out with some conclusions about if it is legal to sell data collected by smartwatches. This point is very important for the continuation to the next step because they are inseparable. Without a legal base, creating a business model for selling the data collected from smartwatches would be difficult. Another important point of the analysis method is the market research that was made to define the market's current situation and requirements regarding the sale of data.

The second step included assessing whether there was a market for the data collected by smartwatches. At first, an assumption of a XYZ was made. The different blocks of the Value Proposition Canvas and the Business Model Canvas have been used to evaluate the different business-generating aspects of XYZ and elaborate on the who, what, how and why questions. Consequently, a market research was conducted to find out if there is a customer segment to sell the data to. Lastly, the SWOT- analysis was used to analyze the strengths, weaknesses, opportunities and threads that XYZ might have to deal with in the current competitive market, with the purpose of detailing the external factors further i.e. opportunities and threads.

## 7.5 Business Model Theories

The Oxford dictionary defines a business model as *“a plan for the successful operation of a business, identifying sources of revenue, the intended customer base, products, and details of financing.”* Thus, the concept of a business model is connected to the organization structure and market structure [1]. A business model can have many forms, it can be in the form of a concept or an actual plan that varies in the level of precision. The concept is used to describe the economic processes and/or trends in the market it operates in [2, 3, 4]. However, while the scope of a business model is dependent on the strategic choices' a company previously has made, it can also reflect current strategies for future goals [5, 1].

A business model often is used to describe the key components such as key value, customer relationship, and channels of a given business [5]. A good business model is the first step into a successful business as it often is developed with the purpose of creating and capturing value.

According to Alt and Zimmerman the basic components of business models that turn up in definitions are [6]:

- **Mission**
  - Determine the overall vision, strategic objectives and value proposition.
- **Structure**
  - The actors and the role they play within a specific business environment.
- **Process**
  - Concrete translation of the mission and the structure of the business model into operational terms.
- **Revenues**
  - The investment needed in the medium and long term, cost structures and revenues.

The difference between business models lies on the components they focus on. For instance, the STOF model has four components which lay a foundation for the method used in designing a business model for mobile services. STOF is an acronym of the components the model focuses on; **S**ervices, **T**echnology, **O**rganizational arrangements, and **F**inancial issues. Hence, the approach the STOF model focuses on is customer value, the organizational, technical, and financial arrangements needed to provide a service that offers value to customers and allows the providers of the services to capture value as well. [6]

Bowman, H. et.al., the developers of the STOF model, define value as “*part of an equation in which customers in target markets compare the perceived benefits and total costs (or sacrifice) of (obtaining) ownership of a product or service.*” [6] and put an emphasis on value and differentiate between perceived value versus experienced value by creating a distinction and putting an emphasis on the gap between Intended Value, Delivered Value, Expected Value, and Perceived Value [6]. Where, intended value is the value that an organization wants to provide to the customers/end users. Delivered value is the value that an organization actually provides to the customers/end users. Expected value is the value that a customer expects from a service, based on their experience from previous versions and company reputation. Lastly, Perceived value is the value that a customer perceives when they use the service and is defined as the difference between delivered value and expected value [6]. Consequently, because the components of the STOF model focus on and lay the foundation for the method that is used when designing business models for mobile services [6] it is not used in this project. However, the creators of the Business Model Canvas Alexander Osterwalder and Yves Pigneur explain that

*“a business model is nothing else than a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network*

*of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and robust revenue streams [7].*

Thus, a Business Model Canvas is simply an illustration of the relationship of how an organization creates, delivers, and captures value. The Business Model Canvas describes how business-generating activities are connected such as XYZs. Bowman H. et.al., the authors of STOF state that business models are given shape by answering questions with regard to customer needs, the way services are provided, availability, the way resources such as technical, financial, and human resources are put in place [6]. This is easily achieved by using the Business Model Canvas in combination with the Value Proposition Canvas also developed by Canvas Alexander Osterwalder and Yves Pigneur [7]. The Value Proposition Canvas looks at how a given company creates value for the customer and then it is used as one of the building blocks in the Business Model Canvas. The Business Model Canvas is made up of nine building blocks where the first is the Customer Segments and next in line is the Value Propositions where the findings from the Value Proposition Canvas are used. The remaining building blocks are; Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, and finally Cost Structure. Note that the building blocks in the order they are supposed to be answered. However, the Value Proposition Canvas and the Business Model Canvas do not consider the external factors that affect a company and the weaknesses of a company therefore the SWOT-model was used. The SWOT-model looks at the internal and external environment the company operates in, in order to analyze the strengths and weaknesses it has to work with as well as the opportunities and threats it may be faced with in the future [8]. The SWOT- model is used in the analysis because the external factors are not considered in the Business Model Canvas.

## **8 Theoretical Frameworks**

This Chapter, defines and describes the business model theories that are used in the analysis chapter. It also explains how to process data with respect to pseudonymization and anonymization and the difference between these two. Which factors affect the data quality as well as the restrictions set by the GDPR when collecting user data and the basis for the market research used in the analysis chapter.

### **8.1 The Value Proposition, The Business Model Canvas, and the SWOT-model**

The Business Model Canvas and Value Proposition Canvas are used in the analysis in chapter 10. The Value proposition canvas is a tool that is divided into several building blocks that together describe the value a customer wants and needs from a service or product.

*“The Value Propositions Building Block describes the bundle of products and services that create value for a specific Customer Segment” [7].* The Value Proposition Canvas was developed as a framework in order to ensure that the product

or service meets the customer needs. Thus, the Value Proposition Canvas helps design products and services customers want. [7]

The Business Model Canvas is a tool, that is used to define and describe a business idea simply while working on the fundamental elements of a business model. That is: *“A business model describes the rationale of how an organization creates, delivers, and captures value”* [7].

A SWOT analysis is used to describe a firm at a particular moment in time. The tool is used to identify a competitive advantage while also looking at the external factors that can affect a firm. SWOT is an acronym for Strengths, Weaknesses, Opportunities, and Threats where the first two are internal factors whereas Threats and Opportunities focus on the external factor that can affect a company. External factors include competitors, changes in legislation, technological change etc. The SWOT analysis is used because the BMC does not take external factors that affect a company’s strategic plan into account. [8]



Figure 3- SWOT-model [8]

## 8.2 Ways to Handle Data

There are many factors that affect data. Some of the major factors are researched in this subchapter which includes anonymity, quality of data, and the legislative requirements when collecting, processing, and possessing the data of European residents. This subchapter begins with looking at why data needs to be anonymized and the different techniques to achieve anonymity. Then continues with looking at what influences the quality of data and continues with the scope of the law and how personal data is to be handled.

### 8.2.1 Anonymity

Sharing and releasing data is necessary for research, data mining, cost analysis, fraud detection, transparency, and many other fields. It is an essential tool for companies, research facilities, and governments. As technology progresses, exponential growth in the data collection is observed containing person-specific information to be processed by Big Data, Artificial Intelligence and Machine Learning techniques. Around 87 percent of the US population can be uniquely identified with just their 5-digit zip code, gender, and date of birth combined [9]. Thus, underlining the importance of anonymity. Anonymity, according to the Cambridge Dictionary, is the situation in which someone's name is not given or known [10]. People feel safer and they feel as though they are protecting their personal data when the data is anonymized because there is no way to identify them. Anonymity should not be confused with pseudonymization they are two different terms. The General Data Protection Regulation and the Data Protection Act 2018 define pseudonymization as:

*“the processing of personal data in such a manner that the personal data can no longer be attributed to a specific data subject without the use of additional information, provided that (a) such additional information is kept separately, and (b) it is subject to technical and organizational measures to ensure that the personal data are not attributed to an identified or identifiable individual” [11].*

Meaning that a pseudonym is used to replace any identifying characteristic. In pseudonymization, the data are present but changed in such a way that makes it difficult to identify an individual, while in anonymity the sensitive data related to a specific individual are completely erased. Consequently, when personal data is pseudonymized the data is kept but modified in such a way that it becomes difficult to identify an individual whereas anonymized personal data is not kept but deleted completely. This results in, once data are truly anonymized and related individuals are irreversibly prevented from identification, the data will therefore automatically fall outside the scope of the GDPR, according to recital 26 [11]. Consequently, when data is outside the scope of the GDPR it allows organizations to keep the data for as long as they want and use them for purposes beyond the purpose for which they were collected. For these purposes, anonymization of just the name of the individual is not enough, therefore other attributes must be anonymized in order to truly anonymize data and thereby the data individual's identity. [12]

In 1998, Samarati and Sweeney introduced a technique of privacy-preserving called k-anonymity and by then, anonymity techniques became one of the most important research topics about an individual's in order to protect individual's privacy and k-anonymity is one of the classic models used when anonymizing data. K-anonymity is a technique where each release of data must be arranged such that every combination of values of quasi-identifiers can be indistinctly matched with at least k individuals

[13]. The data that are undoubtedly correlated to an individual, such as ID, full name etc., are called identifiers and must be removed from the records. Quasi-identifiers are identifiers or other attributes that may appear in other public databases and may allow identifying the person linked to that data. These data are more generic data such as date of birth, place of residence etc. In isolation, the data often not enough to identify any specific individual, but if the data is combined with other quasi-identifiers it becomes possible. This result, in the need for modifying those identifiers thereby making it more difficult to identify the data subject i.e. the person related to the data, else the data has to be anonymized. A different type of data is sensitive data, that can have a great impact on an individual's privacy, data defined as sensitive include data such as union membership, disease, medical history etc., and they must not be linked to a data subject.

These data have a big interest in the data processors and usually, they are the main reasons for companies' research and development. Basically, the process of anonymization aims to detach the identifiers from the quasi-identifiers. It is not focused on sensitive attributes. [14]

Samarati's and Sweeney's approach to providing k-anonymity is based on generalization and suppression. Generalization allows the release of data in a more general form, in a way that they are provided within scope or as part of a group with the same values, this results in loss of accuracy. Suppression hides the elements, so no one can see them at all [13]. These two methods must be carefully adjusted to achieve an individual's privacy and simultaneously maintain data quality. If data is generalized to much it can lower the quality and thereby introduce distortion to the result of the analysis and to reality.

Taking anonymity into practice, a 2-anonymity means that in a database with m number of rows and n number of columns, a combination of quasi-identifiers can be found at least 2 times indistinguishable. So, each individual shares the same values with another individual. Figure 4 and Figure 5 show the transformation of raw data set to the 2-anonymized data set.

Identifiers		Quasi-identifiers		Sensitive attribute
Name	Sex	Age	Zip Code	Disease
Mary	F	27	1620	Cancer
Julie	F	25	1650	HIV
Paul	M	37	1785	HIV
Jack	M	32	1755	Respiratory

*Figure 4 - Raw data set*

Identifiers		Quasi-identifiers		Sensitive attribute
Name	Sex	Age	Zip Code	Disease
*	F	[25-30]	16*0	Cancer
*	F	[25-30]	16*0	HIV
*	M	[31-40]	17*5	HIV
*	M	[31-40]	17*5	Respiratory

*Figure 5 - 2-Anonymized data set*

However, this method of anonymizing can still be vulnerable to certain attacks. Attacks become easier if the sensitive values are all the same for a set of  $k$  records that also share quasi-identifying attributes, or in cases where the value of  $k$  is low or very high and in general. Generally, cases where  $k$ -anonymity does not hold in a correct and very cautious way result in an increased possibility of an attack. There are many different methods of attacks, these include homogeneity attack, unsorted matching attack, complementary release attack, temporal attack, and background knowledge attack. In order to prevent any kind of attack, other techniques of anonymity are introduced. T-closeness, l-diversity are some of them which are extensions of  $k$ -anonymity.

To solve the vulnerabilities of  $k$ -anonymity, l-diversity is applied. L-diversity aims to determine the issue of attribute disclosure. This method requires that sensitive data attributes, at least  $l$  well-presented values must be diverse within each quasi-identifier equivalence class. [15]

The t-closeness model extends the l-diversity model by treating the values of an attribute distinctly by considering the distribution of the data values for that attribute. So, it demands that the apportionment of a sensitive attribute in any equivalence class is close to the apportionment of the attribute in the overall data set. [15]

These methods are just a few among many methods that are extensions of  $k$ -anonymity and are used in combination with  $k$ -anonymity as an attempt to reduce attacks. Because there is an increased need for preserving the privacy in data sets, and current methods are inadequate as they cannot guarantee privacy, researches continuously try to improve the existing methods or develop new and stronger techniques. Algorithms play a significant role in anonymization, which is why many organizations use them. People cannot deal with the vast amount of data and format data row by row to achieve anonymity. Rules are applied to algorithms and then they execute the procedure of anonymity. There are many different algorithms and software that can be implement in order to make  $k$ -anonymity possible. The main objective of these algorithms is to mitigate the risk of de-anonymization of the data and reveal the data subject's identity. Obviously, companies cannot publish or post on



their websites how they apply and handle anonymity. If data privacy techniques were published, anyone could uncover people's status. Usually, organizations state information on how they handle this in their privacy policies but in very broad terms and often inaccurately. This results in sensitive data belonging to a data subject is safe but without having a clue how this is achieved.

## 8.2.2 Quality of The Data

There are many ways to collect data and many ways to use data. However, ultimately the value of data heavily depends on the quality of the data acquired. For instance, the data acquired by the Forerunner 945 is intended to be sold to different customers (see the Business Model Canvas) yet the data will only be in demand if the quality of the data is perceived as adequate for the purpose of the data is needed by the customers. Which is why the level of data quality depends on what the data is needed for and how the receiver that need the data perceives them.

### 8.2.2.1 Assessing Data Quality

There are a variety of data and metrics that can be used to measure the quality of data. Consequently, there are disagreements between data quality professionals on how to measure data quality. However, when assessing the dimensions that influence data quality the DAMA UK has defined six core dimensions that should be used when categorizing types of data quality measurements [16]:

- Completeness
- Uniqueness
- Timeliness
- Validity
- Accuracy
- Consistency

Where *completeness* raises the question of whether the data set is complete and if all data recorded are included in the data set. Completeness is also related to the validity and accuracy dimension. *Uniqueness* raises the question of the uniqueness of the data set and is related to the consistency dimension. The *timeliness* dimension looks at how the data set represents reality and is thus related to the accuracy dimension. The validity dimensions questions whether data is valid by looking if the data conforms to the syntax of its definition. The *validity* dimension is mandatory to be used when assessing data quality and it is related to the accuracy, completeness, consistency and uniqueness. The *accuracy* dimension is a measure of how closely the data represent the state of the real world at any given time and is therefore also related to the validity dimension. The *consistency* dimension deals with the absence of differences when a representation of datasets is compared against a definition. The consistency dimension is therefore also related to the validity, accuracy, and uniqueness dimensions. The word dimension is adopted to identify the aspects of data that can be measured and qualified.

### 8.2.2.2 Requirements for Data Quality by Segment

In order to use the six core dimensions mentioned above, it is important to define the expectations the different segments may have of data. (see the Business Model Canvas – customer segment)

If the requirements for data quality were to be arranged in such a way that they illustrate the level of precision expected by each customer segment. It would require interpreting the qualitative definitions of the six core dimensions into data quality measurements such as “Data Quality scores” (DQ). Thereafter, measured according to a relevant metric that provides an objective assessment of quality. The DQ score can be a score for a dimension or an aggregated score of multiple dimensions etc. [17] Furthermore, the quality requirements, that data is expected to meet are set by the company in the form of criteria, however, these criteria differ and reflect the nature of the company [18]. For instance, advertisers may value the timeliness higher than say accuracy. That is, advertisers or athletics brands may find it more important to have data available in a timely manner, in order to have time to respond to market trends, whereas researchers may not be as time-sensitive but require data to be highly accurate. Thus, the same data may not achieve the same score by two companies, if the companies differ in nature.

### 8.2.3 General Data Protection Regulation

This subchapter contains the legal regulations that are relevant when working with data from European residents. This chapter is divided into two where the first part specifics the *General Data Protection Regulation* and the second part the *Danish Data Protection*.

#### 8.2.3.1 Geographical Scope and Definition of Data Sensibility

In order to protect European citizen, the member states of the European Union (EU) have set common rules that apply for all member states in the form of the *European Union General Data Protection Regulation* (GDPR) which was proposed by the European Commission and entered into force in May 2018 [19]. The territorial scope and the material of the EU Data Protection Regulation (hereafter referred to as “The Regulation”) are treated in Article 2 and 3 in the Regulation. The Regulation focuses on setting a standard on the protection of personal data thereby imposing regulation on the processing of personal data and the movement on such data. The Regulation applies to organizations based inside and outside the European Union if they collect or process data of EU residents. The Regulation operates with two definitions of data sensibility that is “personal data” and “sensitive data”. Personal data are defined in Article 4(1) where personal data is defined as data that contains information related to *an identified or identifiable natural person*, where identifiable natural person is defined as:

*one who can be identified directly or indirectly in particular by reference to an identifier such as name, an identification number, location data, an online identifier,*

*or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.*

While sensitive data is defined as data that is related to the person's racial or ethnic origin, political beliefs, religious or philosophical beliefs, union membership, genetic or biometric data, physical or mental health, sexual orientation. When treating data that is defined as personal or sensitive the regulation requires explicit consent from the data subject.

### **8.2.3.2 The Danish Data Protection Act and Practices**

The Danish Data Protection Act (hereafter referred to as “the DDPA”) sets the principle rules and practices for the collection and processing of personal data. The DDPA applies to private companies, organizations, associations, and the government. The DDPA sets out different terms and conditions that define the way personal data are processed and when they may be processed. The DDPA defines processed in section 3(2) as *processing shall mean any operation or set of operations which are performed upon personal data, whether or not by automatic means*. The DDPA categorizes personal data in three different categories: sensitive information, information regarding private affairs, and common non-sensitive information. Section 7 in the DDPA defines sensitive information the same way as the GDPR i.e. information regarding race, ethnic background, political, religious or philosophical conviction, union membership and information related to health or sexuality as sensitive information. The DDPA deals with the use of social security numbers in section 11(2), where social security numbers are categorized as sensitive information. However, the use and processing of social security numbers are merely regulated in section 11, unlike personal data which according to section 7 (1) requires a legal base for processing. Moreover, section 11(3) states that even publishing is possible if consent has been given. However, the category of personal data and the level of sensitivity of the information is not definitive in how the information is handled, as the essence is important as well: *“the context the personal data are held or used might be more important than the data itself”* [20]. Consequently, social security numbers in Denmark are commonly processed and treated as sensitive data, even though they legally are not characterized as such. This is because social security numbers give access to sensitive data and are used frequently as login credentials i.e. NemID. Nonetheless, section 6 in the DDPA covers the general rule, where merely explicit consent is required unless specific personal data is regulated such as the data in sections 7 and 11.

### **8.2.3.3 Consent and Rules on The Processing of Data**

The Regulation discusses the question of consent in Article 7 where it is stated that the declaration of consent must be distinct from declarations related to other aspects of consent such as acceptance of terms or acceptance of general conditions. The Regulation defines consent in article 4(11) as *“consent of the data subject means any*

*freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of personal data relating to him or her". [20]*

Consequently, the Regulation requires stricter standards for getting consent and thereby obtaining the data of subjects. Furthermore, the DDPA states in section 6 that personal data may only be processed if [21]:

- a) The data subject has given explicit consent; or
- b) Processing is necessary for the performance of a contract to which a data subject is a party in or if the data subject has given permission in connection with the establishment of a contract.

Regarding the processing of data, the DDPA states in section 5(1) that data must be processed in accordance with good practice for *the processing of data*. Furthermore, the DDPA also demands in section 5, that the collected data may not be kept in a form that allows the data subject to be identified for a longer period of time than the time required to process the data for which purpose it was first collected. Moreover, the collected data is also required to be accurate and corrected if it is not accurate. Accordingly, the DDPA also requires that the data be organized in a way that ensures that no inaccurate or misleading data is processed. [22]

### **8.3 Market Research**

For conducting an efficient marketing and sales-related operations, many companies use marketing research processes with the purpose of investigating behaviour, gather information about their customers etc. Marketing research processes can be described in a few stages. First, the problem and objectives of the company are defined by management to the marketing department. Thereafter, a plan for the investigation of the market is made, which usually is related to the problem definition. Data used for the market research can be primary data, which typically is data that is collected recently and specifically for the defined problem. In a market research, primary data involves collecting data directly from target groups which is why access to primary data is expensive and often time-consuming. However, secondary data which is already existing data is often used as well, although it is of lower quality as it is not as precise as primary data and therefore also less expensive. The market research usually is complete when the collection of data is performed and an analysis of the data is presented to the decision-makers, i.e. management [23].

The data used in a market research can also be a combination of primary and secondary data. Whereas the data collection methods i.e. qualitative and quantitative, are contained in primary investigations. Qualitative methods rely on close sources and methods such as interviews, observation, studies, measurements of targeted groups. However, it is often expensive for companies and not feasible to contact each customer when using a qualitative data collection method. Therefore, the norm is to

apply sampling plans that are based on statistics, where a group represents the target customer.

Problems related with the qualitative approach are closely linked to the gathering of information from groups. Language barriers can be present if the survey is meant for a broad international market or participants do not fully answer questionnaires, or the questionnaires are conducted incorrectly, etc. Qualitative methods use more detailed questions and examinee answers containing more variables than say a quantitative method [24]. On the other hand, the quantitative methods gather fewer variables in the research but have a higher number of participants. The results of a quantitative research is descriptive and based on a statistical summary. Furthermore, the flexibility of structuring research layout is low and the communication between the interviewer and the participants is usually one-way direction. However, triangulation allows room for the qualitative and quantitative method to be used resulting in a symbiosis where the methods complement each other. Consequently, the output of the research is more complete, and it improves the understanding of the investigation. Measurement for all types of research methods needs to have reliability and validity since the examination without them is worthless. While sampling plans are based on probability and non-probability sampling. [24]

Secondary research uses as described secondary data. This research is performed from the location of the company, which means that the data is mainly gathered from the Internet and other sources. The effects of this approach are enhanced objectivity and are low costs but are less reliable. Sometimes data is simply not available and is scarce for some areas. The classification of available data can be too broad, and not accurate enough. Moreover, the data sources can be internal or external. Internal data refers to existing data the company already has, this includes data such as total sales, sales volume, historic pricing information, etc. Furthermore, the external data available is public and it is data about the external business and factors impacting the sales of product. Methods for secondary research can be “*proxy indicators*” or “*chain ratio*”, lead-lag analysis, estimation by analogy, etc. The proxy indication refers to data that is difficult to collect from a direct source, thus gathering data from other sources that are similar or in correlation with the targeted source. The chain ratio is an estimated calculation, for instance, multiplying the population X with the percentage Y of ones who have resources to buy the product and multiplying again with another chain factor percentage Z. The result of  $X \times Y \times Z$  will give an estimated base number of possible customers. Lead-lag can be described as a method that takes into consideration two business curves from two countries in two timespans. It analyses future trends with these two parallel variables. On the other hand, an estimation analogy relies on the comparison of values from two different markets, thus making the needed estimation. These are some of the methods among other secondary research approaches. [24]

## 8.4 Requirements for Devices to be Certified as Medical Grade

Devices need to go through several phases before they are certified to be included in the medical device category. From the early stages in the development process where ideas for the product are being constructed, manufacturers recognize and bear in mind that they are developing a device for medical purposes. Therefore, because devices need to comply with strict regulations in later development stages, products are categorized as medical in the early development stages. [25] One of the relevant regulations is “DIRECTIVE 98/79/EC” where the definition of a medical device is defined as [26]:

*“‘medical device’ means any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application, intended by the manufacturer to be used for human beings for the purpose of:*

- *diagnosis, prevention, monitoring, treatment or alleviation of disease,*
- *diagnosis, monitoring, treatment, alleviation or compensation for an injury or handicap,*
- *investigation, replacement or modification of the anatomy or of a physiological process,*
- *control of conception,”*

Consequently, devices that are already presented on the market and do not comply with this definition are not eligible for the certification as a medical device. That is, smartwatches that have numerous features that are not indented for diagnostic purposes or prevention etc. cannot be graded as medical devices. On the other hand, this does not necessarily mean that the performance of smartwatches for monitoring and activity tracking is lower than the performance of medical graded devices. If multimedia features or other none health features of wearables are neglected, and the device can continue with the procedure, it would need to go through several other stages for the categorization. In the test phase, the manufacturer has the option of proving that the abilities of the device are the same as that of products already on the market or a notified body needs to explore into details a new non-existing product and approve. Upon approval, a device needs to get a classification class mark. The European Commission has published a guidance document for grading medical devices. For instance, devices that are either not in contact or in light contact with the user’s skin are categorized as class I. Devices graded as Class I include, devices such as, a dentist’s hand mirror, lights for illumination, active monitoring devices, etc. While other grades of classes are distributed according to the risk impacting the patient’s life. That is, devices with a higher-class grade, are used in more invasive situations, for instance, class II includes devices such as infusion pumps or tubing, etc. Therefore, if smartwatches were able to be certified, they would be categorized

and possibly graded as class I. There are four possible classes for medical devices; I, II a, II b, III. [27]

For the European market, all medical devices within class I are required to be “CE” marked. This tag proves that a product is regulated and complies with the EU requirements. The notified body oversees and assesses whether the technical documentation, the safety of the device, and quality etc. meet the requirements for the CE mark. Furthermore, when a product is placed on the market, they are obliged to report to the Danish Medicines Agency any irregularities associated with the device. Customers can also report any issues they may have with a device themselves as well. Moreover, re-certification is needed for higher classes and stricter rules are applied. [25]

On the other hand, internal components of smartwatches can be of the same quality as medical devices, even though the smartwatch as a whole is not regulated. For example, a sensor used for measuring the heart rate can be “off the shelf”<sup>1</sup> integrated circuit cheaply sold in large quantities. For instance, the “Rohm Semiconductor” company produces optical sensor “BH1790GLC-E2” for heart rate monitoring sold by “Mouser Electronics” wherein the datasheet of the component it is stated that reliability is enough for medical purposes of class II b and class III. This implies that if the smartwatch had an internal component such as this “of the shelf” sensor as described, that internal component would satisfy the requirement for medical-grade usage. [28]

## 8.5 Sub conclusion

It can be concluded that the Value Proposition Canvas and the Business Canvas are good development frameworks for creating a blueprint of XYZ and its product. While on the other hand SWOT analysis as the acronym states, looks at the strengths, weaknesses, opportunities and threats for determining and securing a stronger position in the market. Regarding anonymity many information are available online therefore there is a way where an individual has high probability to be identified from different sources of data. Furthermore, if data is anonymized too much the quality of data is reduced. Moreover, regulations related to the GDPR and Danish Data Protection Act are established in order to safeguard privacy and rights of people using devices and digital platforms. Furthermore, if data is anonymized it falls out of the scope of the GDPR. For the market research of XYZ company there were shown two categories for collection of data. The second category called secondary data will be used for the purposes of this report since it is the public data that can be easily gathered. At the end it was shown that devices such as smartwatches cannot be classified as medical devices as they do not meet the legal requirements.

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<sup>1</sup> “off the shelf “– sold on the open market, not designed for specific usage, purpose or order

## 9 Technologies Applied

This chapter looks at four different smartwatches and continues with a general comparison of the smartwatches and their differences. The chapter continues by focusing on how data is handled by the network infrastructure when it is sent and received from the smartwatch. Furthermore, the chapter looks at the legal requirements, privacy and permissions related to the Garmin Forerunner 945. Different application programming interfaces of each smartwatch company are described as well, along with their web services and features. In the end, a conceptual software architecture is depicted that is used internally by XYZ that processes and sells data to other entities or businesses. The technologies used are general ones that are included because they are important to provide an overview for the collection of data.

### 9.1 Introduction to Different Smartwatches

This subchapter looks at four different smartwatches and brands. Smartwatches have different built-in features and most of these features generate some activity information. Moreover, each smartwatch model described has different sensors, features, and characteristics. Smartwatches can save data in their specific format and record similar, the same or different kinds of user data. These brands have a different price range, data accuracy and overall quality build. The data communication is held with the help of protocols across wireless technologies such as Bluetooth and Wi-Fi. In addition, smartwatches can be specialized for sport or to be universal tools. However, most of them are used as extensions for smartphones. Thus, a description of the smartwatches operating systems, applications, software and overall user experience is provided.

#### 9.1.1 Google Watch

Google smartwatches were introduced with Wear OS. Google does not develop its own smartwatches, therefore when referring to Google watch, it is a reference to smartwatches that use Google's operating system. Many well know and established designer brands use Google's operating system in their version of the smartwatch. This group of brands includes brands such as Fossil, Michael Kors, Armani, Mobvoi, etc. Each of them may have different hardware specifications (sensors, battery life, etc.) but the software philosophy is similar.

WearOS, previously known as Android Wear, was first launched in 2014 with main design goals being simplicity and functionality. The simplicity goal may have been achieved as it is easy for Android users to use these smartwatches. The WearOS allows compatibility with Android 6.0+ (apart from the Go edition) and iOS 10.0 and later software versions, that is, iPhone 5 and later versions, the latest version of WearOS is v26.0. The features that are supported may vary between platforms and countries [29]. Most WearOS devices have round displays. WearOS provides some



“built-in” applications which include Google apps such as Calendar, Assistant, Weather, Fit, Maps, Translate, Play Store, Pay. Some of the smartwatches produced by Mobvoi, also include applications such as the Tic Exercise, Tic Pulse, Tic Health, according to the watch producer. These applications were included because they are expected to help the user in his or her everyday life. The user can get notifications on the display when new messages, calls, or emails are received. In addition, the watch also notifies the user when it is time to go for a walk after a long period of inactivity such as doing a stationary desk job at work. The smartwatch tracks a user’s activities such as walking, running, and biking etc. while also measuring the heart rate.

Users can navigate through the smartwatch as if they were using their smartphone, this is achieved by getting rid of extra information and by providing only primary action buttons that represent the top actions of an app or activity. Furthermore, the smartwatch offers easy access to the user's most used and most important information, by displaying them on the main screen. In addition, WearOS apps have two state modes, active and always-on. In active mode, the display is on and receives input continuously. In active mode, all animations and interactions are enabled. In always-on mode, all interactions are disabled and the display switches to power-saving mode. It reduces battery usage by reducing the number of lit pixels on the display [29]. Smartwatches have microphones which allow the users to make use of Google Assistant, or reply to message and speaker so that they can answer calls directly from their watch.

The Mobvoi TicWatch C2 is a” Google Watch”. It is a stylish smartwatch that has won two design awards, the iF Design Award 2019 and the Red Dot Design Award 2019. The Mobvoi has a stainless-steel case and a leather strap that is interchangeable and has two buttons to help the user navigate through the interface. The price according to the official website is about DKK 1500. Regarding the technical specifications, the TicWatch C2 dimensions are 42.8x42.8x12.7 with 1.3” AMOLED 360 x 360 px round display. Its platform is Qualcomm Snapdragon Wear 2100 with 512M RAM and 4GB ROM. Battery capacity is 400mAh, which translates to a battery life of up to 2 days, depending on the usage. The Mobvoi TicWatch supports Bluetooth v4.1 and WiFi 802.11 b/g/n (other newer WearOS devices can also support 3G and LTE connections). In addition, the TicWatch C2 has a multi-navigational system for precise and responsive positioning, including GPS, GLONASS, and Beidou. Furthermore, sensors play an important role in the operation of every smartwatch. This smartwatch is equipped with an Accelerometer, Gyroscope, a Heart-rate sensor and supports NFC for payments, which is very useful and has gotten very popular recently. The further technical specification includes the fact that the smartwatch is waterproof with an IP68 rating, meaning that it is water and dust resistant. It is possible to swim while wearing it, in shallow waters. [30]

### 9.1.2 Apple Watch Series 5 (GPS with Cellular)

Apple Watch Series 5 was launched by Apple Inc. on September 10<sup>th</sup>, 2019 as the continuation of their product line. This smartwatch compared to previous version was an upgrade where the improvements include the three main features - Always-On Retina display, compass sensor, and International Emergency Calling. Furthermore, it features watchOS 6 operating system with a few new apps. [31]

Customers can choose a model with additional cellular support; this will ensure standalone Internet connectivity for the smartwatch. However, due to power efficiency, it will search connection from the paired phone via Bluetooth, or if the phone is not within an area of connectivity, it will try to connect to a Wireless Network. Therefore, if either the phone or Wi-Fi is unavailable it will use a cellular connection. Cellular connectivity enables this smartwatch to fetch information from the Internet as a standalone device. [32]

The series of Apple watches is only compatible when paired with Apple smartphones, requiring a minimum version for the device as iPhone 6s and iOS 13 for the operating system of the smartphone. It is stated that lithium-ion battery can handle around 18h of usage and it can be recharged with a magnetic cable. As previously mentioned, the Apple smartwatch supports cellular connectivity LTE and UMTS, wireless standard 802.11b/g/n on 2.4GHz frequency for Wi-Fi and Bluetooth 5.0 version. The storage capacity of the watch is 32GB. The main hardware for wireless is W3 chip and S5 chip for processing with an integrated 64-bit dual-core processor. [33] Backplane technology for the organic light-emitting diode display (OLED) [34] is a low-temperature polycrystalline oxide (LTPO) [35] resulting in a very bright screen with 1000 nits, where the display has the option to be always on. Sensors in this watch are a compass, barometric altimeter, electrical heart sensor, second generation of optical heart sensor, accelerometer (up to 32 g-forces), gyroscope, ambient light sensor, touchscreen, and microphone. Supported systems for navigation are GPS, GLONASS, Galileo, and QZSS. [36]

The watchOS 6 comes with 37 preinstalled applications ready for usage. The apps can be set for quick accessibility in the Dock menu (up to 10 apps). It is possible to reorganize the positions of apps in the hexagonal structure view via smartphone graphical interface or on the watch itself. Additional apps can be installed with the App Store app with the phone or the watch and already compatible installed apps on the phone can be added to the watch. There is an option in the smartphone setup of the watch where the user can enable or disable “hide sensitive compilations”, this will hide sensitive data when the user is not looking at the watch and the wrist is turned away. [37] Preinstalled apps can be useful for a user to monitor his or her health state by following the heart rate information and electrocardiogram or they can be organizational tools to provide quick access to reminder notes, email content, calendar, voice memos, etc. Moreover, it offers some applications for customers to

take their observations for physical activities such as walking, running, swimming, and other workouts or to meet their daily activity targets. Users can enjoy multimedia apps such as listening to music, audiobooks or podcasts as well as track stock market values, be informed about the weather, look at the latest news or listen to local radio. In addition, many of the apps are tools that help in various ways to ease the daily actions by providing help with utilities such as alarms, world clock, calculator as well as navigate the user by providing the user current directions with a compass and give user location on the map. This smartwatch can serve as a communication device as well, for example, messages can be answered by converting audio speech to text strings thus making it convenient for short replies as well as for answering phone calls. Moreover, if users connect to each other using Wi-fi or Bluetooth it can serve as a walkie talkie. Further, some applications offer remote connectivity, for instance, Apple TV can be controlled via the watch, or smartphone can take a picture that is remotely triggered with watch. [37] Moreover, it has the ability for a user to do transactions with the watch at stores by using Apple Pay. Special safety features for this watch are fall detection, quick emergency call, and noise level safety. [37]

### **9.1.3 Samsung Galaxy Watch**

The Samsung Galaxy watch was launched in summer 2018, the Galaxy watch is a lifestyle focused smartwatch that is equipped with many different features such as Samsung Pay as well as support for many different fitness activities. The Galaxy offers tracking for many fitness activities including running, walking, cycling, swimming, and yoga [38]. The Galaxy watch is connected to the Samsung Health App which helps the watch autodetect 7 of 39 features, as well as stress management and breathing features. The Galaxy watch has many other preloaded health related features which include a collection of 19 indoor exercises and 39 tracked workouts [39]. The Galaxy watch is available with cellular function, which allows the watch to receive calls, text, and maintain access to the internet when it is not connected to a phone or Wi-Fi.

The Galaxy watch comes in two sizes the 46 mm dial and a 42mm dial, weighing 63g and 49g respectively without a strap [39]. The different sized watches have different sized batteries, the 46mm has a 472mAh and the 42mm a 270mAh. The battery of the Samsung Galaxy Watch lasts up to 168 hours for the 46mm model and 120 hours for the 42mm model. However, the actual battery life depends on the features used and the network environment. Subsequently, when using the GPS functions for its weather applications and outdoor tracking exercises the battery consumption is significantly increased. [40]. Furthermore, the Galaxy watch has “Always on Display” features which also reduce the battery life significantly. [38] The Galaxy watch has a Circular Super AMOLED display and a resolution of 360 \* 360. AMOLED (Active Matrix Organic Light Emitting Diodes) developed by AU Optronics which later Samsung has marketed as Super AMOLED [41]. The Corning Gorilla Glass DX+ feature enhances display readability up to 75% compared to the older version [42].

The operating system used in the Galaxy watch is the Tizen Based Wearable OS 4.0. Tizen is a Linux based mobile operating system which is developed and used by Samsung Electronics. Samsung merged its previous mobile operating system 'Bada' into Tizen in 2013. Since then, Samsung has been using the Tizen Operating System in their wearable devices. The Galaxy watch runs on the Tizen Operating System because it needs support for the functionalities of the rotating bezel. However, the Tizen Based Wearable OS 4.0 does not have many third-party app supports which results in the user being forced to use the default app provided by Samsung. The Core architecture is Cortex A53 with clock speed 2Ghz comes in a System-on-Chips (SoCs) named Exynos developed by Samsung Electronics [43]. It has 4 GB Flash Memory along with 1.5 GB RAM for the LTE version of the Galaxy watch whereas the Bluetooth version only supports 768 MB RAM with 4 GB Flash Memory. [39] The Galaxy watch is up to 5 ATM water resistant and IP68 certified, which consequently means that it is not suitable for diving or high-pressure water activities [44]. The watch is compatible with all Android 5.0 or higher devices as well as iOS 9.0 or above.

#### **9.1.4 Garmin Forerunner 945**

The Garmin Forerunner 945 (Forerunner) is a smartwatch that is part of Garmin's wearable collection. The Forerunner is categorized by Garmin as a triathlon athlete watch, where it allows the user to utilize different build in features such as maps, training status, performance monitoring, Garmin pay, music, safety and track features that send the location with any chosen contact etc. Furthermore, Garmin allows new apps to be downloaded to the Forerunner via the Connect IQ Store where a selection of training related apps is available. As well as, apps that are deemed useful when doing everyday tasks such as calendars, Uber, weather, news, Wikipedia, phonebook, smart lock etc. [45]. The operating system used by Garmin smartwatches is the Garmin OS, which was developed to specifically for Gamin watches. [46]

The Forerunner was introduced in April 30, 2019. The price begins at \$599.99 without extra equipment [47]. Furthermore, it also provides access to the Garmin Connect online community, where it allows the user to share workout plans, history, and milestones with friends that are part of the Garmin Connect online community. Thereby, get inspiration when planning workout plans from friends and get motivated [48]. The Forerunner, as many other smartwatches also allows activity tracking features, this includes step count, distance traveled, calories burned, and sleep statistics etc. However, many of the features that provide information related to the recorded activities require a Garmin heart rate monitor to be paired with the Forerunner. [49]

When the Forerunner detects an incident during an outdoor activity the Garmin Connect app, that the Forerunner is connected to sends an automated message containing the user LiveTrack link and GPS location to the chosen emergency contact. Before the message is sent it appears on the Garmin Connect app with a 30 second countdown indicating the remaining time the user has left for canceling the alert. The LiveTrack, feature is a feature that allows the user to invite viewers using email or social media to view the user activity data in real-time on the Garmin Connect tracking page. [50]

The *Performance condition* is a feature in the Forerunner where performance is assessed in real-time and compared with the user's average fitness level. The feature *Training load* focus is also a real-time feature that analyzes the physiological impact of an activity when intensity varies. The calculations for the training load focus feature are conducted using information from the EPOC-based training load feature which evaluates data recorded on a weekly basis of all the activities recorded using heart rate data. EPOC is an acronym for excess post-exercise oxygen consumption, which is the oxygen consumption after a workout compared to the oxygen consumption during rest. All Garmin watches are equipped with a Firstbeat analytics engine, which can analyze heartbeat data and apply advanced mathematical learning and machine learning and thereby predict EPOC in real time. [51]

The Forerunner has a wrist-based *Pulse Oximeter* built in. The pulse oximeter calculates the peripheral saturation of oxygen in the user's blood. Thereby, helping the user determine how the body is adapting to high altitudes. Furthermore, the Forerunner allows the user to turn on "all-day-readings" as well which allows the Forerunner to analyze and collect data on the user's oxygen saturation and elevation level. On the Forerunner device the data is presented as an oxygen saturation percentage and a colored graph. Furthermore, the Forerunner allows the user to conduct a Heart Rate Variability (HRV) stress test. The HRV test that can be conducted using the Forerunner where the level of stress is determined by using a chest heart rate monitor and scored from 1-100 where low scores indicate a low level of stress [52] [53]. *Lactate threshold* is the exercise intensity in which lactic acid starts to accumulate in the bloodstream and when a runner exceeds the threshold, fatigue starts to increase in at an accelerated rate. In order to determine the lactate threshold a chest heart rate monitor is required.

The battery the Forerunner is equipped with is a rechargeable lithium-ion battery. The Forerunner has a battery life of up to 2 weeks in watch mode, which includes activity tracking, smartphone notifications, and wrist-based heart rate. However, the battery life is reduced to 14 hours when music is played. On activity mode where GPS and the wrist-based heart rate monitor built in the Forerunner are used, the battery life is reduced to 36 hours. The battery life is further reduced to 10 hours on activity mode

when music is added. However, on UltraTrac mode the battery life is 60 hours, and 50 hours when the wrist-based heart rate monitor is used. The UltraTrac mode is a feature built in the Forerunner, where the GPS is periodically off with the purpose to save battery life. When UltraTrac is on the Forerunner uses the accelerometer to calculate speed and distance [45].

The storage in the Forerunner is approximately 20GB. However, when maps are downloaded to the watch, the storage reduces significantly. Thus, the storage amount that is left for songs that can be downloaded into the Forerunner is reduced and, in some cases, significantly [54]. Furthermore, the Forerunner stores training history which includes time, distance, average pace or speed, lap data and optional sensor information, and when the device memory is full the oldest data is overwritten. However, if data is transferred to Garmin Connect it can be stored indefinitely.

The Forerunner uses Bluetooth to connect to Garmin Connect that is downloaded to the smartphone. The Bluetooth connection allows for alerts to be received. However, the Forerunner also supports WiFi connections, which is used in instances such as when new training plans are selected in the Garmin Connect site, the plans are automatically transferred when the Forerunner is connected to WiFi, this is also how the activity data is sent to the Garmin Connect [55].

Which map that is preloaded in the Forerunner depends on the continent the watch was bought. Consequently, adding an additional map or changing to a different map includes some additional charges to the watch users. Furthermore, these new maps require that the files be transferred from a PC and if a Mac is used it requires Android file transfer to copy the files manually. [56]

When the map is in place, the user can create the routes using Garmin Connect or use the “popularity routing” feature in the Forerunner which calculates the routes based on popularity on the Garmin Connect. This, however, also means that areas that are not as popular or that are remote have fewer routes, if any. [57]

The Forerunner is equipped with three different satellite systems, GPS, GLONASS, and Galileo. By default, the Forerunner uses the GPS satellite system. However, the Forerunner allows one of the other satellite systems to be active while using the GPS satellite system, however, this results in loss of battery life. [58]

## **9.2 Differences Between the Various Smartwatches**

The smartwatches previously mentioned have their strengths and weaknesses, as each of them has a different operating system. Their functionality differs and the level of simplicity is subjective as the target groups differ. The Google watch, the Galaxy watch, and the Apple watch focus more on everyday usage and tasks, while the Forerunner 945 watch is dedicated to athletes. That does not mean that non-athletes cannot or should not use the Forerunner 945, but the features that the Forerunner

provides were developed with athletes in mind. Another important consideration about functionality is the compatibility with smartphones. For instance, the Apple Watch series 5 is only compatible with iPhones whereas the remaining smartwatches are compatible with both Android and iOS. Though, in some cases some of the features are limited when using iOS.

When comparing the design of the different smartwatches, the Forerunner watch is designed with a focus on a durable exterior and is thus more tolerable to exterior impacts, while the other watches are designed with focus on an elegant exterior. All of them can be connected to a smartphone using Bluetooth but can also work individually with WIFI or a cellular connection, except TicWatch C2 that does not support cellular connectivity. Users get a notification when messages, calls, emails, events etc. are received.

When comparing the technical specifications of the different smartwatches, the Forerunner has the largest number of sensors 10, the Apple watch has 6, the Galaxy watch has 5, and Google watch has 3 sensors. The more sensors a watch has the more precise data and functionalities it offers. Though the number of sensors in the Forerunner is greater than the other three smartwatches, it achieves a battery life of up to 2 weeks, with normal usage while the others only manage a couple of days. The Forerunner has a longer battery life, because the other smartwatches have more interactive interfaces with color displays, appearing more appealing to some users. Whereas, the Forerunner was built to withstand difficult situation.

What differentiates the Galaxy watch from the others, is the rotating bezel that helps users explore the screen by scrolling up and down, increase and reduce volume, zoom in and out etc. Whereas, the TicWatch C2 merely offers the basic functionalities but differentiates from the other watches by being the cheapest. Whilst the Apple Watch Series 5, differentiates by the rectangular shape of the case and the Forerunner uses 5 buttons to navigate.

### **9.3 The Different Ways to Collect Data**

The different smartwatches that were mentioned in the last subchapters differ from each in other areas as well. This subchapter looks at the differences between the API's and SDKs of the different smartwatch brands. As well as, the storage and handling of the data collected by Garmin smartwatches, and the legal requirements, privacy and permissions related to the Garmin Forerunner 945.

#### **9.3.1 API's And SDK's of Different Smartwatch Brands**

Smartwatches come with different operating systems, applications and watch faces depending on a brand. Applications for installation on smartwatches are usually located on a public web place where they can be downloaded via the Internet.

Installation of applications on the smartwatch can be done standalone, with the help of a smartphone or even with a computer. Companies often offer devices and software together with web services and environments for developing applications. Moreover, it is common that the Application Programming Interface (API) is provided for third parties if the web service is offered. In the following examples of services are shown, of some smartwatch software and device producers:

Google – Google Wear OS is a software development kit (SDK) for wearable devices. This SDK is based on the Android platform. It enables developers to write applications for smartwatches with cross-platform features like notifications and “Action on Google”. Action on Google is a feature related to Google Assistant where it expands the usability of smart devices with voice commands. Furthermore, Google offers an online web service where users can download applications, called Google Play Store. Before publishing applications on the platform, applications need to meet basic Google quality and design guidelines. [59] In addition, this company offers a multitude of SDKs together with programming APIs and web APIs documentation. Moreover, if the physical activity of a user is taken into consideration most related product would be Google Fit. This product has development APIs for easier data collection, sensor discovering, user activity history handling. It offers REST API as well for their web service that contains an overview (web app) and storage (fitness store) of activities. Further, they have a partnership with other entities that produce handheld and wearable applications compatible with Google Fit. [60]

Apple –Apple has framework Health which has a software development kit. Apple’s Health Kit simplifies programming of applications by providing libraries that offer smoother user experience, support for interconnectivity with web service and convenient help for the representation of parsed data from sensors. Furthermore, Apple offers health application for smartphones and dedicated web services with API for third-parties access. Data collected with collaborator apps is stored with other activity data on the Apple Health web platform. [61]

Garmin – Garmin provides the Connect IQ SDK for developers to build smartwatch applications. Apps are written in Monkey C language and developed in the integrated development environment (IDE) Eclipse. The environment with SDK offers a simulator, where the graphical interface of the application can be tested. [62] In addition, Garmin has Health SDK accessible by company enterprise clients. This SDK is intended for mobile phones in order to support data collection from wearable devices. Moreover, Health SDK is divided into two categories Standard SDK and Companion SDK. The first one does not have support for real-time data, Garmin Connect applications, etc., while Companion SDK, on the other hand does, but it has fewer data types available, supports more Garmin wearable devices and all-day history logging. [63] Web service is available under name Garmin Connect where



data can be analyzed, tracked, shared, etc., from Garmin wearables. Further, along with the web service, access for data for third parties is provided by Garmin Health API. [64] Data of workouts can be uploaded to the centralized Garmin Connect place with Training API. Both web APIs are based on REST architecture and data for apps can be configured independently. Applications built for smartwatches support custom Garmin geographical maps. [65]

Samsung – Applications for the Samsung smartwatches are developed in Tizen Studio IDE with Samsung SDK. Development of apps is conducted in three approaches: by using the .NET framework and writing apps in C# language, by creating a web app that relays on the watch with HTML5, CSS and other web native languages, by developing a native app in C language. When apps are finished, they can be tested remotely on the web service. [66] Samsung Health is a collection of SDKs and applications for smartphones. These SDKs helps to track activity and help to share data with other partner apps by complying with user approvals. There are no web access points of centralized storage of data collected for Samsung Health. [67]

### **9.3.2 Storage and Handling**

A multitude of prevailing smartwatches such as the Apple and the Samsung smartwatch have an internal storage that does not exceed more than 32GB. [68] The internal memory of the smartwatches is used for storage of the operating system, various apps, and storage of the user data. User data space is mostly used to save music and other files of interest, for instance, to keep data always available with a user if the smartphone is not available at the time. Further, the internal storage can be used for the installation of additional apps, however, this depends on the different watches as they have different operating systems, software and hardware architectures. [69] In addition, some smartwatches can have the memory capacity increased. For example, iHome Fusion is a smartwatch that has an option to expand memory capacity up to 32GB with a micro SD card, while most of the other smartwatches do not offering the same feature. [70]

Because devices such as smartwatches are placed on the wrist, they need to be small. Lack of space means less place for internal electronic components such as a battery and small size obviously results in small screens. Energy scarcity results in limited capabilities of processing multimedia content and smaller screen can provide less information. For instance, Garmin Forerunner 945 has a screen of 1.2 inches and by the look reminds very much on regular circular shape watch with needle pointers. [71] Consequently, in some scenarios smartwatch applications are designed to make the watch to function as a streaming devices for notifications and messages. Thereby, making these devices best suited for modest interactions such as keeping the user updated when it is unsuitable or impossible to use a smartphone. This kind of usage where information is only shortly consumed does not require substantial capacity for

storage as there is no long-term data to persist on the device. For example, the Garmin smartwatches offer smart notifications where the user can see incoming text messages and calls but extensive history is not available. [72] However, there are other situations when the user needs to view, forward or share prolonged outputs over time from sensors. Moreover, the inbuilt support for navigation systems and map data can be substantial in size.

Data collected by the watch can be saved locally in the memory of the watch, it can be transferred to a smartphone app via synchronization or it can be sent over the network for storage on servers. Moreover, the data can also be synchronized with other wearables or smartphones by fetching information from the cloud storage. The parties can gain permissions and accessibility via an application programming interface (API) in cloud services. Different brands of smartwatches offer their own frameworks for data collection and web services for access.

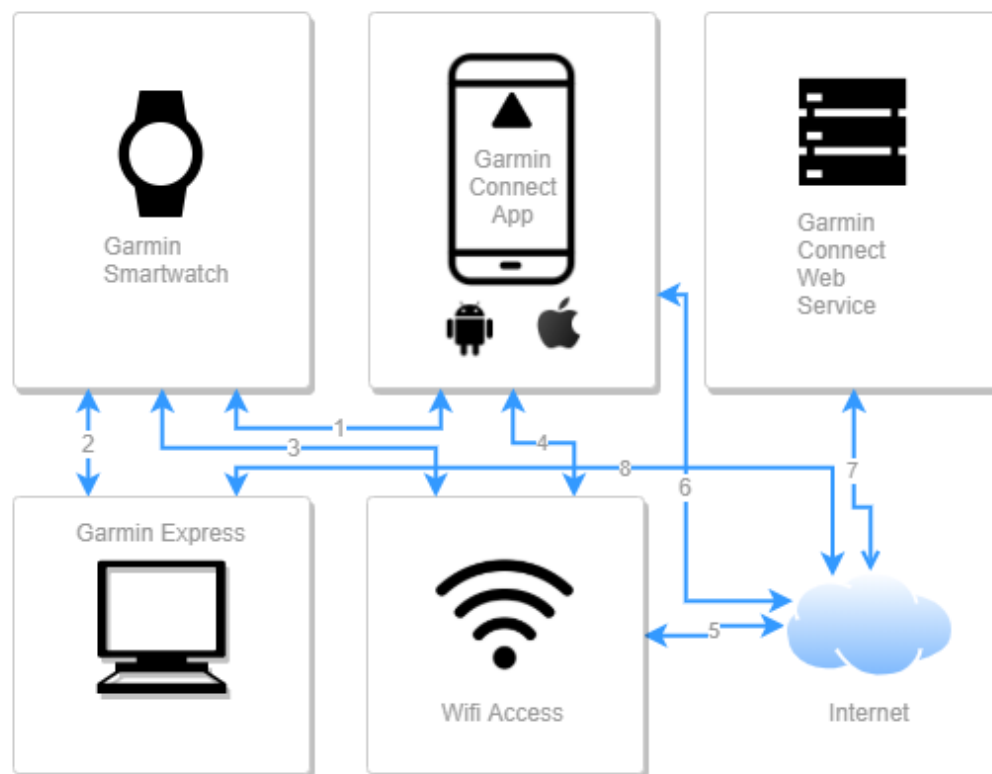
Data storage and collection accessibility can be categorized as:

- Data from smartwatch – local storage
- Data from Web Service – online service storage
- Explicit data collection – direct access to records
- Implicit data collection – data fetching through another device or platform.

Data is accessible on both locations by an implicit as well as an explicit way. That is, for smartwatch storage, fetching data directly would mean an explicit way and accessing the same data through a smartphone would mean implicit access. On the other hand, cloud storage explicit access would characterize data flow with API to the third party and implicit through another entity. [73]

For Instance, more sophisticated Garmin smartwatches support connection over Wi-Fi. Moreover, in order to set up a wireless connection for the smartwatch, a pairing with a smartphone is needed, when the smartwatch is paired with a smartphone, the wireless network can be set up with the credentials. Garmin offers three ways to integrate network communication on third-party apps installed on the smartwatch: Direct Messaging, communication over Garmin Connect Mobile and Wi-Fi Bulk Download. Wireless access allows explicit access to local storage for third party applications installed on the watch without the help of a smartphone. The implicit way of accessing local storage would be the Garmin Connect Mobile approach, in this way the watch uses the Garmin Connect app installed on the mobile phone as a proxy for external communication. Moreover, both implicit and explicit ways of communication with data from local storage can send web requests. On the other hand, communication is possible between smartwatch and handhelds exclusively with a dedicated mobile application via Bluetooth with Direct Messaging. Since the smartwatch can connect to the Internet standalone and send web requests, it can become an Internet of Things device. [74]

Data persisted in the local storage of the smartwatch also can be synchronized by a default way to the Garmin Connect web platform via the application Garmin Express on a personal computer (PC) by connecting the watch and PC via a USB cable. The PC application can install apps, update software, install maps, register devices, etc., however, it cannot access data in an explicit or implicit way. Synchronization can also be done with Garmin Connect apps which are available for Android and Apple devices. [75] *Figure 5* shows connections 1, 2 which represent local smartwatch data transfer paths to other connected devices such as a PC or smartphone and connection 3 shows the possibility of accessing wireless interfaces for outside communication.



*Figure 5 - Storage and Data Handling of Garmin Smartwatch*

As previously mentioned, data from a smartwatch can be synchronized to the web service Garmin Connect, by a Desktop PC application, with Wi-Fi access to the internet or with the help of a smartphone applications. The explicit access for third parties of web services is Health API. This API allows the development of other platforms by integrating data fetched from Garmin. The web service is accommodating support for REST and Pull, Push architecture. [64] The pull architecture refers to common techniques for a data transfer method between client and server, known in general for the REST approach with request and response messages. On the other hand, in the push architecture the server sends information to the client, while a client is subscribed for specific periodical notifications or streams of data. This kind of model can increase efficiency in communication if the server is

sending activity data based on preset criteria, thus reducing wasteful requests from the client. [76] In addition, the Health API offers subscriptions to data types of interest for third parties. Different delivery formats can be arranged for different customers in agreement with Garmin, while providing detailed data of more than 30 types of activities such as running, swimming, snowboarding data etc. The default format for request and response is refined JSON. Moreover, the API is providing convenient web features for authorization, sample data, verification tools, etc.

The API can deliver pre-processed data using analysis tools in a scalable manner, for instance by delivering all-day activity information and as well as activities gathered by a chest heart rate device. [64] Implicit access to a web service refers to access through another layer of devices such as handhelds or computers. This layer would take data from Garmin Connect Web Service shown on the Figure 5 and pass it to a third party. However, it is possible to create an application for a smartphone with Garmin SDK and push information to another web service. The data in this case would travel by links 4, 5, 6 and out through the Internet to a third party.

### **9.3.3 Legal requirements, Privacy and Permissions**

The Garmin Privacy Policy defines ‘Personal data’ as an information that can be related to an identified or identifiable natural person. [77]

Garmin requests personal data from users in order to create an account that is needed to use most of the services and features Garmin provides for its wearable device users. The personal data that Garmin collects include; Users name, email address, password, location information, and other information that is needed for the different services to function properly [77]. Similarly, Garmin uses some of the information to provide support which includes notification when policy changes occur, account verification if any issues are experienced by the users. The account information is also needed to log in to the password protected services, such as Garmin connect [77].

Personal information are also required by Garmin for the processing and shipment of items acquired through Garmin’s webpages. The processing of the payment information provided by users is processed by a third party, Ayden, as well as the shipment information, which is processed by Narvar on behalf of Garmin [77].

Furthermore, Garmin also collects user data related to the apps provided by Garmin as well as Garmin Express. The data include information about the users, IP-address, log on the date and time the user accesses app services provided by Garmin, app version, geographical location data, user behavior, content that is downloaded to the app, information related to the state of the hardware and software of the device.

Furthermore, Garmin also collects network information, which includes information related to how data is synchronized i.e. WiFi or cellular. Garmin states that this data is collected with the purpose of providing user support [77]. However, Garmin request that users provide additional contact information and device information during support calls [77]. Furthermore, when users interact with Garmin support

representatives via email, telephone or online, not only does Garmin collect the user's personal information, they also collect information about the products own by the user, such as the model serial number and date of purchase. Garmin creates different event logs that they use for diagnosing the product or resolve any issue related to a specific product. With a user's prior consent Garmin's customer support representatives can access the user's Garmin account to help fixing any issues [77]. In their privacy policy, Garmin also clearly states that in order to provide information such as weather updates or traffic updates, fuel prices or other local event information, Garmin may collect data related to the geographic location of their devices. [77] Such data is collected by Garmin only if the users chooses to use location based features that are implemented in the device. [77]

In their privacy policy Garmin states that they don't sell user data. However, Garmin also states in their privacy policy that they share personal data in specific situations. Situation such as, when required by law or are under any legal obligation or in the event of any reorganization, sale, joint venture or other disposition of Garmin's business such as bankruptcy or similar activities. [77]

Furthermore, Garmin discloses that the personal data related to users that reside within the European Economic Area (EEA) or in the UK are stored by Garmin Würzburg GmbH and only accessed by Garmin International, Inc. and Garmin AT, Inc [78] [77]. In addition, Garmin also states that Garmin International, Inc. and Garmin AT, Inc. comply with the EU-US privacy shield principles for collecting, using, sharing and storing the user's data from EEA. [79] Garmin Service, Inc and Garmin AT, Inc. are subject to oversight and responsible for transferring user data to third parties that process the data on Garmin's behalf [77]. Garmin also discloses that they use analytics services from Google Analytics, Hotjar, several Microsoft services such as Azure Application Insights and HockeyApp as well as yahoo services such as Flurry. Garmin has legal ground for processing and sharing user data with third parties as Garmin acquires explicit consent from each user during the creation of the Garmin account. [77] However, Garmin also states explicitly that users have the option to opt-out from their consent to share or sell user data to third parties [77]. Which is required by the GDPR.

Furthermore, Garmin has partnered with several third-party fitness websites which include Endomondo and Nike+ that allow Garmin customers to connect their Garmin Connect account with the third-party's thereby transferring user data to the connected third-party. [80]

#### **9.4 Internal Software for the Collection and Processing of Data**

A company that collects digital data needs a systematic way to handle the data from the sources it receives data from. The handle data tasks include saving, processing, and formation of the data. There is a need for software to handle all those tasks and help a company prepare the data for its customers. Furthermore, the data warehouse needs to accommodate large amounts of information, and an architecture for big data needs to be taken into consideration. When data is collected from smartwatches the

process begins with the smartwatch users generating data, this data is then transferred from smartwatches to various server storages available under web services of other companies. Data will be in a textual format since activities are mostly recorded as logs in various databases, other types of data such as images and audio files will be not processed or collected.

The software architecture can be divided into several functional layers. The first layer is data fetching therefore, the software needs flexible access points to be compatible with RESTful, SOAP or other web service approaches in order to receive external data. The second layer is concerning storage, the data will be stored in databases, this database can be a classical relational database management system (RDBMS) or more appropriate distributed clustered systems such as NoSQL. The third layer would organize, and sort acquired data with utilities offered by companies like Hadoop. Consequently, this data can be analyzed and processed to reduce wasteful data and perform general segregation. The last layer would be search and accommodation of data for the formats that could be visualized as graphs, outputted in format files, processed in the statistical procedure etc. by request of customers. [81]

The software solution would be suitable to be placed in a cloud-based system, such as Google Cloud, Amazon Web Services, Azure by Microsoft or other compatible cloud services by opting for plan that is suitable depending on the price and the requirements of XYZ. Figure 6 depicts the architecture style provided by the Microsoft Azure cloud systems that complies with the mentioned layer description. The orchestration is responsible for automatized workflows for different operation blocks and data sinks. For orchestration, depending on the cloud platform that is chosen for integration purposes, a tool, such as the Microsoft Data Factory can be used. Moreover, these block services can be used within open source technologies. This kind of architecture provides elasticity regarding the size of data volumes and offers viable performance. [82]

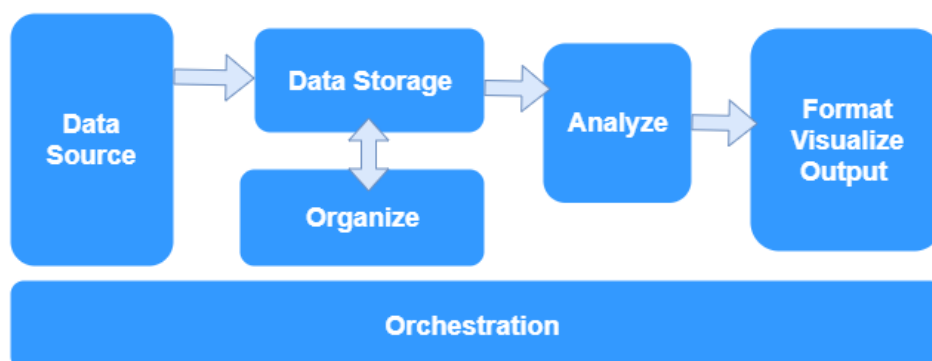


Figure 6 - Big Data Architecture Style [82]

## **9.5 Sub conclusion**

It can be concluded that the Garmin Forerunner 945 has similar general capabilities as the other brands mentioned that have advanced technological achievements in hardware and software. However, the Garmin smartwatch is targeted at athletes and sport, and is therefore best suited for monitoring physical activities, whereas the other smartwatches focus other features. Therefore, they are probably the most precise smartwatches for collecting health related data. The data workflows of Garmin watches offers a number of way for third parties to synchronize/acquire information to their web services. The Garmin API's and SDK provide great flexibility to developers to connect to external access point, making the platform attractive to information business. It was shown that legal aspects are accommodating protection for the company and comply with user rights determined by law. Lastly, it was concluded that the architecture of the software for XYZ company that will be used for data processing is the most suitable to integrate in cloud services since it will handle a vast number of data.

## **10 Analysis**

In this chapter an analysis is performed based on the methods described in the methodology and the findings of the theoretical framework chapter. This chapter presents the process and the results, which are based on the gathered data and research conducted. An analysis of XYZ is presented based on the limitation and assumptions previously made. Helpful tools for this analysis are the Value Proposition Canvas, the Business Model Canvas and the SWOT analysis. A market research is also an important part of this analysis and it is adjusted to the needs of this specific case.

### **10.1 The Value Proposition Canvas**

The Value Proposition Canvas illustrates the pains of the customer and how XYZ creates and captures value and thereby caters to the customer segment. It describes what is the customer problem and how to satisfy the customer need. Normally, a Value Proposition Canvas is done for each customer segment, however, because the determined pains related to data the customer segment experiences are roughly the same, only one Value Proposition Canvas is included in this report. The customer segments will be explained later in the Business Model Canvas. While customers do a job, they often experience some pain associated with doing that specific task. These pains are listed in Figure 7 these pains create a customer need for a product. The product in this case is a service, the service is constructed such that XYZ provides a pain reliver by selling data that is properly formatted to the customers which results in some gains for the customer. The Customer Jobs, Pain and Gains are listed in the customer profile. Whereas the Pain Relievers, Services, and Gain Creators that XYZ offers are listed in the Product profile. The two blocks complement each other and are subsequently explained.

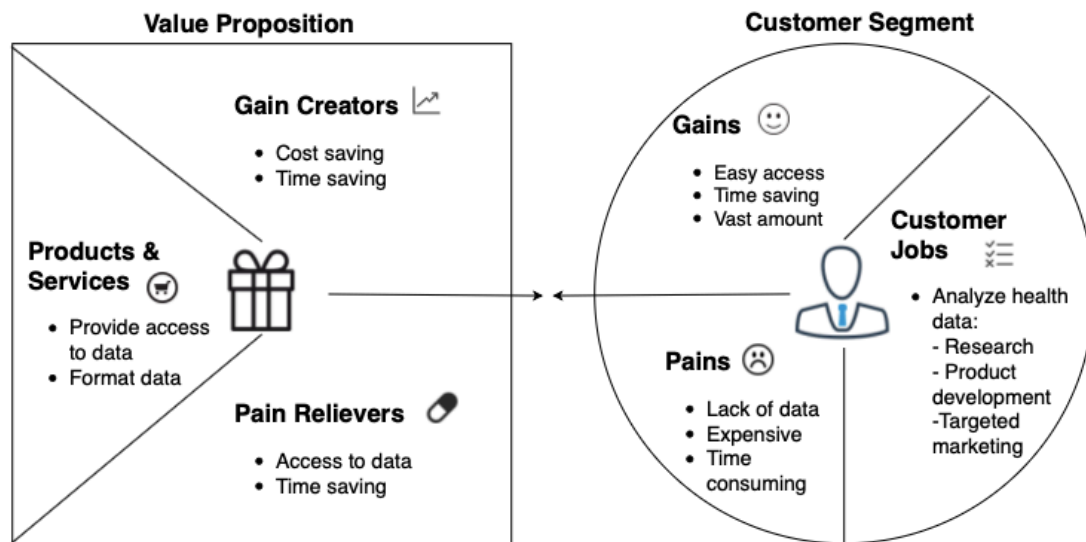


Figure 7-Value Proposition Canvas [105]

### 10.1.1 Customer Jobs

The Customer Jobs block describe the job the customers are trying to solve. It can be a specific task they are trying to get done or perform. The “jobs” can have many forms such as functional, social, emotional, supporting, buying, co-creating, and transferring. The specific context in which the customers perform affects the costumer jobs and it may dictate some constraints or limitations. The job of ‘XYZ’ ‘s customers is to analyze health data that is need in fields such as researches, product development or targeted marketing.

### 10.1.2 Customer Pains

The Customer Pains block describes the negative emotions, costs, conditions, and risks the customer experiences before and while they are trying to get a task done. That is, the ideal customer experiences the listed pains while trying to get the job or task done.

The customers listed in the customer profile experience the lack of data, the price of data, time consumption while processing the data as pains. Lack of data also includes access to data as well as quality of data. Whereas the price of data the customer pays includes both the price of the data when the data is bough as well as the price the customer pays if they were to collect the data themselves. Furthermore, if the customers were to collect data themselves it would also be time-consuming, which also applies when the customer is formatting the data.

### 10.1.3 Customer Gains

The Customer Gains block describes the results and the benefits that the costumer expects, wants or would be amazed by. Functional utility, social gains, positive emotions, and cost savings are included in the customer gains block. Thus, the Gains expected by the customer segment from using XYZs service include; easier access to



data, less time consuming to analyze the data, access to a vast amount of data. The more data are available to the customer, the more precise conclusions are customer able to draw.

#### **10.1.4 Value Proposition - Products & Services**

The Products & Services block is a list of all the products and services a value proposition is built around. It deputizes the products and services that help the customers accomplish a job or satisfy their basic needs. It also allows customers to complete the jobs that are mentioned in the Customer Jobs block.

The customer segment does not assess all the products and services offered the same way. Some are more important to the customer than others, some are necessary for the customer to complete the core activities, while can be categorized as nice-to-haves.

A company's value proposition usually consists of various types of products and services that can be categorized as physical/tangible, intangible, digital, and financial products/services. XYZ offers a service to the customer by providing data to the customers and formatting the data as needed by the customer. In addition, XYZs services are scoped such that, customer do not have access to all data, it limits the customers access to data that are relevant to the customer and its activities. Only specific attributes are provided.

#### **10.1.5 Value Proposition - Pain Relievers**

The Pain Relievers block describe how a company's products and services cure their customers pains. The Pain Relievers notably outline how a company aims to eliminate or reduce some of the pains, that are listed in the Customer Pains block. However, a great Value Propositions usually only relieves or reduces some of the pains the customer experiences. A pain reliever can be relatively relevant to the customer. It is good to distinguish substantial pain relievers and nice-to-haves. In XYZ's Pain Relievers cure the pain of time and access. XYZ provides easy access to the data without creating further pain for the customers and reduces the time consumption. Unfortunately, XYZ cannot relieves the pain related to the cost to access the data. Because of the importance, sensitivity and demand of data, this cost are high resulting in a high price for the service. Furthermore, the market competition is high as there are many companies that offer it data, though, not necessary the same type of data.

#### **10.1.6 Gain Creators**

The Gain Creators block describe how a company's products and services creates gains for the customer. They explicitly contour how a company aims to create customer gains just as they are described above. A gain creator can generate relevant results and benefits for the customer. XYZs customer, benefit from using the offered service by reducing the time spend on processing data for analysis and the costs associated with access to data, as well as the reduction of costs gained by the time reduction.

## 10.2 The Business Model Canvas

The Business Model Canvas is a framework that describes a company's business generating activities. The Business Model Canvas describes how XYZ creates, delivers, and captures value. The framework consist of 9 different building blocks that combined describe the canvas. The nine building blocks include, the customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and the cost structure. When all the blocks are defined, the profile of XYZ is developed.

Generally, the canvas is important to be conducted in the beginning of the creation of a company. It is critical to make any necessary changes to the canvas frequently; this requires continues updates and reflection of the building blocks. Subsequently, each block of the canvas is being explained in detail.

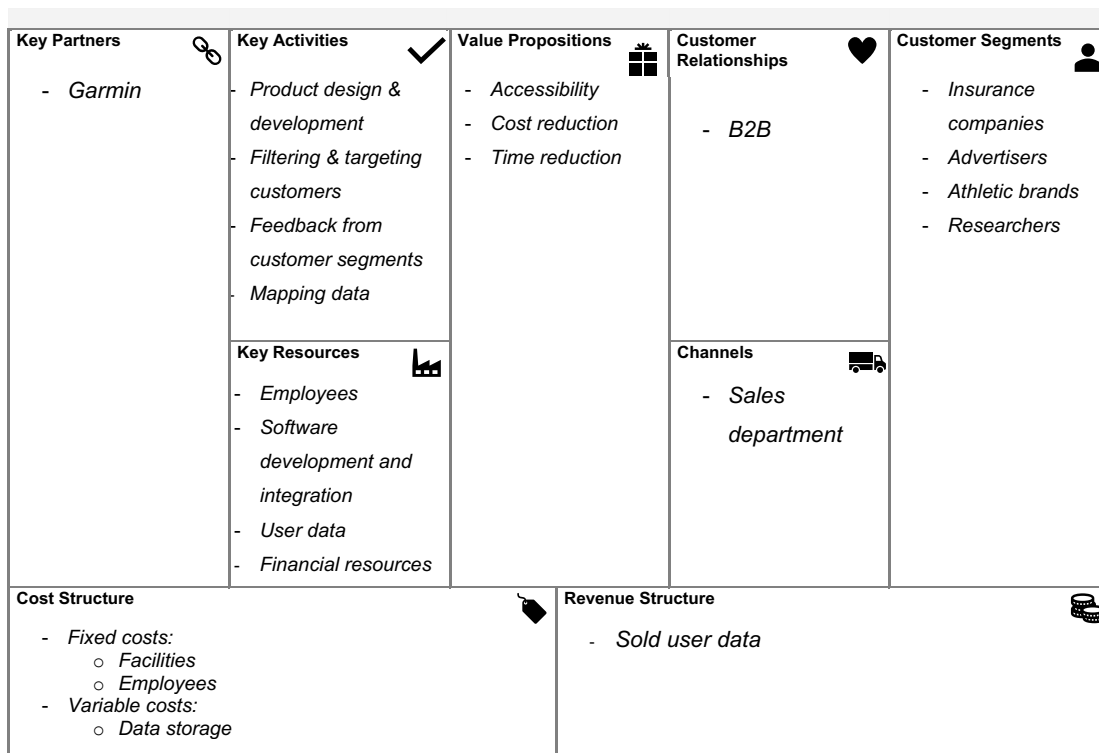


Figure 8 - Business Model Canvas [83]

### 10.2.1 Customer Segments

An organization serves several Customer Segments. Customers are the ones that bring profits to companies and companies can serve one or multiple customer segments. In order to provide a better service to customers, companies usually segment their customers into different groups, based on shared characteristics. XYZ has separated its customers into the following customer segments based on what the data is expected to be used for:

- **Insurance companies:** Need the data to create insurance policies or to predict when their customers might need changes in their insurance policy. They do risk assessments from evidence-based data on public health<sup>2</sup>.
- **Advertisers:** Target customers to predict their needs. In this segment, advertisers that do sponsorship, direct advertisement, trend predictions etc. are included.
- **Athletic brands:** Athletic brands may be interested in the data for future or current product development. That is, running shoes with better shock-absorption, or lightweight running gear that also can be used in a cold or warm environment, or other products for athletes.
- **Researchers:** Specific data needed in research fields such as health, marketing, academics etc. and they need the data to have more specific results for their researches, e.g. how a parameter such as EPOC is affected by changes in weather etc. Researchers also includes governmental agencies that do research or need data for other purposes than research.

### 10.2.2 Value Propositions

The Value proposition block is as explained in value proposition canvas. XYZ's value proposition to its customer segment is access to data, that are formatted the right way thereby saving time and reducing costs for its customers.

### 10.2.3 Channels

Channels segment describes how the company reaches and communicates with their customers to deliver the value proposition. XYZ's only channel is the Sales Department, where any customer segment, with a need for accessing data, for any purpose, is in contact with the department. The sales department is the direct link between a company's product or service and its customers and builds the relationships between to the customers. Sales Department responds to request on the data needed or the data the customer is in searching of, the volume needed, customer support and other relevant requirements. This department also identifies customer's unique needs related this to the customer pains. The job of the channel is also delivering the value proposition to the customer.

### 10.2.4 Customer Relationships

The Customer Relationships block describes the type of relationship between the company and the customers. In XYZ's case, is a B2B (Business-to-business) relationship. B2B is a situation where a company exchange its services to other companies as well as B2G (Business-to-Government). XYZ takes data from Garmin and then sells them to another company. The company's motivation is to acquire customers, retain them by continuously identifying customer pains and supplying

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<sup>2</sup> Data does not include personal information. Thus, this does not apply to individual policy creation.

customers with pain relievers. Thus, the customer relationship is also a sales department operation, especially in the beginning, as customers acquisition will be in focus to begin with. Therefore, the customer relationship requires personal assistance as well as co-creation.

#### **10.2.5 Revenue Streams**

Revenue Streams block represent the company's incoming financial resources. In XYZ's case, all the earnings from all the Customer Segments are coming from the user data that is sold. There are two different types of Revenue streams: the transaction revenues and the recurring revenues. Transaction revenues represent a one-time payment for a transaction where the customer pays whenever they need data. This may be the revenue stream related to the customer segment that includes advertisers. Whereas, recurring revenues represent payments that are under an agreement or repetitive i.e. licensing, subscription fee. This revenue stream may include the following customer segments, insurance companies, researchers, athletic brands.

#### **10.2.6 Key Resources**

The Key Resources make it possible for a company to offer its value propositions to its customers. A company needs resources to sustain and support the business. A key resource can be physical, financial, intellectual, or human. The resources are essential in creating value for the customers. They are needed to sustain and support the business operations and they are considered as assets if the company possesses the key resources needed to for its core activities. The key resources that XYZ needs include employees, software integration and development, financial resource, and most importantly user data.

It is important to note that some of the key resources can be held by the company or acquired from a key partner. Such is the case of XYZ, who is dependent on user data from its key partner, Garmin.

#### **10.2.7 Key Activities**

The Key Activities describe the most important activities that in cooperation with the key resources, make the business model work. They are the most important actions an organization must do, and they answer the question: "What can the company offer?" or "What is the company doing?". These are the most important tasks a company must accomplish in order to provide its customer segment with the intended value proposition. As with the key resources, key activities are similarly pivotal in an organization fulfilling its value proposition, reaching its customer segments, sustain its customer relationships and ultimately create long-term revenue streams. The Key Activities of XYZ include:

- **Service design and development:** how the company will handle the data and provide them to its customers. XYZ needs improve its services consciously, this also applies researching for new data suppliers.
- **Filtering and targeting costumers:** the interested customers are evaluated for their adequacy, safety and profitability. This process is done for the costumers that XYZ wants to approach.
- **Feedback from customer segment:** The feedback is received from the customer segment. It is important to identify if the costumers are satisfied with the service provided. However, it is also important to receive customer feedback and use the feedback for improving the value proposition.
- **Mapping data:** due to enormous amount of data and different customer's needs it is important to integrate those data, separate them and make sense of them. Data mapping is used in the process of establishing relationships between separate data models.

### 10.2.8 Key Partners

Key Partners are the relationships between your company has with partnered companies, governmental, or non-consumer entities that help your business model actually work. These can be the relationships that a company has with suppliers, manufacturers, business partners, networks etc. Partnerships are the corner stones of a business model. There different types of partnerships includes partnerships such as strategic alliances, coopetition, joint-ventures, buyer-supplier relationships. XYZ's main partner is Garmin. The data provided by Garmin is are a crucial source for the revenue stream. This is because, unless XYZ locates a different data source, the revenue stream depends on the data collected by Garmin devices.

### 10.2.9 Cost Structure

Cost structure refers to the expenses that a company acquires while it operates. There are two primary cost structures that is fixed costs and variable costs. However, the cost structure can also be influenced by economies of scale and economies of scope. The costs XYZ acquires are mostly fixed costs, under which the following are relevant: facilities, employees, research and development. These costs remain the same despite the amount of data XYZ buys or sells. However, the costs related to acquiring user data depend on the agreement achieved. That is, it is theoretically possible for XYZ to reach many different kinds of agreement with Garmin about the pricing for the user data. The agreement can be; a fixed price for the data of a certain number of users, a fixed price for access to the user data of all users, some form of variable pricing that is dependent on the agreement. However, XYZ may be characterized as a value-driven. As once the data is acquired be XYZ, the same user data can be offered to multiple customers.

### 10.3 The SWOT Model

As Figure 9 illustrates the findings from the SWOT-analysis which is the identification of XYZ's strengths and weaknesses (internal factors), and the opportunities and threats (external factors). Furthermore, the purpose of this evaluation is to provide XYZ with an illustration of the external factors that may affect XYZ when entering the market as well as the opportunities it may be presented with in the future. [23]

<b>Strengths (Internal)</b>	<b>Weaknesses (Internal)</b>
<ul style="list-style-type: none"><li>• Startup -&gt; small company – fast decisions-</li><li>• Quick to respond to market changes.</li></ul>	<ul style="list-style-type: none"><li>• Startup -&gt; High startup costs</li><li>• Dependable on external sources of data</li></ul>
<b>Opportunities (External)</b>	<b>Threats (External)</b>
<ul style="list-style-type: none"><li>• New ways to collect data</li><li>• Joint venture</li><li>• Health data from other sources</li><li>• New suppliers</li></ul>	<ul style="list-style-type: none"><li>• Changes in legislation</li><li>• Competition</li></ul>

Figure 9 - SWOT analysis, [8]

#### 10.3.1 Strengths

One of the greatest strengths in establishing a company, in general, is related to its size. That is, because a newly established company usually is small in size the time it takes from a decision is made until it is installed is short compared to a large company. This is because a large company such as Garmin Ltd. with many employees usually has a procedure plan that involves several employees such as district managers, operation managers etc. look at the proposal before it progresses further. Whereas, a small company with fewer employees and a limited amount of resources, requires skilled employees that are able to make fast and preferably right decisions. Thereby automatically shortening the decision-making process. The fast-decision-making ability is of extreme importance when a company's core activities depend on meeting market trends. Furthermore, the small also indicates that the company is faster to adapting to changes related to its internal as well as external environment.

### **10.3.2 Weaknesses**

The weaknesses of a newly established company usually have to deal with are related to its size. This includes the high startup costs associated with establishing a company as well as lack of non-financial resources such as know-how but also bargaining power when doing business with larger companies regardless of whether the company is a supplier or a customer. This is also why a significant weakness the company will have to deal with is the dependency on Garmin for the supply of data. This also applies if the supplier were a different company of a larger size than XYZ. This is because XYZ does not own the data and is therefore forced to establishing a deal with a third party to gain access. This results in a dependency on the data supplier, especially during the starting up period, later the company may have better financial resources and/or higher bargaining power for the dependency to become lower. However, lowering dependency requires that contact to more suppliers is established and/or that a high position in the market is established.

### **10.3.3 Opportunities**

The opportunities XYZ is presented to when trying to enter the segmented market include joint venture. This may be in collaboration with Garmin or a different company that specializes in data, though not necessarily health-data. This can be considered as an opportunity for XYZ due to the size and complexity of the targeted segment and reduce lack of experience in operating in the market segment and the new insights may result in success on the first trial. Furthermore, a joint venture can also provide access to data and increase the bargaining power that is expected to be low in the beginning. A joint venture can also provide access to a network of relevant contacts, clients, and employees. Other opportunities for XYZ may include doing business with health data that were collected using other mediums than smartwatches. The number of opportunities further increases if new ways to collect data are made available or access to data that are not health-related is established. Further opportunities include establishing contact with new suppliers or increasing the number of suppliers.

### **10.3.4 Threats**

The threats that should be expected when entering the market include competition. Threats due to competition should be expected regardless of the age of the company. New entrants experience competition by established companies that have had the time to position themselves, this especially applies when they enter a saturated market where several competitors should be expected. While established companies, especially if they are large in size can experience threats by new entrants such as startups, that have found a smarter way to do business or that are faster in performing radical changes to meet market demands such as market trends. Other threats include changes in legislation, this is experienced by all companies that operate in the market. This is because changes in legislation often are made due to changes in society, and changes in society are often pushed by technology. For instance, the regulation on

protecting personal data of European residents in the form of the GDPR was initiated by the changes in technology that allowed easier monitoring and access to user-generated data. However, technological development also gave easier access to personal information and while governments in an open market cannot exclude certain user tracking technologies, it can regulate what data may be tracked and from whom and when. Consequently, changes in legislation may affect XYZ if governments were to introduce further regulations and restrictions. This also includes changes due to political reasons such as restrictions or sanctions on doing business within a certain company that is based in a country with sanctions.

#### 10.4 Market Research Analysis

This market investigation will use some of the principles mentioned in the chapter Market Research under the Theoretical Framework chapter. Therefore, problems and objectives need to be defined first. The objectives of the market research will depend on several factors. These factors will show the number of resources, feasibility of data, competition aspects and others. The market research will help in the understanding of the target market and may support for the business and creation of marketing strategies. Figure 10 depicts the marketing research phases.

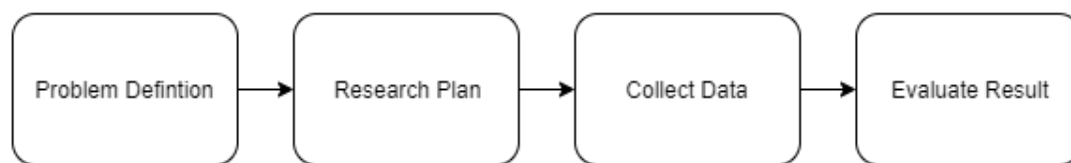


Figure 10 - Market Research Phases

The research plan constructs a design of investigation for the target market and target points. The collection of data includes information gathering and based on the data gathered an evaluation is made. This is the most expensive and labor extensive part of the research phase. The results in the real business environment can be presented to the higher management who decides the next step for the product. The decision is important as it will define the subsequent resource usage and framework for the sales and development department. [8] For instance, the same analogy can be made using oil extracting companies as an example. The market research would represent geological research and feasibility investigation for drilling and setting work environment on possibly inapproachable places. Followed by contracts with other companies, governmental bodies, and business. Thus, the work process and oil extracting process would be based on the decisions made using the results of the initial research as the base.

##### 10.4.1 Problem Definition

One of the problem formulation questions would overlap with research formulation as stated at the beginning of the report by stating *“is there a market for selling collected*



*data*". This question sets the base for the market problems, for the product. These problems can be elaborated and described through collected data in market research. The problem definition needs to set the question for wanted answers. However, those answers should not be binary, and the question should not be too narrow or too broad. For instance, if the question is too broad the results will not be useful after the research process in the evaluation part and if it is too narrow it will be too expensive and misleading. [8] Therefore, the better question would be "*investigate the market that would buy the data collected from Garmin smartwatches*".

#### **10.4.2 Research Plan**

The research plan provides a blueprint for the market research. It sets aspects that are needed to be explored for the product to be sold. From the global point, there should be an overview of other smartwatch brands, smartwatch competitors and their market shares in the world with comparison by the Garmin company. There should be a short overview of the Garmin business concepts and philosophy. The other factor would be to explore trending statistics in the wearables market. It would be useful to see if this type of devices are ascending or declining in sales in order to evaluate if the company can retain the trade in the future. If the market share declines so does the revenue of the company, which may result in closing the business.

Because technology is emerging every day, the complexity of wearables rises and medical devices as well as other devices have the potentially to provide additional user activity data. This would be an opportunity for the company to expand data sets and quality of the collected data. It would be useful to analyze the level of market competition. Similar companies might be market research conductors, that sell data or reports created using data gathered from different sources. Smartwatches usually have pre-installed applications that record data and transfer this data to other information storage units such as web servers or smartphones. Therefore, it is of importance to look at the applications that are made available by Garmin. Among Garmin's clientele are companies that develop applications, the clientele has its own clusters of clients. Those clusters are information generators and possible data sources for XYZ.

#### **10.4.3 Data Collection**

The information presented is related to the market research for XYZ and its product. This data is as previously mentioned, secondary data. Smartwatches are a recent technology that began thriving a couple of years ago and have had a constant incline in the market. Mordor Intelligence, forecasts that the sold amounts totaled to be around 40 million in 2018 and will increase to over 110 million in 2024. [83] Furthermore, the major companies dominating the smartwatch market share, that also are expected to continue doing so are Apple, Fossil Group, Fitbit, Samsung, and Garmin. One of the main drivers of growth are fitness activities, practicality, health consciousness and the development in the Internet of Things among other factors. The prevailing smartwatch market is located on the North American continent followed by

Asia and Europe, while South America and Africa generate the lowest revenues. The smartwatch market is very competitive and there are no few monopoly players, instead it is very fragmented and diverse. [83] Figure 11 bellow presents the data in yearly quarters, from the second quarter in 2017 to the first quarter in 2019. of smartwatches sold worldwide by different companies.

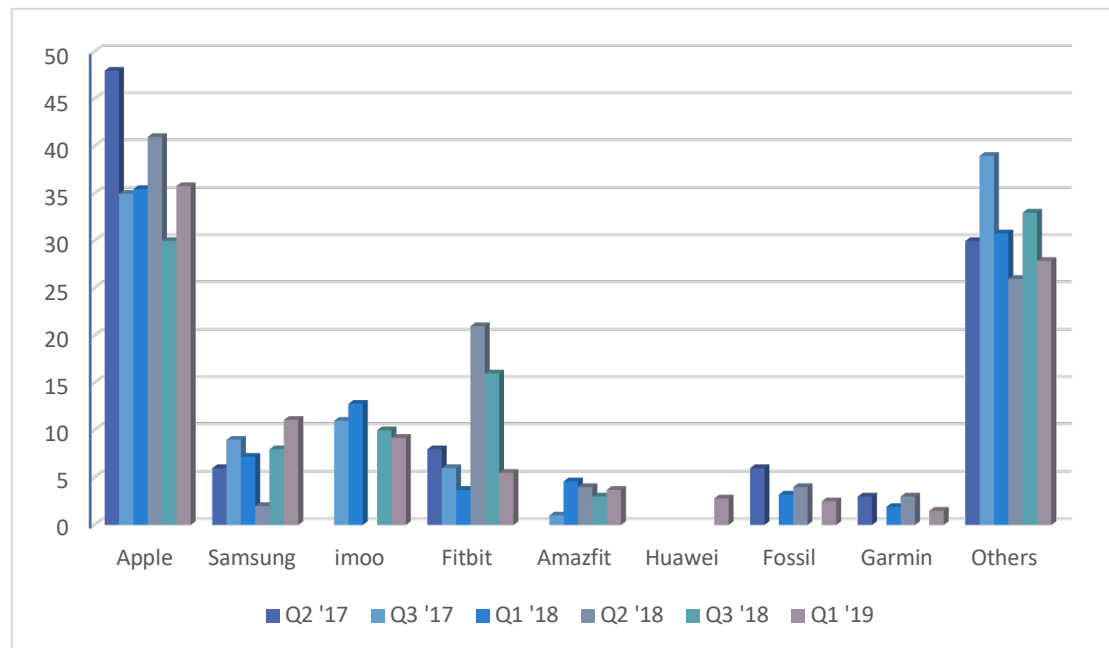


Figure 11 - Quarterly smartwatch shipment share in percentage internationally from 2017 to 2019 [84]

The figure shows that, Apple has the largest market share, while other companies follow with a smaller percentage. Garmin, in this case, accounts for less than four percent of the smartwatch deliveries and the majority of the remaining smartwatch brands (around 30 percent) are performing at a lower level. However, if wearables are taken into consideration and not smartwatches alone the overall estimated figures in sales are much higher. [84]

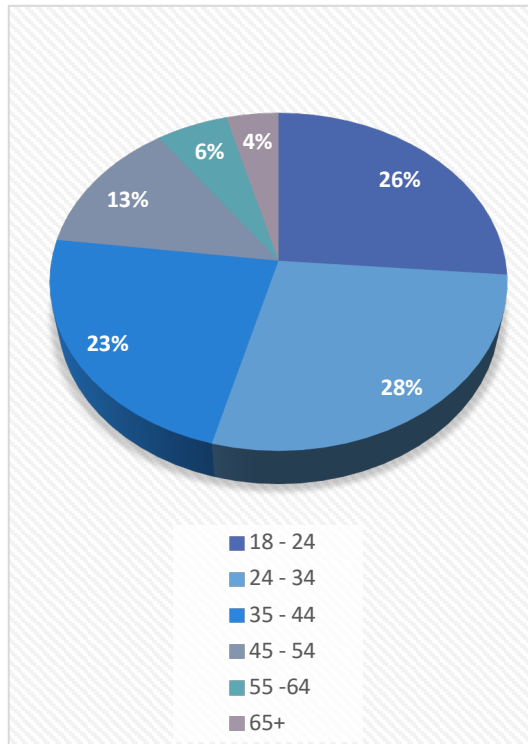


Figure 12 - Share of the population buying wearables in the United States in 2017, by age [85]

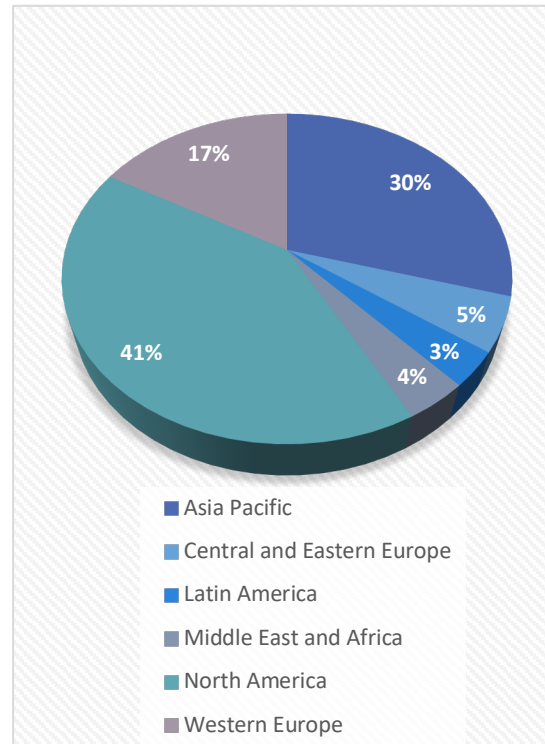


Figure 13 - Number of connected wearable devices in 2017 by region with 4G [86]

Figure 12 and Figure 13 show the demographics of wearables users by age on the left and by region on the right. The right figure shows connected wearables with 4G in percentage by geographic area.

Garmin has existed for over 30 years and sells among wearables many other technologies/products such as navigation systems, cameras, web services, instruments etc. They have divided their business into five segments automotive, aviation, marine, fitness and outdoor. In the outdoor section, they are offering adventure smartwatches and in the fitness segment running and multi-sport watches. Their products are sold across 100 countries through standalone traders such as Amazon, Walmart, Decathlon, etc. They recognize their competitors in the smartwatch segments (outdoor and fitness segments) companies such as Apple Inc., Huawei Technologies Co., Samsung Electronics Co., Wahoo Fitness and others. Their research and development department has around 5000 engineers and developers employed, while the total number of employees is 13.000 thousand. The manufacturing departments are in Taiwan, China and the United States of America. Their smartwatches have some of the best capabilities for physical activity tracking since they have focused the features for sports and outdoor activities. Over the past few years there was a growth in sales driven by wearables. [87]

The default mobile application for Garmin smartwatches is Garmin Connect. This app is available on Google Play Store (Android) and in the App Store (Apple). On the Google Play store, the application was downloaded more than one million times and

has around two thousand reviews, while on the App Store it contains around twelve thousand ratings and currently 61. in ranking and disclosing the number of downloads. [88] [89] However, there are other applications as well that have a partnership with Garmin and the data is synchronized with the Garmin Connect application. These applications will receive information from Garmin Connect but they will not send their data back except the following applications MyFitnessPal, Strava, TrainingPeaks, and Zwift. It is possible to transfer data from partnership applications to Garmin by exporting manually and uploading or by provided linking options. [90]

Companies similar to XYZ, that function as information broker companies. They are selling public or private user data collected from devices, contained in public spaces such as the Internet, accommodated on social networks, by surveys, etc. and sales related to that data constitute most of their services. [91] There are more than four thousand information brokers worldwide. For instance, one of the largest data brokers companies is Acxiom, holding 23 thousand servers that collect and analyze data. This is a big industry worth more than 200 billion USD and storing information collected from millions of people. The personal data for these companies is so valuable that they are even paying consumers to access their data, for example, social media accounts. It is possible in some companies in the United States to find your own data and consumers are given a choice to opt-out from further collecting and usage of their data. [92] For instance, the mentioned Acxiom company serves several different sectors such as the automotive, financial, healthcare, and insurance etc. They are offering data packages categorized by themes, significant events, media and others. Partners are well-known companies such as Microsoft, Hadoop, Adobe and a multitude of different corporations. [93]

#### **10.4.4 Result Evaluation**

The results of the research are evaluated for further decisions for product placement on the market. The data collected can be categorized into two points, the first one for sources of data and the second one for the business eligibility. It can be concluded that the smartwatch industry certainly trends in the sector of “smart” devices and that will continue to grow in the future. The shipment of smartwatches has an exponential increase. One of the major smartwatch players among others is Garmin, however, Apple has the biggest market share. The financial situation of Garmin indicates that the revenue growth is supported by their wearables line. The company’s performances are shown to be a stable with a diverse market share, manufacturing products with proven quality. Data streams from Garmin smartwatches are shared with third parties, which enables a more diverse information fetching. Currently, most smartwatches are sold are in the North American region followed by Asia and Western Europe and the population buying these smartwatches are mostly young. Regarding competitors and similar companies that collect and sell data, it is shown that there is a developed in the market worth billions. For instance, the company Acxiom can be a proxy indicator of

successful business with respectable partners. Their customers are very wide sectors covering insurance companies, healthcare, etc. It can be concluded that there is plenty of data sources from Garmin smartwatches and smaller companies entering the market will have strong competitors and they will need creative marketing strategies.

## **11 Discussion**

Based on the research and analysis performed it was evident that several important factors influence the success of creating a business plan for selling data collected by smartwatches.

One of the most important aspects of this report is the legislation. The legislation in combination with some techniques make it possible for XYZ to enter a market where they cater the customer segment defined in the Business Model Canvas. This is important, as personal data have a significant role nowadays. Technology plays a major part in the lives of people that use devices connected to the Internet.

Furthermore, the increase in sales of devices i.e. wearables and smartwatches etc. that connect to the internet result in an increase in user data. This is because, the devices generate user data, and user data is of high value.

The European Union has tried to regulate how user data may be collected, processed, and stored by implementing the GDPR. The GDPR, applies to all companies that collect, process, and store the personal data of people residing within the European Union. Thus, in order to sell the generated data and comply with the scope of the GDPR, data is processed using different anonymization methods in order to make the data not “identify/relate to a specific individual”. However, nowadays vast amounts of information is available online, making it possible to identify a person. In some databases some information is missing while in other databases, different information is missing, making it possible to complete the puzzle of the profile of an individual, and identify a person. Thus, further changes in the legislation, if the changes are much stricter it may result rules to access user data. In addition, processing data usually reduces the quality of data, and stricter laws may result in more processing steps thus lowering the quality of the data further.

With the emerging technologies, an additional factor that may change the odds of success is, if sensors implemented in smartwatches were to be classified as medical device. This would result in smartwatches being used by patients resulting in more data and a new type of data of great value especially in a competitive data driven market. In addition, if XYZ were to include other types of user data or user data generated by devices that are not smartwatches it could increase the number of possibilities for success. Furthermore, if Garmin were to expand their services to

accommodate Internet of Things it could also further increase the possibilities of success.

These changes may consequently affect the appeal of entering the market for a company such as XYZ, especially considering the high level of competition in the data driven market. Yet, if a joint venture was possible the chances of success could increase considerably.

It is also very important to mention that the results presented are affected by the interpretation and availability of data as well as the chosen methods, assumptions made, and limitations set.

## 12 Conclusion

This report researches how data is extracted from smartwatches and what business models can be created from data collected from smartwatches.

There are a number of ways to collect data from smartwatches, though the exact way depends on the brand. However, most of them allow in one way or another, a third party to gain access to data as long as there is an explicit consent from the user.

For instance, the data workflows of Garmin watches offers a number of ways for third parties to synchronize/acquire information to their web services. Thereby, collecting data from smartwatches. The Garmin API's and SDK provide great flexibility for developers to connect to external access point. However, accessing the data requires legal base as stated by the GDPR. The GDPR applies to all companies that collect, process, and store the personal data of people residing within the European Union. The GDPR also states the need for legal base for collecting, processing and storing the data of European residents. Thus, the requirement of explicit consent, the restrictions set by the GDPR have resulted in stricter requirements for gaining access to the data.

Thus, in order to sell the generated data and comply with the GDPR, data is processed using different anonymization methods in order to make the data not "identifiable" or relate to a specific individual". Consequently, if data is anonymized properly it falls outside the scope of the GDPR. However, if data is anonymized "too much" the quality of data is reduced and resulting in a decrease in the value of the data. This data can be used to create a business model where the data is offered as a service or product.

This conclusion was achieved using the Value Proposition canvas and the Business Model Canvas. The Value Proposition Canvas was used to identify how to create value for the customer segment and define the services needed to meet the customer

needs. The Business Model Canvas was created and used to describe the business generating activities. A SWOT-analysis was also conducted, this was done in order to assess the threats and opportunities a company that operates in this market may face. A market research analysis was conducted with the purpose of assessing the market. The conclusion is thus, that there is plenty of data sources including Garmin wearables and that there certainly is a market for data extracted from smartwatches. However, the market competition is great, thus, a joint venture could be considered especially for a startup company, this would provide access to data. As well as increase the possibility of success on first trial and reduce lack of experience in operating in the market segment.

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