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The IoT Rapid-Proto Labs Value Proposition for Start-ups and SMEs

IoT Rapid- Proto Labs

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The objective of the study is to identify and suggest relevant elements of value on which the IoT Rapid-Proto Labs will focus to correctly structure, define and create a value proposition for the start-ups and SME's segments. Hence, the study develops on the idea of value creation in the context of university-industry cooperation and explores further on the concept of value proposition. Hence, a theoretical tool called "The Value Proposition Canvas" is used for mapping the elements of value which are essential for the start-ups and SMEs market segments.

The study uses an inductive research method, and primary qualitative data were collected through semi-structured interviews with start-ups and SMEs. The aim of these semi-structured interviews was to understand their interpretation of the value enhancing elements. Additionally, the secondary data were gathered through Internet searches, as saved time and resources.

During the data collection and analysis of the research findings only the start-ups and SMEs perspectives were considered. The viewpoints of the HEIs and staff involved in the IoT Rapid-Proto Labs were excluded as they are not considered relevant for the identification of the needs and sources of anxieties of the start-ups and SMEs customer segments. Hence, the study exemplifies an outsider's viewpoint which provides an impartial analysis and assessment of these results.

The research interviews with start-ups and SMEs revealed that many types of jobs, pains and gains include concerns around activities such as funding, scalability, lack of operational capital, access to technical knowledge and other day-to day activities on which firms engage in order to generate revenue and eventually profit. Subsequently, interviewees highlighted that HEIs have different working pace compared to the private commercial consultancy firms. Hence, rapid-prototyping and rapid MVP deployment for commercialisation is a requirement sought from potential HEIs partners.

In conclusion, this study recommends to create of a new value proposition based on interviewees suggestions, which includes two different components: cost effective rapid-prototyping and co-creation of MVP, rapid deployment for commercialisation. Moreover, the current four IoT Rapid Proto Labs value propositions were included as product and services within the value proposition canvas aiming to build an improved value proposition.

Keywords
Higher Education Institutions (HEIs), Internet of Things (IoT), IoT Rapid- Proto Labs, SME's, Start-ups, University-Industry Cooperation, Value creation, Value proposition.

Contents

Abbreviations

AI	Artificial Intelligence
B2B	Business to Business
BICs	Business Innovation Centres
BMs	Business Models
CBD	Customer Business Development
CPIs	Corporate Private Incubators
HEI	Higher Education Institutions
ICTs	Information Communication Technology Services
IoT	Internet of Things
IPIs	Independent Private Incubators
LoRaWAN	Long Range Wide Area Network
MVP	Minimum viable product
NB-IoT	Narrowband IoT
NIC	Newly Industrialised country
PPP	Public Private Partnerships
SaaS	Software as a service
SME	Small to mid-size enterprise
UBIs	University Based Incubators
UIC	University Industry Cooperation
VoLTE	Voice over Long-Term Evolution
VP	Value Proposition

1 Introduction

As results of the investments in the 5G infrastructure around the world, the interest and business opportunities for the Internet of Things (IoT) has assigned flows of capital into interesting ventures which are developing such technologies. Around the world, venture capital firms, private investors and business angels are financing ventures (start-ups and SMEs) which have an attractive business model and offer ways for rapid testing and performing these ideas into concrete actions. (International Finance Corporation 2019)

The business opportunities for the Internet of Things (IoT) are numerous, some of these can be mentioned as opportunities for analytics and optimisation of logistics in manufacturing sector, efficiency and automation in Industrial IoT, consumer electronics and connected cars, etc. Hence, many companies, researches and business hubs are venturing quickly into ways of collaborating for maximising efforts.

The objective of the study is to identify and suggest relevant elements of value on which the IoT Rapid-Proto Labs will focus to correctly structure, define and create a value proposition for the start-ups and SME's segments. Therefore, the project will use this value proposition for targeting start-ups and SMEs needs and provide solutions for them.

The sponsor is the IoT Rapid-Proto Labs project, co-funded by European Union Erasmus+ Knowledge Alliance Programme and coordinated by Haaga -Helia University of Applied Sciences. The IoT Rapid-Proto Labs is a European transnational project, which gather together higher education institutions and businesses intending to accelerate Internet of Things (IoT) product development. (IoT Rapid-Proto Labs 2020)

The IoT Rapid-Proto Labs use a multidisciplinary course curriculum which includes ICT, Design and Industrial Engineering focuses on a real problem-based innovative IoT product development for SME's and start-ups. The project established geographically distributed multidisciplinary teams aiming to rapidly set-up, trial and test an innovative IoT solution for their SMEs and start-up clients. (IoT Rapid-Proto Labs 2020)

These teams are supported by faculty, researchers, and practitioners using agile and lean methodologies aiming to add value for enterprises, and strengthen the employability, creativity and career prospects of students. (IoT Rapid-Proto Labs 2020; TU Delft 2020)

The project serves a two- sided marketplace, including start-ups and SMEs, and Higher Education Institutions (Figure 1). The purpose of serving these two-sided market places is to bring added value, providing in an International dimension during the IoT projects lifecycle. The project goal is to construct an open-design learning that facilitates multidisciplinary teaching, learning, and co-creation within higher education, research institutions, and businesses. (IoT Rapid-Proto Labs 2020)

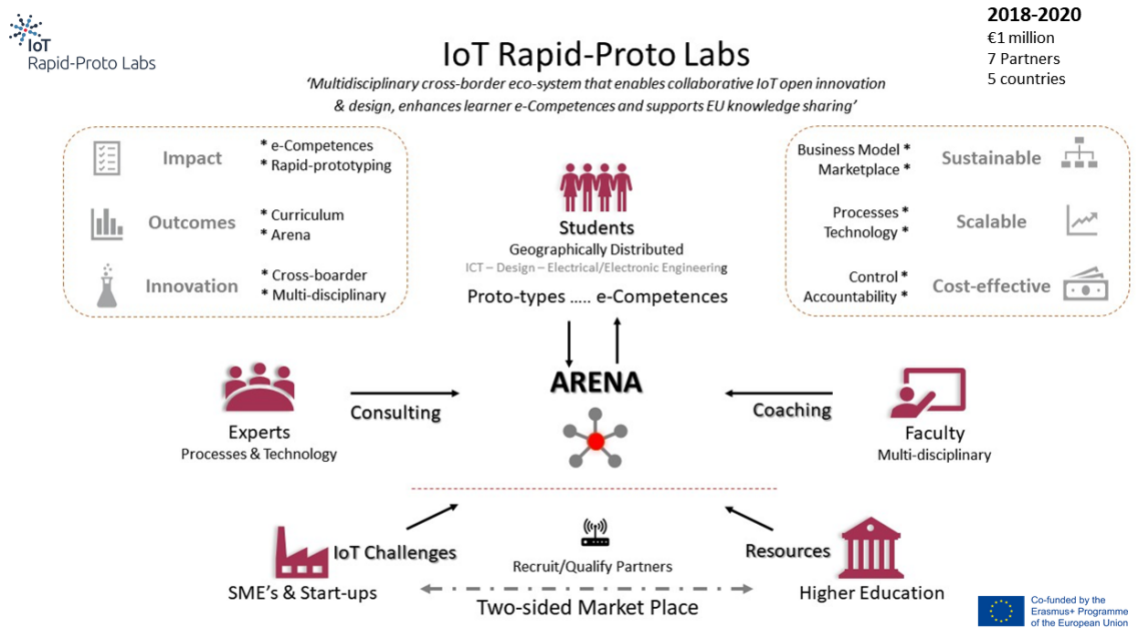


Figure 1. The IoT Rapid- ProtoLabs (IoT Rapid-Proto Labs, 2020).

The goal of this project is achieved throughout a project-based learning setup which includes working on projects to solve IoT Rapid-Prototyping challenge for companies. These groups working on solving such challenges include: HEIs students, faculty and external experts where the sole purpose of these groups is to generate inputs and create value in the two-sided marketplace. Thus, the project has been funded until the end of 2020 which marks a phase where needs to prove the reasons for its continuity, remain sustainable in the long run and demonstrating an added value for both the external and internal stakeholders. (IoT Rapid-Proto Labs 2020)

1.1 Research problem, goals and objectives

The main research problem and objective of this study is to identify and suggest relevant elements of value on which the IoT Rapid-Proto Labs will focus to correctly structure, define and create a value proposition for the start-ups and SME's segments. Therefore, the main question of the study is: How the IoT Rapid-Proto Labs would provide an added value for the start-ups and SME's during rapid-prototyping and the creation of minimum viable product concepts?

Moreover, the sub-questions related to the main research problem are described in Appendix 1, which displays a summary of the academic theories and models used for answering these questions, research methods adopted as well as the results achieved.

These sub-questions are exemplified as follows:

What are the motivations of start-ups and SMEs to engage in collaboration with the IoT Rapid-Proto Labs and how these would align with their organisational goals?

How a value creation and value proposition strategy would effectively offer a solution for start-ups and SMEs obstacles and challenges?

Would a collaboration with the IoT Rapid- Proto Labs increase the possibility for start-ups and SMEs to commercialise IoT developments while using cross-border multidisciplinary teams?

1.2 Scope of the study

The objective of the study is to identify and suggest relevant elements of value on which the IoT Rapid-Proto Labs will focus to correctly structure and define a value proposition for the start-ups and SME's segments.

The study used semi-structured interviews with start-ups and SME to collect primary qualitative data, aiming to understand their interpretation of the value enhancing elements. Subsequently, during data collection and analysis of the research findings only the start-ups and SMEs perspectives were considered. The perspectives of the HEIs and staff involved in the IoT Rapid-Proto Labs are excluded, since they are not considered relevant for the identification of the needs and sources of anxieties of the start-ups and SMEs customer segments. Hence, the study illustrates an outsider's viewpoint delivering an impartial and unbiased analysis and assessment of such results.

The study will not be discussing any technical challenges of IoT, and will focus only in the business-related challenges of one segment of the two-sided market place of the project i.e. start-ups and SMEs.

2 Value creation and university-industry cooperation in the context of IoT

This section reviews concrete and up-to-date literature spinning across the concepts of start-ups and SME's, as well as the notion of Internet of Things (IoT), university-industry cooperation (UIC) and the interpretations of value proposition and value creation.

The discussion within this section starts with definitions start-up and what involves setting up a strategy within start-ups e.g. business modelling and disruptive innovations. Moreover, a review of SMEs definition is presented to clearly establish the differences between a start-up and what constitutes an SME.

Henceforward, it is presented what is Internet of Things (IoT). Within the context of IoT there exist relevant concepts such as: IoT applications and its domains, smart connect products and its capabilities. Subsequently, it describes the context on which university-industry cooperation takes place, its interactions and start-ups and SMEs motivations to engage in such cooperation.

Lastly, this section describes relevant theories of how to create value for customers, definitions of what includes value creation, types of value co-creation and the value proposition canvas used in this study as a mapping tool. This value mapping tool aims to create a fit between a product or service and a specific market or marketplace, and to improve an existing product or service offering. Henceforth, this section concludes with introducing the concepts of value creation within the context of the Internet of Things (IoT).

Therefore, this theoretical background, aims to establish, comprehend and clarify how these concepts contribute to the formation of the value proposition for the start-ups and SME's segments.

2.1 Start-ups: Definition, disruptive innovations and business model

The word start-up has been very popular lexicon among the business circles and the new generation of entrepreneurs. For this reason, it is important to know its origins and really what a start-up is.

The most widely cited and popular definition of start-up has been articulated by Steve Blank; where a start-up is defined as a temporary organisation formed to search for a repeatable and scalable business model (Blank 2013, 63–72). Moreover, exists another generally adopted definition used by Clarysse & Bruneel (2007) "a start-up is a company, partnership or temporary organisation designed to achieve a repeatable and scalable

business model". (Ojaghi, Mohammadi & Yazdani 2019, 1065). Moreover, Skala (2019, 14) stated that word start-up denotes any business which is at its early stage. However, through time its significance has pointed to activities which are dynamic, aspiring and technological in nature.

Furthermore, it is important to highlight certain characteristics of start-ups depicted by (Ojaghi et al., 2019) which are classified as follows: a) start-ups does not have customers at the beginning, they cannot apply a pre-designed business model, and since their survival is the primary objective the need for testing and iterating different alternatives become relevant. b) "start-ups introduce an idea to the market and constitute a new business, and thus, play an active role in the innovation process" (Ojaghi et al., 2019, 165). c) Start-ups are in an early phase; therefore, they lack organisational structure, tangible and intangible resources and they have challenges to develop an idea-to-market cycle which is also called the four phases of innovation.

Moreover, Nambisan & Baron (2013) stated that new small entrepreneurial venture start-ups have contributed in a stream of innovation ecosystem lead by the changes in the marketplace. Hence, it becomes important to mention the disruptive innovation model developed by Clayton Christensen - professor at Harvard Business School. In several of his publications Christensen defines start-ups as organisations that create breakthrough innovations and in the long run can change the patterns set by their respective marketplaces. (Christensen & Raynor 2013).

In other words, start-ups are established by entrepreneurs who are seeking to create something new or disrupt the market. Hence, the concepts described in the Innovator's Dilemma (Christensen 2011) and the innovator's solution (Christensen & Raynor 2013) create an important description about what start-ups are, their objectives and performance.

Furthermore, there exist elements on which start-ups, SMEs and large companies to rely to innovate. These elements are depicted in a model called the disruption innovation model (Christensen 2011; Christensen & Raynor 2013), which is illustrated in Figure 2. This model consist of three critical elements described as: a) in every market exist a rate of improvement that customers can understand or use, b) in every market exist a different pace of technological progress which innovating businesses offer as they present original and enhanced products, and c) depicts the difference between sustaining and disruptive innovation, where the sustaining targets "demanding high-end customers" offering an enhanced product or service that can execute in a superior mode than those which were previously available.

Additionally, Christensen & Raynor (2013, 34) stated that disruptive innovations do not try to bring better products to traditional customers in existing markets. In contrast, they seek to fluster and redefine the market by introducing products and services which are not as good as the current products available in the marketplace. However, the products or services offered by the disrupters are more convenient and simpler to use, and less expensive, which can appeal to new or less-demanding customer.

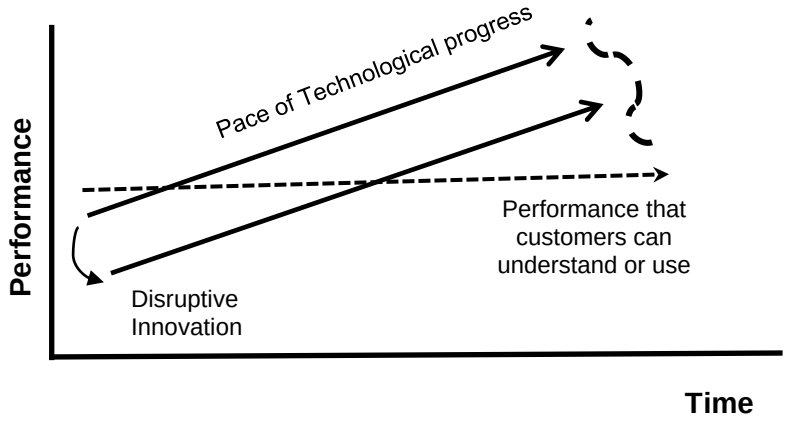


Figure 2. Disruptive innovation model (adapted from Christensen & Raynor 2013, 33)

Moreover, Skala (2019, 25) denotes that start-ups test an innovative business model under high and low risk conditions; and their ultimate goal is to create an innovative product or service to produce a disruptive state on the marketplace. Hence, creating an opportunity for hyper-scaling such business model considering that the demand barriers are conquered.

In contrast, Blank (2013, 67) defines start-ups as testing hypotheses, collecting initial and regular customer feedback in order to create minimum viable products (MVP) for future prospects. While doing this process the start-ups acknowledge that their primary task is to find a feasible business model; contrasting with established companies which execute ideas into their business models.

According to Blank (2013) a start-up is not a small version of a large company and these shows the following characteristics: a) goals, which can be very ambitious aiming to become a large company; b) a function which is constantly in a is a search for a feasible business model (testing verification, and possible modification of later versions of the business model; and c) a financing arrangement which might include resources from external investors and reduces the founders shares in the company's capital. (Skala, 2019)

Additionally, Blank (2013) proposed a new strategy for start-ups or organisations based on a quick, responsive development. In traditional customer and product development each stage occurs in linear order and lasts for months. On the other hand, agile development (Figure 3) builds products or services in short, repeated cycles where the output is to create a "minimum viable product" containing only critical features gathering feedback from customers, and then starts over with a revised minimum viable product" (Blank 2013, 69)

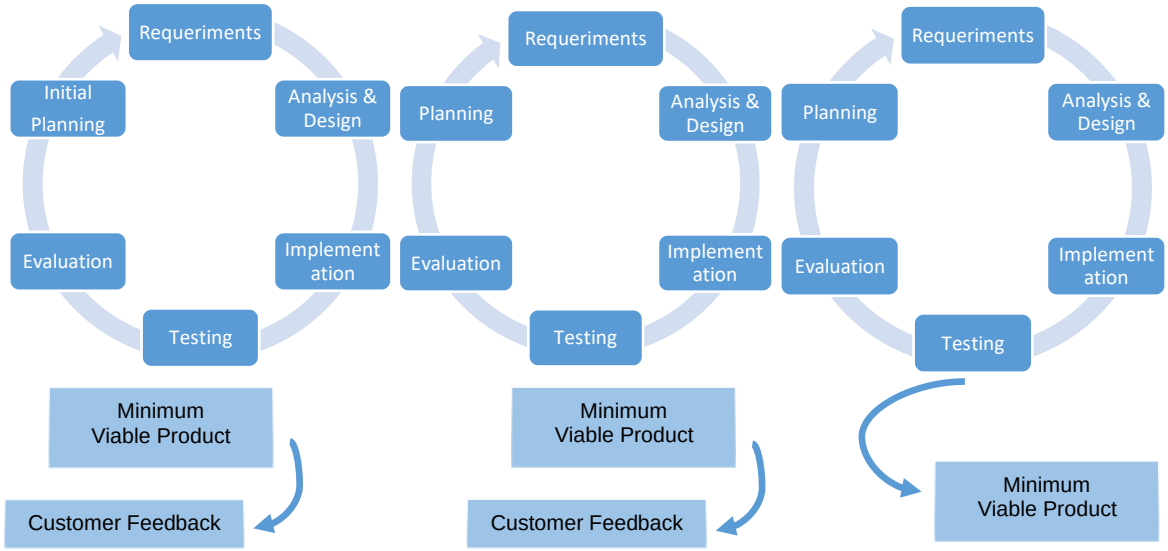


Figure 3. Agile product-customer development (adapted from Blank 2013, 72)

Henceforward, Blank (2013) argues that during the customer-product development phase, a start-up explores a business model that might work. If customer feedback reveals that its business assumptions are wrong, it either reviews them or turn to new theories. As is depicted in Figure 3, the process of agile customer-product development includes six phases where within the deployment of the MVP a customer feedback is highly valuable. Therefore, allowing the process to gather the feedback and improve the MVP if possible. Each stage of customer development is repetitive: A start-up will perhaps fail numerous times before finding the right approach. Then, immediately a model is proven, the start-up begins to execute, building a proper organisation.

In contrast, Skala (2019, 26) illustrated that a start-up life cycle consists of three basic stages: initial, expansion, and maturity. Where: a) the initial phase a start-up is an organisation with limited resources which identifies a market problem, recognises demand, or validates its solution; b) at the expansion stage: it is an entity that grows rapidly; and c) and at the maturity stage it is a hyper-scalable organisation. (Skala 2019, 26)

Consequently, as explained by (Blank 2013; Christensen 2011; Christensen & Raynor 2013, 34) it can be suggested that start-ups are temporary entities formed with the mere purpose of exploring and finding a feasible, repeatable and scalable business model which might create disruptive innovations in the marketplace.

2.2 Definition of SME (Small and medium-sized enterprise)

According to Mutula & Brakel (2006, 403) currently there is not a worldwide definition of SMEs that is commonly accepted. The definition of an SME is revised depending on the context where the company has its operations, and it is frequently based on these criteria: country of operations, employment which generates, assets and resources available.

SMEs are not an identical set of businesses, but a diverse group which usually operates in the service, trade, agribusiness and manufacturing sector; and they are classified based on the focus of their production, operations, management structure, internal competence financial practices and trading relations. SMEs differ from each other on elements such as: enterprise age, location, sector, organisational mode, knowledge base, power and control of resources and innovative capacity. (Ongori & Migiro, 2010; Lukacs 2005, 3; Vivienne & Roberts 2005, 522)

On the other hand, the European Commission published a reviewed definition of SMEs in their “User guide to the SME definition” (European Commission, 2015), where they stated that an enterprise is: “any entity engaged in an economic activity, irrespective of its legal form” (European Commission 2015, 9). In fact, under this definition self-employed, family firms, partnerships and associations or other entities which are engaged in an economic activity are considered as enterprises.

Hence, under this definition proposed by the European Commission (European Commission, 2015) small and medium-sized enterprises (SMEs) are defined as: a) enterprises which provide employment for less than 250 persons (staff headcount); b) an annual turnover not exceeding EUR 50 million or c) an annual balance sheet total not exceeding EUR 43 million (Figure 4).

Furthermore, under the “User guide to the SME definition” small and medium-sized enterprises (SMEs) are classified in three different categories. Where defining each of these categories as a type of relationship that a company could have with another, and argues that such distinction is essential to establish a clear view of what the economic situation of such enterprises is and to exclude those which are not an authentic SME. (European Commission, 2015).

The categories proposed by the “User guide to the SME definition” (European Commission, 2015) are defined as follows:

- “Autonomous enterprise: if the enterprise is either completely independent or has one or more minority partnerships (each less than 25 %) with other enterprises.
- Partner enterprise: if holdings with other enterprises rise to at least 25% but no more than 50%, the relationship is deemed to be between partner enterprises.
- Linked enterprise: if holdings with other enterprises exceed the 50% threshold, these are considered linked enterprises” (European Commission 2015, 7).

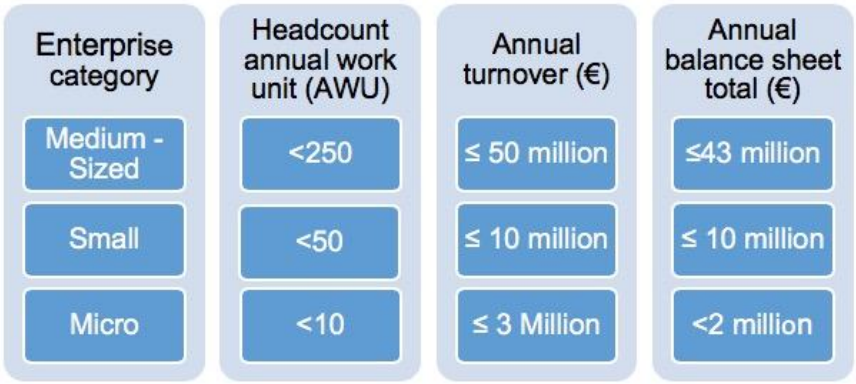


Figure 4. SME Definition - Thresholds (adapted from European Commission 2015, 11)

Subsequently, it is important to highlight the significance of the SMEs within the world’s economy. As (Singh, Garg & Deshmukh, 2009) describes SMEs are considered the backbone of economic growth since they produce about 80 percent of global economic growth and, that in newly industrialised countries (NICs) the largest percentage of the workforce is employed by SMEs. Accordingly, as Ongori & Migiro (2010) argues SMEs have an important position since they contribute to job creation, income production and distribution and they provide an environment where entrepreneurs and employment can flourish.

Likewise, it is argued among scholars that SMEs are facing constantly a great amount of challenges, some of these can be summarised as follows:

Within SMEs exist a lack of managerial skills, finance, market information and commercial intelligence gathering- SMEs are also faced with the problems of small markets, inadequate regional integration, poor infrastructure, bad governance, legal and administrative hindrances and failure to access credit (Ongori & Migiro 2010). In addition, a flat structure increases the frustration among employees since they cannot find a way how to meet their short or medium-term career goals into the current organisational structure. Therefore, SMEs find it hard to employ and generate employee engagement for the high performing staff. (Singh et al., 2009).

SMEs are commonly concerned with attending local niches or serving somewhat narrow specialised markets. Some of these constraints of limited resources can be described as: a lack of technical expertise, reduced intellectual capital, slow pace for innovation and a flat organisational structure. (Zhao, 2014).

As result of trade liberalisation foreign manufacturers and retailers, have increased their capacity to penetrate both remote and underdeveloped markets. Therefore, in a globalised economy, the majority of SMEs operating only in local markets are having difficult times to maintain their current business position; or in better terms to exist since their products and sales are highly segmented and localised. (Singh et al., 2009).

SMEs are having their competitiveness at risk since they have inability to meet the demand for multiple technological competencies including access to up to date technologies, excessive costs of product development projects. Additionally, a lack of effective selling techniques and limited market research, lack of information between marketing and production functions, and lack of skilled human capital to exploit and improve ICTs within the business (Ongori & Migiro 2010; Singh et al., 2009)

Hence, it can be deduced that as result of lack of resources (capital, human resource and technological capabilities) SMEs are pushed to form alliances in order to compete in today's marketplace. Consequently, so as to tackle the obstacles mentioned above organisations use strategic alliances as the key method for enhancing internal operations, expanding to new market segments, and prosper within a fast-moving business environment. (Zhao 2014, 888).

Academic research and day-to-day business practices have indicated that alliances are an efficient method for overcoming resource and capability flaws and increasing the chance of success for internationalising firms. (Lu & Beamish, 2001). Additionally, alliance partners symbolise a significant foundation of host country knowledge for SMEs, as they can contribute to defeat the shortages of capital, and tangible assets while sharing resources between the parties involves in these alliances. (Lu & Beamish 2001, 55)

Thus, SMEs can compete more effectively against large organisations while adopting a co-opetition strategy, which is a synchronised cooperation and competition between SMEs. While collaborating with each other SMEs can mitigate risk, leverage resources together and create economies of scale. Hence, this would enhance the competitiveness of SMEs, given that they critically depend on the success of their alliances. (Zhao 2014).

2.3 Internet of Things (IoT) – What is it?

The actual first definition of Internet of Things (IoT) is attributed to Auto-ID Labs, which is a world-wide network of academic research laboratories specialised in Radio-Frequency Identification and sensing technologies. The main focus of Auto-ID Labs has been the "development of the Electronic Product Code™ (EPC) to support the spread use of RFID in world-wide modern trading networks, and to produce the industry-driven global standards for the EPCglobal Network™ "(Auto-ID Labs, 2020; Atzori, Iera & Morabito 2010, 2788).

There is not a unique definition for the Internet of Things (IoT) which researchers, academics, developers, innovators and business people are in unison accepting. Hence, it is relevant to compare different meanings given by diverse sources.

According to Madakam, Ramaswamy & Tripathi (2015) the best definition for Internet of Things (IoT) has been attributed to Kevin Ashton who is an expert on digital innovation. His definition states that IoT it is "an open and comprehensive network of intelligent objects that have the capacity to auto-organise, share information, data and resources, reacting and acting as changes appear in the environment" (Madakam et al., 2015, 165)

In contrast, Internet of Things (IoT) is defined as "Interconnection of sensing and actuating devices, providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications". (Gubbi, Buyya, Marusic and Palaniswami 2013, 1647)

Likewise, Atzori et al., (2010, 2788) described Internet of Things (IoT) as "a world-wide network of interconnected objects (heterogenous) uniquely addressable, based on standard communication protocols"; and implies that objects which uses RFID tags, sensors, mobile phones, etc., are able to interact and collaborate with each other to reach mutual objectives.

Moreover, (Gubbi et al., 2013; Atzori et al., 2010, 2789) portrayed that IoT can be understood using the term Internet of Things Paradigm, whose results on a convergence of different visions illustrated by Figure 5. While this explanation is essential since Internet of Things it is interdisciplinary in nature, and its practicality can be applied in a domain where the three paradigms interconnect (Gubbi et al., 2013) and the conjunction of the three main visions interconnect (Atzori et al., 2010, 2788).

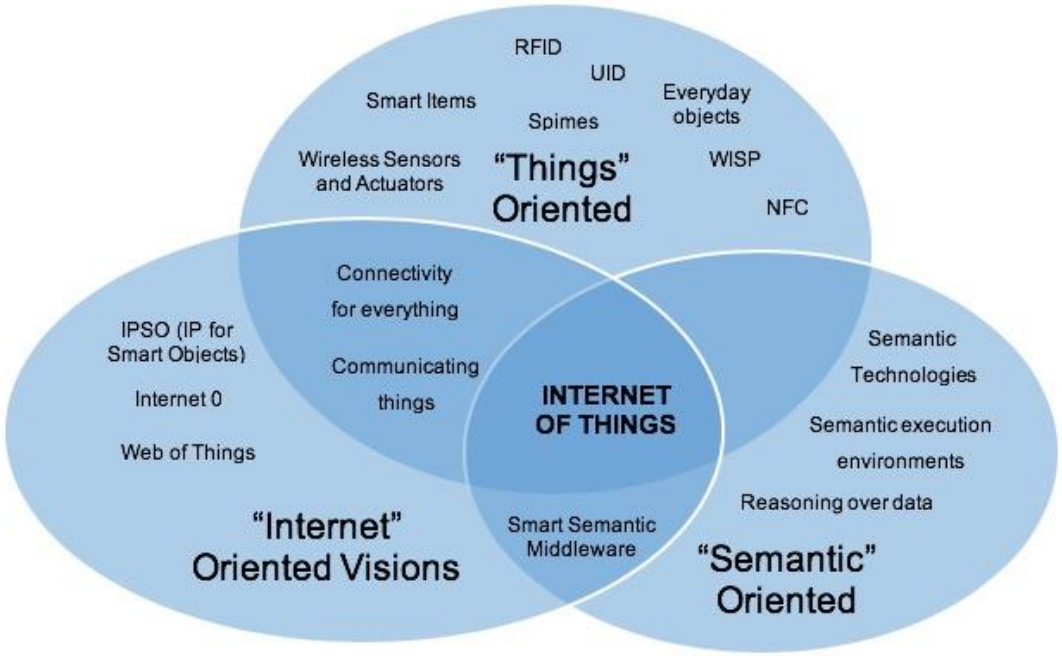


Figure 5. ‘‘Internet of Things” paradigm (adapted from Atzori, Iera & Morabito 2010)

Therefore, based on Atzori et al., (2010, 2789) IoT operates within the conjunction of these three different dimensions (Figure 5) and includes: a) things oriented: RFID applications such as logistics and retail, portable medical devices, smart watches, etc.; b) internet oriented: which refers to web connections, communications and interactions among this realm; and c) semantic oriented: which denotes the technology used for collecting, search and understanding data which is produced by all the connected devices and its users.

According to (Vermesan & Friess 2014; Patel, Patel & Salazar 2016) there are fundamental characteristics of IoT which includes the following:

- Interconnectivity: Regarding IoT, all things can be connected with the worldwide communications and information infrastructure.
- Things-related services: Internet of Things (IoT) can deliver thing-related services while operating within the restrictions of things-oriented domain; e.g. semantic consistency between physical things and privacy protection.
- Heterogeneity and dynamic changes: Since the devices used in IoT are developed based on different hardware platforms and networks, these are heterogenous and dynamic in nature. Therefore, these can interact with other devices or platforms throughout diverse networks as well as their state changes dynamically.
- Enormous scale: IoT requires that a vast number of devices are connected and interact with each other, hence the device-triggered communication will increase and the data generated from such interactions.

IoT Applications

According to Gubbi et al., (2013, 1649) the applications of the IoT are classified based on the type of network availability, coverage, scale, heterogeneity, repeatability, user association and impact. These categories are described in four domains: Personal and Home (individual or home scale); Enterprise (scale of the community); Utilities (national or regional scale); and Mobile (extents through other domains mostly because of the nature of connectivity and scale).

In contrast, (Atzori et al., 2010) argues that the IoT applications can be grouped in transportation and logistics domain, healthcare domain, smart environment (home, office, plant) personal and social domain (Figure 6). Further, Atzori et al., (2010) develops the idea that among these possible IoT applications, there exist a difference between “directly applicable” meaning those which are closer to our current living environment and the “futuristic”, since the societies and current technologies are not ready for their implementation.

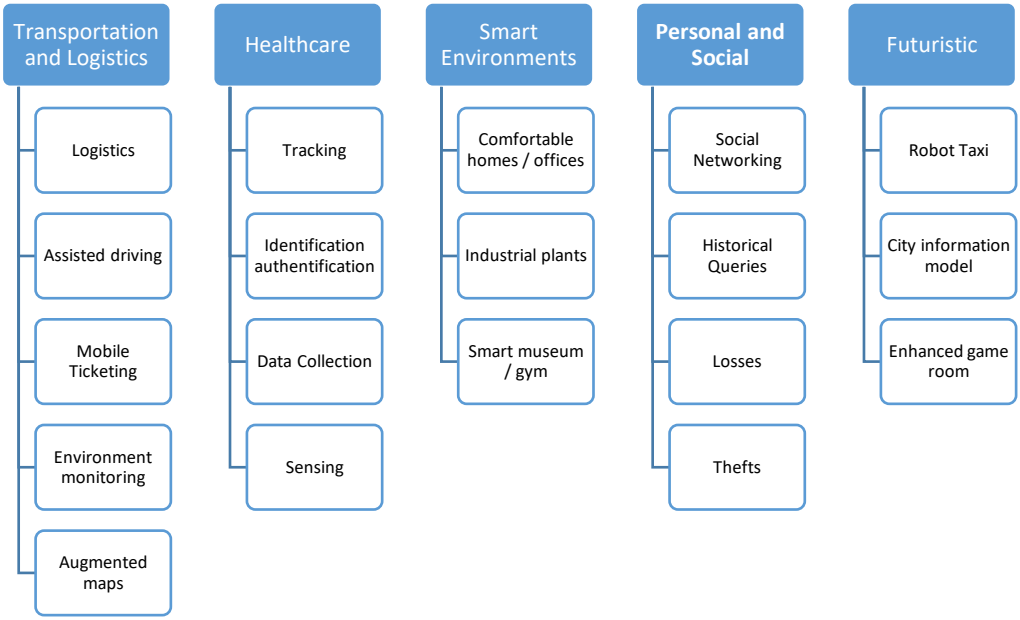


Figure 6. Applications domains and relevant major scenarios. (adapted from Atzori, Iera and Morabito 2010)

As of 2020, technologies have developed in a much faster speed and implementation of the applications proposed by Gubbi et al., (2013) and Atzori et al., (2010) might obsolete. Some of these new technologies have allowed a disruption in the market and enlargement of newer applications is expected, i.e. self-driving cars, supermarkets with no checkouts using AI and IoT (Amazon Go), Amazon delivery drones, etc.

Smart connected products

As technological disruptions increase the need for “smart, connected products” rises within the IoT dimensions and its applications. Based on Porter & Heppelmann (2014) smart connected products offer opportunities for new functionality, superior reliability and capabilities that could surpass traditional product limitations. Hence, the changing nature of these products is disrupting value chains, setting strategic alternatives on how value is created and captured, and opening new competitive opportunities and threats.

Furthermore, Porter & Heppelmann (2014) described that “smart, connected products” have three core elements such as: physical, smart and connectivity components. Where smart components (sensors, microprocessors, data storage, controls, software, etc.) strengthen the capabilities and value of the physical components (product’s mechanical and electrical parts), where connectivity (ports, transmitters, receivers, protocols, and wired or wireless connections, etc.) magnifies the potentials and value of the smart components and qualifies some of them to live outside the physical product itself.

Capabilities of Smart connected products

Based on Porter & Heppelmann (2014, 69) the capabilities of smart connected Products (Table 1) a firm is obliged to select a set of capabilities which outline its competitive setting and deliver the most customer value. These categories are classified into four areas: monitoring, control, optimisation, and autonomy. Hence, each capability outlines on the previous one and the end goal is that smart, connected products eventually can perform with full autonomy.

Table 1. Capabilities of Smart Connected Products (Porter & Heppelmann 2014)

	Monitoring	**Control**	**Optimisation**	**Autonomy**
Description	Sensors and external data enable the comprehensive monitoring	Software embedded in the product or cloud	Usage of monitoring and control capabilities enable algorithms that optimise product operation	Combines monitoring, control, and optimisation
Function	Monitors the external environment, the product’s operation and usage	Enables control of product functions and customisation of the user experience	Enhances product performance and allows predictive diagnostics, service, and repair	Allows autonomous product operation, product and enhancement. Self-diagnosis, self-operation and service with other products

2.4 Context of cooperation between HEIs, Start-ups and SMEs

In today's marketplace start-ups and SMEs are in the need for access to external experts to improve their knowledge base and increase their competitiveness while working on their short and long-term strategy. These parties (HEIs, start-ups and SMEs) have different motivations for engaging in cooperation; as the interaction channels between them adjusts according the style of motivation selected (Franco & Haase 2015).

According to Franco & Haase (2015), researchers at HEIs have certain motivations for engaging in university-industry cooperation, and depicts that the use of the interaction channels (e.g. service, traditional, bi-directional and commercial channels) depends on the researchers' motivations and disciplinary affiliation. Such motivations can be determined by the shortages of public funding, therefore interaction with industry (companies) can be crucial to find resources (Franco & Haase 2015, 42) and the main barriers obstructing university-industry cooperation are bureaucracy, legal framework and lack of organisational support (Franco & Haase 2015, 49).

The interactions between university-industry cooperation runs through many channels and these can exist in different forms. Such intercommunications could involve transfer of knowledge within academic research material such as publications, licensing and patents; applied research and development projects, students, graduates and researcher mobility, consultancy and training, academic start-ups and spin-offs. (Franco & Haase 2015, 43)

Subsequently, there exist four different interaction channels for university-industry cooperation (Franco & Haase 2015). At first, the service channel associated with offering technical and scientific services for a fee (e.g., use of equipment for quality control purposes, test, monitoring and consultancy). In this channel the knowledge flows from universities towards firms and includes a short-term interaction. Secondly, the traditional channel comprises firms gaining unidirectionally from academic activities e.g. employing graduates, publications, conferences.

Thirdly, the bi-directional channel, exemplifies bi-directional flow of knowledge which contains collaborative research and project development, participation in networks, science technology parks and other similar activities. Lastly, the commercial channel specifies the academic spin-offs and business incubators, also including technology licences and patents. (Franco & Haase 2015, 44)

Furthermore, Franco & Haase (2015, 49) indicated that the universities of applied sciences have a challenge when combining their research agenda with institutional supply; and active participation of academics in research projects with industry should be stimulated with the use of appropriate incentive policies. Similarly, Franco & Haase (2015, 49) research concludes that bi-directional and the commercial interaction channels seem to be relevant for polytechnics since they have a more applied, practical research and teaching approach.

Therefore, in order to understand how universities, try to promote business innovation and development through the use of business incubators as a form of cooperation between university and industry, it is important to define the commercial channel (Franco & Haase 2015, 44) and business incubators as a concept (Piterou & Birch 2012; Grimaldi & Grandi 2005).

According to Grimaldi & Grandi (2005) incubators are classified into four categories:

- Business Innovation Centres (BICs): Are publicly funded centres which deliver simple services to their occupiers such as space, information about financing programmes, IT infrastructure, etc.
- University Business Incubators (UBIs): Similar to BICs however, they highlight knowledge transfer from universities to the industry.
- Independent Private Incubators (IPIs): These are created by persons in order to support small businesses at the growth stage, as also called “business accelerators”.
- Corporate Private incubators (CPIs): Are created by large corporations to boost the arrival of corporate spin-offs.

Further, Grandi & Grimaldi (2004, 25) described that University Business Incubators (UBIs) are non-profit institutions, which prioritise business ideas that come inside or from their parent organisation, as they are more likely to generate academic spin-offs and corporate spin-offs. (Grandi & Grimaldi 2004, 26)

In contrast, Independent Private Incubators (IPIs) and Corporate Private Incubators (CPIs) are profit-oriented institutions, and these are established by private individuals with the goal of generating profit. Moreover, Business Innovation Centres (BICs) and Independent Private Incubators (IPIs), are seeking for new entrepreneurial ideas to incubate because they are not affiliated to a certain university or business. (Grandi & Grimaldi 2004)

As Grimaldi & Grandi (2005, 116) further described that UBIs provide various university related benefits such as access to laboratories and equipment, scientific and technological knowledge and to access networks of key relations. However, UBIs are less time sensitive than private incubators time-to-market customer’s projects and quickening the likelihood to have liquidity (converting ideas into cash). Also, Grimaldi & Grandi (2005) mentioned

that one of the main deficiencies of UBIs is their failure to provide management, funding and economic capabilities for day-to-day operational support.

Moon et al. (2019) portrays two types of activities which universities perform when they collaborate with firms and these aims to generate innovation. These are classified as people-based activities (using people's or human asset knowledge into the company's working processes to create innovation) and problem-solving activities (joint research, contract research, consulting services providing access to special material, equipment and product prototyping). Hence, such activities might improve a company's innovation performance.

In contrast to the activities described above, absorptive capacity (a firm's capacity to locate, incorporate, and use knowledge from the environment) has different effects on the relationships between HEIs activities and firm innovation outcomes. Moon et al. (2019, 535) argues that absorptive capacity is influenced by a corporation's relation with its external partners, thus building the firm's knowledge and connecting organisational learning and innovation.

A firm's absorptive capacity reinforces the positive role of problem-solving activities achieving a company's profound innovation. Subsequently, at a higher level of absorptive capacity the better external knowledge, achievement and application leading to innovation; and an effective use of problem-solving skills gained from HEIs.

Moon et al. (2019) concluded that people-based activities have no effect on firm innovation and firm's innovation can be achieved by working with HEIs through problem-solving activities; as they offer a constant feedback and in-depth knowledge transfer to the firms.

Henceforth, according to Johnston & Huggins (2018) small companies might benefit from engaging in university-industry (U-I) relationships by adding resources, increasing innovativeness and competitiveness while pursuing the development of new ideas. In addition, small firms measure the credibility of their prospective partner when involving in cooperation with HEIs.

Thus, a firm pattern selection is based on credibility, and can be described as the capacity to deliver the promised knowledge and expertise in a particular field. Such statement represents the firms' appraisal of the usefulness of such HEIs as a potential partner. (Johnston & Huggins 2018,15)

In particular, while engaging in university-industry (U-I) cooperation these parties seem to be responding to different incentives, and therefore tensions might arise. At first, firms are seeking knowledge for commercial reasons and academics are looking for research while increasing a status in a particular field. Secondly, tensions between companies and HEIs may result from their different logics and methods of working. Thirdly, individuals within companies and HEIs work opposing time scales, with firms working with a narrower timetable driven by commercial demands. Fourthly, distinctive communication styles might obstruct the transfer of knowledge.

Lastly, a great amount of academic research may not be important to private businesses, resulting in a relevance gap. Consequently, in order to establish a successful university-industry collaboration these tensions must avoided, predominantly as exist an expectation that such cooperation might have a positive effect on the firm. (Johnston & Huggins 2018,16 -19)

Furthermore, Johnston & Huggins (2018, 24) conclude that small companies analyse the credibility of their potential university partners around the practicality, capacity and precision of their knowledge. In other words, these companies measure such cooperation as how well is harmonised with their organisational goals and objectives, as well as the degree on which a potential HEIs partner can outline a plan of action, and the completeness for such cooperation.

As the goal of companies is to commercialise their business ideas, it becomes relevant to explore how cooperation with HEIs can lead to commercialisation. As Perkmann et al. (2013) implies that academic engagement can relate to commercialisation. Thus, first it is necessary to understand what is academic engagement (informal technology transfer); which is defined as a knowledge-related cooperation by academic researchers with non-academic corporations. These interactions include formal activities (collaborative research, contract research, and consulting) and informal activities (networking with specialists and providing spontaneous advice). (Perkmann et al. 2013)

Moreover, Perkmann et al., (2013) develops on the idea how does academic engagement can relate to commercialisation. At first, academic engagement as collaboration and commercialisation might happen while performing academic entrepreneurship. This constitutes establishing a firm with the objective to exploit commercially a patented invention, or a set of non-patented expertise to reap financial rewards. (Perkmann et al. 2013, 424). In other words, academic engagement often leads to commercialisation, and in some cases might also complement commercialisation, for example, when spin-off companies work collaboratively with the university labs they originated from.

Consequently, commercialisation is considered a major “example for generating academic impact because it constitutes immediate, measurable market acceptance for outputs of academic research” (Perkmann et al. 2013, 423). In order to support commercialisation, HEIs have created specialised structures such as technology transfer offices (TTOs), science parks and incubators and created supportive internal rules and procedures. (Perkmann et al. 2013, 423).

2.5 Value proposition and value creation

As a starting point, it is relevant to set a proper definition of value proposition. Based on (Barnes, Howard & Blake 2017) a value proposition is an outline for a firm to produce an actual value for its customers, supports a company to become customer centric and provide a foundation for creating influential sales propositions.

Hence, a value proposition can be defined as “the total value proposition is the sum of the offerings and experiences delivered to your customers, during all their interactions with your organisation” (Barnes et al. 2019, 33). Along this definition three words are highlighted: offerings, experiences and interactions. These can be described as follows: a) offerings: includes products, services and solutions along with its corresponding functionalities; b) experiences: how the customers experience the products and services offered by a certain company, and c) the customer’s experience through company’s communications: customer service, sales and after sales, marketing, delivery, invoicing, contracting and legal.

Additionally, Osterwalder & Pigneur (2010) defines value proposition as the reason why customers choose one company products or services over another. It is an array of products and services that meet customer needs and solves the problems of a specific customer segment. As some value propositions might be innovative, offering something new or disruptive, others could be similar to existing market proposals with added features or properties. (Osterwalder & Pigneur 2010, 22)

Furthermore, (Anderson, Narus & Rossum 2006) depicts a method for creating value propositions, and claims that the majority of managers only list the benefits they consider the offering could be delivered to its target customers, as other managers recognise that customer has an alternative. However, these managers make the miscalculation of supposing that these positive points of difference must be valuable for the customer. In order to tackle this obstacle, (Anderson et al. 2006) defines a value proposition into three types: all benefits, favourable points of difference, and resonating focus (Table 2).

Table 2. Three Kinds of Value Propositions (Anderson et al. 2006)

Value proposition	All benefits	Favourable points of difference	Resonating focus
Includes	All benefits customers receive from a offering	All favourable points of difference a offering has in comparison to the best alternative	Points of difference whose improvement will deliver a greater value to the customer
Answers the customer question	"Why should our firm purchase your offering?"	"Why should our firm purchase your offering instead of the competitor's?"	"What is most worthwhile for our firm to keep in mind about your offering?"
Require	Knowledge of own offering	Knowledge of own offering and next best alternative	Knowledge of how own offering delivers higher value to customers compared with next best alternative
Potential pitfall	Benefit assertion	Value presumption	Requires customer value research

In addition to the concepts defined in Table 2, Anderson et al. (2006) describes the elements of value considered when comparing one's value proposition's firm against competitor's offering.

In other words, how a company's value proposition stands out comparing to similar offering (products or services) and the value proposition from its competitors. These elements are classified into three types: a) points of parity: involves elements perform the same or has similar functionality as those of the best substitute; b) points of difference: comprises the elements which make a firm offering superior or inferior compared to the substitute offering and; c) points of contention are the elements on which the company and its customers disagree about how the performance or functionality competes with those from the rivals.

Furthermore, Anderson et al. (2006) highlights the importance to demonstrate a customer value in advance, this means that the greatest companies make remarkable efforts to prove the value of their offerings comparing to the substitutes available in the market.

Value creation

In order to determine how to create value for customers, it is important to set the ground and delimitations of such idea. It is relevant to understand that value creation is a result of the interactions between buyers and vendors, companies and clients and takes part of a process called “value co-creation”. Thus, “The only debate is a whether customer value is created through exchange (market transaction) or by usage after the product or service is bought by the customer” (Sheth 2019,1).

According to Sheth (2019, 2) there exist three types of customers in enterprises: the buyer (procurement), the payer (finance), and the user (operators). As there are different customers segments (targets), value propositions must be different for each segment. For example, a value proposition for the procurement (buyer) department includes terms of delivery, pricing and simplicity for after sales support. On the other hand, a value proposition for the payer (finance) encompasses terms of payment and financing capital. Consecutively, end customer value is described as having an outstanding execution on differentiation, customisation and quality. (Sheth 2019)

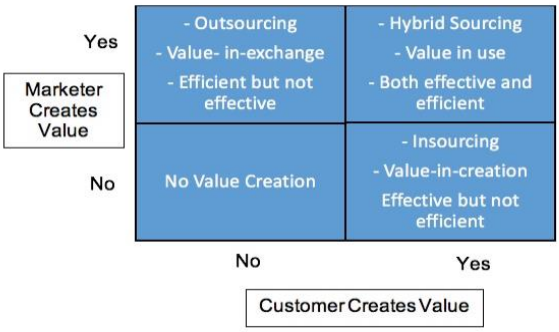


Figure 7. Who creates Value? (adapted from Sheth 2019, 2)

Furthermore, Sheth (2019) establishes the difference between when a customer creates value and when the marketer is the value creator. Figure 7, illustrates the main distinctions amid these, describes in detail when a customer and when a marketer e.g. a company, can create value by themselves or jointly produce value, as well as, establishes the ground for the introduction of value co-creation.

Hence, value co-creation occurs when both the company and the customer participate in an interdependent relationship, as each party is involved in the giving resources that are complementary to value creation. Therefore, value co-creation It is focused on a three-phase win-win-win situation between the supplier, the customer, and the final user. Consequently, Sheth (2019) identified seven types of value co-creation (Table 3), and each of these types of value co-creation has its unique customer value proposition.

Table 3. Types of Value Co-creation. (Sheth 2019, 3)

Type of Value Co-creation	Value Proposition
Growing the Customer Business (CBD)	Is the most common type of value co-creation, also referred to as Customer Business Development (CBD); i.e. typically, a cooperation between the manufacturer and the retailer.
Regulation Compliance	Involves compliance with different regulations (is less strategic in nature). Used vastly within the chemicals industry due to hazardous raw materials and safety concerns. Hence, the B2B customers add value while transforming them in products for specific application (agricultural, pharmaceutical, semiconductor chemicals, etc.)
CSR and Triple Bottom Line	Implicates cooperating with customers in matters related to corporate social responsibility (CSR) and the triple bottom line (profit, people, and planet). The value proposition is grounded in making good while doing business, i.e. water management and conservation, decline in carbon emissions, plastic reprocessing and recycling, etc.
Conscious Capitalism	Focuses on activities related to company culture and not only rising shareholder value. These might include: creating value for all the stakeholders while delivering the financial returns anticipated by investors. Its value proposition has to deliver a solution and not a problem for the society.
Public Policy Reforms	Concentrates on regulating an industry or reducing friction in the marketplace, as well as involving cooperation between industry rivals and their suppliers.
Public Private Partnerships (PPP)	These include partnerships between business and the government, e.g. prisons, motorways, infrastructure projects, privatised technological parks, etc. Value co-creation is essential between the supplier, customer and stakeholders.

2.5.1 Value proposition Canvas

(Osterwalder & Pigneur 2010) summaries in one-page the concept of the Business Model Canvas. This canvas consists of nine segments which give a summary of a specific business model and its execution. Within one of these building blocks exist one called Value Proposition and from which an extra canvas is produced The Value Proposition Canvas" (Figure 8).

The value proposition canvas consists of two parts: a) the customer profile (circle) divided as: customer jobs, gains and pains; which purpose is to improve the customer segment understanding and its interactions. Then a section b) the value map (square): includes products and services, pain relievers and gain creators. The value map explains how a firm produces value to its customers. In other words, explains how these products and

services can ease, and eradicate the customer pains (anxiety) while making their life easier; and how these products and services create value, or benefits to the customer. A fit between the two (customer profile and value map) is accomplished when one meets the other. (Osterwalder et al. 2015; Strategyzer.com 2020)

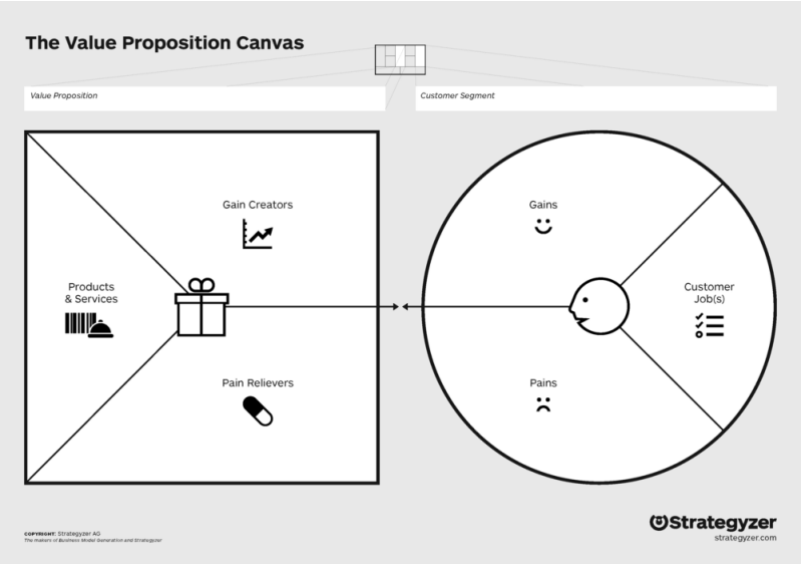


Figure 8. Value Proposition Canvas (Strategyzer.com 2020)

Customer profile

The customer (segment) profile describes specific customer segments in a more clear, structured and organised manner. It distributes the customer into: a) customer jobs: describing what customers are trying to complete within personal and work life (might be expressed in their own words); b) pains: explain bad outcomes, risks, and obstacles connected to customer jobs and; c) gains: portrays the results customers want to achieve the benefits they are seeking. (Osterwalder et al., 2015).

While examining the “customer jobs” section it is important to use the “customer’s perspective” as it establishes the appropriate angle. Thus, the “job context” needs to be recognised within the specific context in which they are performed, as such context may enforce constraints or limitations. (Osterwalder et al. 2015)

Further, Osterwalder et al. (2015, 53) portrays that job importance must be recognised because not all jobs are as important to a customer. (Osterwalder et al., 2015) makes a difference between important (+) and insignificant (-). Some jobs are Important (+) for a customer since not having them done could have serious consequences. And, some jobs are insignificant (-) as the customer worries about other things.

Henceforth, Osterwalder et al. (2015) divides these customer jobs into three main categories: a) functional jobs: outlines a job what customers try to perform or complete a specific task or solve a specific problem; b) social jobs: defines a job what customers want to look good (external perception) or gain status; c) personal or emotional jobs are when customers seek a specific emotional state (feeling good or security).

Additionally, Osterwalder et al. (2015) considered another category called “supporting jobs” which occurs when customers perform these supportive jobs “while purchasing and consuming value” as consumers or as professionals. And these jobs occur as three different roles:

- Buyer of value: For example: comparing offers, deciding what products to buy, completing a purchase, or selecting delivery of a product or service.
- Co-creator of value: These co-create value with the company, e.g. providing feedback, creating product reviews etc.
- Transferrer of value: These relate to the end of a value proposition’s life cycle, e.g. cancelling a service subscription, transferring to others, reselling or discarding a product.

Moreover, within the customer profile, the section pains can be defined as “anything that annoys a customer before, during, and after trying to get a job done or simply prevents them from getting a job done” (Osterwalder et al. 2015, 54). It is crucial to establish the pain severity, which can take the form of an extreme (+) or moderate (-) pain; and it is essential to clearly differentiate them and describe them as concretely as possible.

Subsequently, the canvasser aims to classify the types of pains and these are listed follows: a) undesired outcomes, problems, and characteristics: implies that pain is functional, social, personal or emotional as they are related as the customer jobs; b) obstacles: things that stop customers from starting with a job, slowing them down or achieve the job; c) risks: symbolises undesired potential outcomes and have significant destructive consequences. (Osterwalder et al. 2015)

The last section of the customer (segment) profile is called customer gains, and shows the benefits and results the customer want to achieve. Customer gains have a relevance as they are essential (+), or nice to have (-). Further, these customer gains could be expected gains (basic anticipations provided by a product, service or solution), unexpected (beyond customer hopes) or desired gains (beyond what the customer expects from a solution but would appreciate to have). (Osterwalder et al. 2015)

Value map

Furthermore, Osterwalder et al. (2015) describes the value (proposition) in a more structured and detailed way the exact features of the value proposition which an organisation's use in its business model. It splits the value proposition into: a) products and services; b) gain creators: aiming to explain how these products and services create customer gains and; c) pain relievers: defining how these products and services alleviate customer pains.

Products and services refer to services that helps customers to fulfil basic needs or to complete functional, social, and / or emotional jobs. Hence, it is important to recognise that "products and services don't create value alone–only in association to a particular customer segment and their jobs, pains, and gains" (Osterwalder et al. 2015,79). These products and services are ranked in order of relevance as essential (+), or nice to have (-), and could be categorised as: physical/tangible (manufactured products), intangible (after-sales assistance services, copyrights, etc.), digital (music and software downloads), financial (investment funds, insurances, etc.). (Osterwalder et al. 2015)

Pain relievers describe and outline a company's products and services relieve precise customer pains. Thus, pain relievers could be less or more valuable to customers, as they are ranked in relevance order essential (+), or nice to have (-). This means that essential can relieve extreme issues and create a great deal of value, while nice to have simply relieves average pains.

And finally, the last section within the value map is called gain creators. This section defines how a firm's products and services create customer benefits (e.g. functional effectiveness, cost and time savings, social rewards, positive feelings, etc.). These gain creators can create more or less relevant benefits for the customer as they rated between essential (+), or nice to have (-).

2.5.2 Value creation within the context of Internet of Things (IoT)

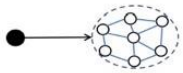
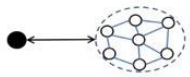
According to Metallo, Agrifoglio, Schiavone & Mueller (2018) within the context of an IoT ecosystem; value creation and value capture encompass a specific mindset (Table 4) for developing innovative Business Models (BMs). This mindset involves the "new nature of products, which should predict and anticipate user needs, the decline of the one-and-done assumption about products, and the wider space for product/service personalisation" (Metallo et al. 2018, 300)

Table 4. Mindset for the IoT industry. (adapted from Metallo et al. 2018, 300)

		Traditional product mindset	Iot Mindset
Value creation	Customer needs	Solve for existing needs and lifestyle in a reactive manner	Address real-time and emergent needs in a predictive manner
	Offering	Standalone product that becomes obsolete over time	Product refreshes through over-the-air updates and has synergy value
	Role of data	Single point data is used for future product requirements	Information convergence creates the experience for products and enables services
Value capture	Path to profit	Sell the next product or device	Enable recurring revenue
	Control points	Potentially includes commodity advantages, IP ownership, and	Adds personalisation and context; network effects between products
	Capability development	Leverage core competencies, existing resources and processes	Understand how other ecosystem partners make money

On the other hand, Ikävalko, Turkama & Smedlund (2018) argues that value co-creation is an outcome of the interactions between a firm and its customers, therefore the recipient benefits of the value co-creation. Hence, these receivers can have different roles (Table 5) which have been identified as: ideators, designers, and intermediaries. These roles have a distinctive working logic and actions on the ecosystems. (Ikävalko et al. 2018, 7)

Table 5. The three service exchange roles in IoT ecosystems (adapted from Ikävalko et al. 2018, 7)

Role	Definition	Main activities	Ilustration
Ideator Contents and service layers	Brings knowledge about their own interest to the ecosystem One way knowledge flows Providing input for service innovation	Articulate need Volunteer data Consume commercial service	
Designer Device, Network and service layer	Mix and match existing knowledge components in the ecosystem Reciprocal knowlege flows Developing service innovation	Analyze data Develop commercial service Deliver commercial service	
Intermediary Network and contets layers	Intermediate flow of knowledge and relationship in the ecosystem Multi-way knowledge flow, arranging service innovation	Coordinate activities Enables access Controls Platfrom	

Moreover, Ikävalko et al. (2018) described a method which they used for mapping cases involved in their research. This method encompasses a combination between the dimensions of: a) role, definitions and main activities described in Table 5; and adding b) digital layer (device, network, service, contents) which is illustrated in Figure 9.

Figure 9. Key elements for mapping roles in IoT ecosystem business model (Ikävalko, et al. 2018, 8

Consequently, Ikävalko et al. (2018) concludes that structuring of activities around the roles and adding digital layers might provide a better understanding of actor drivers and clarifies the diversified and the disorganised environment of IoT ecosystems, as well as understanding of how these IoT ecosystems appear and evolve. As the results of these, a better value proposition could be created by identifying all aspects mentioned above.

According to Hudson (2017), research based on a literature review, interviews and surveys Dijkman, Sprenkels, Peeters & Janssen (2015) developed an IoT business model framework (Figure 10). Within this framework, they have described a business model with fundamental value propositions, including: a) convenience/usability, b) getting the job done operationally, c) improving performance of the operation, d) creating the possibility of later updates, e) reducing cost, f) customisation, etc.

Additionally, Hudson (2017, 8) states that while developing stakeholder value propositions entrepreneurs can discover their business models more accurate. As, there could exist various stakeholders involved, a compelling value proposition for each must be created. Hence, two different IoT clients could use the same IoT proposition for a different purpose, or the same IoT offer could be used differently because of a common fundamental value proposition.

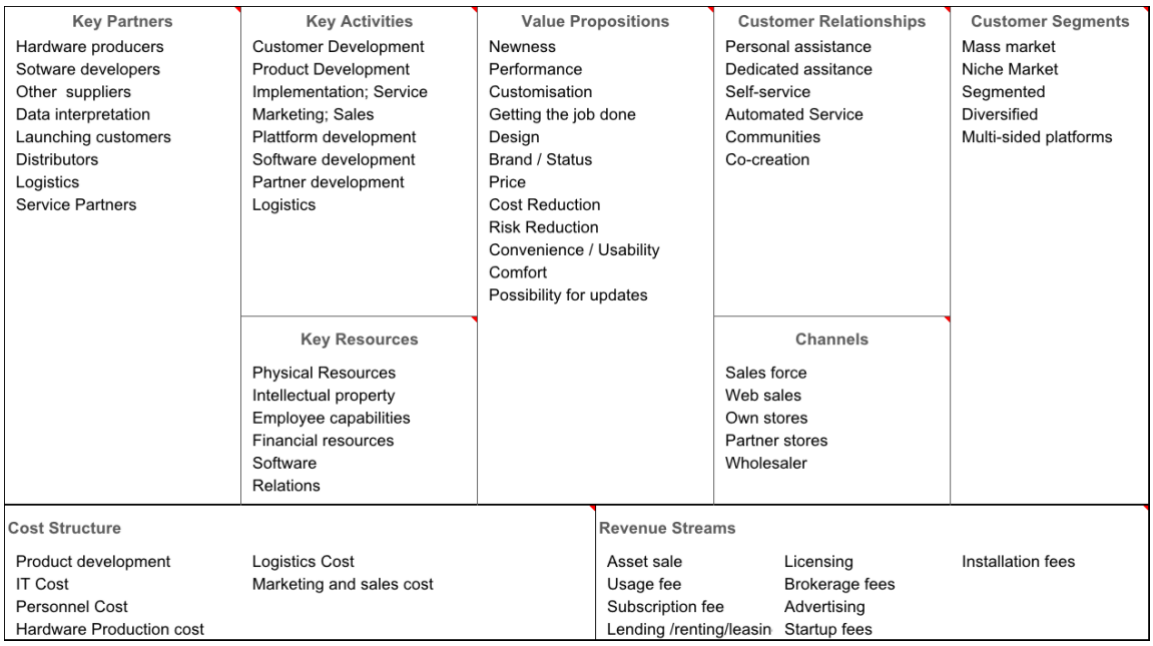


Figure 10. Business model framework for IoT applications (Dijkman, et al. 2015, 676)

Moreover, Hudson (2017) mentions some key considerations to adopt while developing a compelling IoT value proposition (Table 6). These considerations are based on the attributes of compelling value propositions proposed by Anderson et al. (2006) and classified as: distinctive (value produced is superior to the competition), measurable (value delivered can be counted in financial terms) and sustainable (value can be preserved and enhanced for a period of time). (Hudson 2017, 8)

Table 6. Key considerations for creating an IoT value proposition. (Hudson 2017, 8)

IoT Offer Types		
Core IoT	**Adjacent IoT**	**Transformational IoT**
Business performance improvement Cost Reduction Perfomance Improvement	New offers Recognised by market	New offers New market
Attributes of a compeling IoT Value Proposition		
Distinctive	**Measurable**	**Sustainable**
How is the IoT offer superior to competing offers and to the status quo?	How is the value of the IoT offer measured with reference to operations business performance, improvement target market and market strategy	How is the IoT offer's uniqueness comparing to the other alternatives over time?

3 Research methodology

This section describes the research design of the study, more specifically the research approach, strategy, data collection and analysis being used. This study applies qualitative research, more precisely qualitative interviews, as well as inductive approach. These would define how the methods and procedures used as research methodology create a relationship between the research objectives, sub-questions to create an improved IoT Rapid-Proto Labs value proposition for the start-ups and SME's market segment.

This study uses an inductive research, which aims to produce a new theory (e.g. a relevant element of value or value proposition for the established segments) emerging from the analysis described within the theoretical framework context. Therefore, creating a conjectural justification while the qualitative data is being collected and analysed. (Saunders, Lewis & Thornhill 2016, 51)

According to Walliman (2011) an inductive approach or inductive reasoning starts with specific observations and then progresses to a broad conclusion from these, as well as does not only rely on recognising an existing theoretical position, but is planned to let significances to appear from the data while is collected. In other words, lets the researcher to comprehend the problem by analysing the data collected and make sense of the problem. Therefore, the construction of a theory emerges when the related data set is analysed. (Saunders et al. 2016, 144)

This study is focused within a specific context and a precise marketplace (start-ups and SMEs) therefore through inductive research; a small sample of subjects is studied through conducting semi-structured interviews. As stated above, this study is using qualitative research, which purpose is to "study participants meanings and the relationships between them, using a variety of data collection techniques and analytical procedures, to develop a conceptual framework and theoretical contribution" (Saunders et al. 2016, 168).

Accordingly, conducting qualitative research interviews requires an intensive listening and a careful planning and preparation, since a well-planned interview approach can deliver a plentiful valuable set of data. (Qu & Dumay 2011). Therefore, the data generated by this this study is qualitative in nature and cannot be precisely measured and calculated, as it is articulated in words. Hence, qualitative research relies on the detailed meaning of words and human interpretation for the development of concepts and drawing interrelationships between the topic and scope of the study. (Walliman 2011).

Subsequently, the study uses semi-structured interviews which contain structured and unstructured sections with standardised and open-ended questions. The aim of such semi-structured interviews is to have a “problem solution discourse”, and its analysis aims to discover the sequence of the argument in question: situation, problem, response and solutions or results. (Walliman 2011, 141).

Semi-structured interviews involve a prepared interrogative directed by established themes which are introduced in a coherent and methodical manner. As the basis of such interviews is the human conversation, allows the interviewer to modify the style, speed and ordering of questions to induce a full commitment in the responses performed by the interviewee. (Qu & Dumay 2011, 246).

In essence, the goals of using semi-structured interviews in this study are to develop an understanding of the ways in which the interviewees make sense of enhancing value elements; to consider collaborating with the IoT Rapid-Proto Labs project and HEs, as well as develop an understanding of their interaction with the IoT environment. The results of this interviews are used to construct the value proposition canvases for each of the segments e.g. start-ups and SMEs.

Strategy

As stated by Saunders et al. (2016, 175) an exploratory research has the advantage of being flexible and adaptable to change while conducting it. As this is an exploratory study which main purpose is to obtain new insights to a specific need, the research and specifically the semi-structured interviews may begin with a wide focus but this will become narrower as the research progresses. Therefore, the quality of an exploratory study is related to the researchers’ abilities to perceive, gather information and create explanations based on the qualitative data being collected. (Saunders et al. 2016)

The study is concerned with a specific market segment within the two-sided marketplace of the IoT Rapid-Proto Labs project. Particularly, the specific value enhancing elements considered by start-ups and SMEs and how the development of such value proposition would demonstrate added value for these market segments.

Techniques and Procedures

This study collects primary qualitative data through semi-structured interviews aiming to build the value proposition canvases for the start-ups and SMEs. Moreover, while executing a semi-structured interview the researcher can change the direction of the questions or adding further details if it is needed; therefore, flexibility is produced and possibilities to improve the quality of the data collected. (Saunders et al. 2016)

The secondary data is collected through Internet searches, as this method saves time and resources considering the time constraints for the research in this study. The motivations for using secondary data are driven due to the lack of time and resources of the firms contacted, since they would not may not be prepared to engage in additional, voluntary activities. Secondly, the request for access and cooperation may fail due to the lack of perceived value in relation to the work of the organisation, potential sensitivity of the topic, perceptions about the credibility and doubts the researcher's competence. (Saunders et al. 2016)

However, it is important to notice that when accessing and using secondary data it is useful to know what type of data being collected, since it might have a different purpose and suitability for this study might be compromised. (Saunders et al. 2016)

3.1 Research process

As an outsider of the project itself, it was challenging to understand the relevant perspectives to consider while creating a value proposition for the start-ups and SMEs segments. Since, narrowing the perspectives enhances the research process and therefore could have positive effects on the findings.

As described above, qualitative interviews more specifically semi-structured interviews with start-ups and SMEs are the focus of this research process. These companies are currently working within Electronic, IT, AI and IoT developing in Finland and the Nordic countries. The individuals selected for the interviews are based on two criteria: a) their involvement in IoT / AI projects and, b) their role within the company and business strategies e.g. sales managers, marketing managers or decision makers. Some of the interviewee's have sensitive information, therefore information like company names, or product names would not be disclosed in the study.

The companies are described shortly as cases, to understand their relevance to the study and to acquire a better picture of the solutions provided by them and what kind of elements of value are they expecting to receive from the IoT Rapid-Proto Labs project.

Case 1 - Sievo Oy: This company specialises in providing procurement analytics using AI in the background of their SaaS. More specifically, this company transforms procurement data from any source by offering data extraction, classification and enrichment software which can provide additional value for its clients. Sievo's SaaS procurement analytics solutions include: Spend Analysis, Savings Lifecycle, Spend Forecasting and Contract Management (Sievo 2020). The person interviewed is the Head of the Service Design, who has collaborated in IoT projects and software development projects with Aalto University and has extensive experience in university-industry cooperation.

Case 2 - Cumucore Oy: This company provides a disruptive solution that integrates Network Function Virtualization (NFV) and Software Defined Networking (SDN) to deliver a flexible and affordable mobile service. Cumucore offers different types of services which include: SDN mobile backhaul, mobile edge computing and content delivery, virtualised packet core and consulting services. More precisely, in IoT they provide the Cumucore network slice manager based on SDN allows to dynamically slice the network for isolating Narrowband IoT (NB-IoT) data from other traffic. Thus, Cumucore solutions aim to “reduce the entry barriers for mobile network operators to monetise added value services, and IoT and dedicated slices of 5G networks with a click to enable new business models”. (Cumucore 2020)

The person interviewed is the co-founder as well as CEO and CTO of Cumucore. He holds a Doctor of Technology degree from Aalto University in the field of networking, and has working experience of more than 15 years. Both as a researcher and company executive has been involved in university-industry cooperation, especially in IoT development at Aalto University.

Case 3 - Company name not disclosed: The company commercialises electronic moisture sensing instrumentation and testing devices for grains, seeds, hay and silage; as well as an electric fence energisers and accessories. The person interviewed is the export sales manager, who works closely with the R&D department on developing electronics for agricultural and quality control customer needs.

Case 4 - Goodmill Systems Oy: The company provides mobile multi-channel routers and broadband digital solutions for public safety operators. The company products and services enable firms working within public security systems, retail, healthcare, public transportation and industrial applications to share critical information in the form of high definition video, enable real-time database access and Voice over Long-Term Evolution (VoLTE) services. The company’s products offer the advantage of using existing networks without investing in new network deployment, as well as combining two or more relatively

well-functioning networks into one connection that meets the requirements of field operations. (Goodmill Systems 2020)

The person interviewed is the current CEO of the company and has experience in sales and business development, as well as solving business challenges with solutions around cloud infrastructure solutions, cloud native application service, data, design and AI.

Case 5 – Company name not disclosed: The company provides software as a service (SaaS) solutions for semantic context-based intelligence, intelligent user profiling and audience segmentation. The company has been acquired by a larger public corporation at the beginning of 2019, and has merged its services into the new company's service catalogue. The person interviewed is the current sales manager and works within the new organisational structure, being in charge of sales in the Nordic region and has several years of experience in sales of digital solutions.

Case 6 - SuomiConnect Oy / Tinksi: This company provides IoT Sensor Technology, implements control room systems, and automation consulting services. More specifically, the IoT sensor Technology is commercialised throughout the company's brand. Tinksi offers humidity, temperature and motion IoT sensor for indoors and outdoors usage.

The IoT sensors developed by Tinksi use a radio technology called LoRaWAN, which is designed for sending small amounts of data across long distances using minimal amounts of energy. The network can be used to send precise temperature or humidity data. In Finland there is a public LoRaWAN network operated by Digita Oy, on which Tinksi's services work. The person interviewed is the founder of the company, he has several years of experience in semi-autonomous natural intelligence automation and IoT.

Case 7 - Company name not disclosed: Is one of the world's largest technology distributor offering products, services, and solutions for customers in industrial and commercial markets. Their products and services include a wide range of solutions, focusing mainly on cloud services, analytics, data security, and server infrastructure construction and maintenance. They cooperate with a wide network of IT partners, which mainly consists of IT resellers and service houses. Within this ecosystem, they are able to provide solutions and know-how to various business challenges regardless of the industry.

The person interviewed work as technology advisor for the company, whose tasks include sales and consulting for clients in the areas of design, implementation, and developing IT infrastructure, information, software and Internet of Things (IoT) solutions and services.

3.2 Qualitative data collecting process

In this research, the information extracted from the interviews with the companies are used to identify the elements on which the IoT Rapid-ProtoLabs value proposition would be based for these specific market segments. More precisely, a tailored design method (Saunders et al. 2016, 729) is used to construct the semi structured interviews for collecting the qualitative data.

Hence, the interview questions presented below (Table 7) are open-ended in nature, thus allowing flexibility for interviewees to answer. Additionally, a set of probing questions was used to explore further into the research topic or to investigate more clarifying when something has been inquired. (Saunders et al. 2016, 408)

Table 7. Interview questions, semi- structured interview.

Themes	Interview Questions
1. Company's Outlook (Introduction)	1.1 Can you briefly introduce yourself and what do you do in the company? 1.2 Can you briefly introduce your company? products and services, what they do? 1.3 What are your target customers?
2. Company's Outlook (Value Proposition)	2.1 What can you tell me about your value proposition? 2.2 Could you say something more about your company's value proposition offer? 2.3 How your product or service solves/improves problems? 2.4 What benefits customers can expect?
3. Company's jobs (Start-up & SMEs jobs).	3.1. Could you name and describe some job-related and non-job-related tasks that you or your company does while performing or providing products, services or solutions to your clients? How important are these? 3.2 Are these problems you are trying to solve or company's needs?
4. Company's challenges (pains)	4.1. What are the main challenges your company is experiencing? 4.2. What does your company or yourself find too costly? 4.3 What does your company consider as risks? 4.4 What are the barriers for buying solutions and cooperating with other firms, partners or universities?
5. Ecosystem – Value chain (Collaboration with HEs)	5.1. Can you described interesting partners that could be part of your business model for enhancing the total value created for your customers? 5.2 Have you considered HEs as potential partners for your IoT development? Some examples how? 5.3 Do you consider important for your company's IoT/AI developments to get acces to crossborder multidisciplinary teams? 5.4. Could these teams help you with co-creating IoT design, product development and make rapid-prototyping? 5.5. Would a collaboration with HEs give to your company exposure and increase company's recognition?
6. Advantages for companies (gains)	6.1 What would make your job life and your company's life easier? (e.g. flatter learning curve, lower cost of ownership) 6.2 How does your measure success and failure? (e.g. performance, cost, …) 6.3 What outcomes does you or your company consider that would go beyond expectations? 6.4 What would increase the likelihood of adopting a solution or buying a service from a partner / university? 6.5 What you consider to be the benefits of engaging on collaboration with HEs? Would you describe some details? 6.6 How a collaboration with HEs would increase your customers' likelihood of buying from your company? Would this collaboration lower costs, lower risk, or provide a better quality?

As illustrated by Table 7, the interview focuses on six main areas aiming to identify relevant items for the domain area in question, as well as to determine the different element of value and value propositions that a company could offer to their customers, or what they would value for themselves aiming to serve their customers.

This study does not consider value from one perspective only, but attempt to establish a view from both the customer as a provider of products, services and solutions and; as a customer. The aim is to understand the value or business opportunities which the companies can achieve while creating value for their end-users and potential partners. Therefore, understanding the prior can help to establish the IoT Rapid-Proto Labs value propositions for these segments.

3.3 Interviews findings and analysis

These interviews aimed to obtain an understanding of what these companies perceived as an added value and their expectations from a potential collaboration with the IoT Rapid-Proto Labs project. The firms are presented in Table 8, which illustrates the types of firms and the business sectors on which they are currently working.

Table 8. Firms interviewed - Cases

Firm	Interviewee	Sector	Type of firm
Sievo Oy	Head of Service Design	AI - Procurement Analytics	SME
Cumucore Oy	Founder CEO / CTO	IoT Integration Slicing / Networking Integration	Start-up
Company name not disclosed	Export Sales Manager	Agroelectronics / moisture sensing instrumentation and energised fencing systems	SME
Goodmill Systems Oy	CEO	Broadboand solutions for public safety providers	SME
Company name not disclosed	Sales Director	AI - SaaS User Profiler / audience segmentation	Acquired SME by larger foreign firm
Suomi Connect Oy / Tinksi	Founder / IoT Automation Programmer	IoT Sensor Technology	Start-up
Company name not disclosed	Technology Advisor	Tecnology distributor consulting start-ups and SMES in IoT	Subsidiary of a foreign firm

The interview questions were designed to extract information which would be utilisable for building the customer profile and value map sections for the value proposition canvases. Hence, it has been established a clear connection between the semi-structured interview questions, its respective six themes and the key elements perceived by start-ups and SMEs when engaging in university-industry collaboration.

A problem solution conversation took place during the interviews with the company representatives, in these conversations, numerous improvement ideas for the IoT Rapid-Proto Labs project surfaced. Some of these ideas were suggested as an additional service package provided by the IoT Rapid-Proto Labs and will be discussed below in the products and services sections of the canvases.

3.3.1 The customer profile: Start-ups

The elements in the customer profile consist of jobs, pains and gains and these are described from the start-ups angle. These constitute the starting point for a value creation strategy and to propose a set of value proposition benefits designed by the IoT Rapid-ProtoLabs to attract customers.

The research interviews with start-ups and SMEs revealed that many types of jobs, pains and gains include concerns around activities such as funding, scalability, lack of operational capital, access to technical knowledge and other day-to day activities on which firms engage in order to generate revenue and eventually profit. (Figure 11). The details of these concerns and its relations are discussed below in the start-up jobs, pains and gains subdivisions.

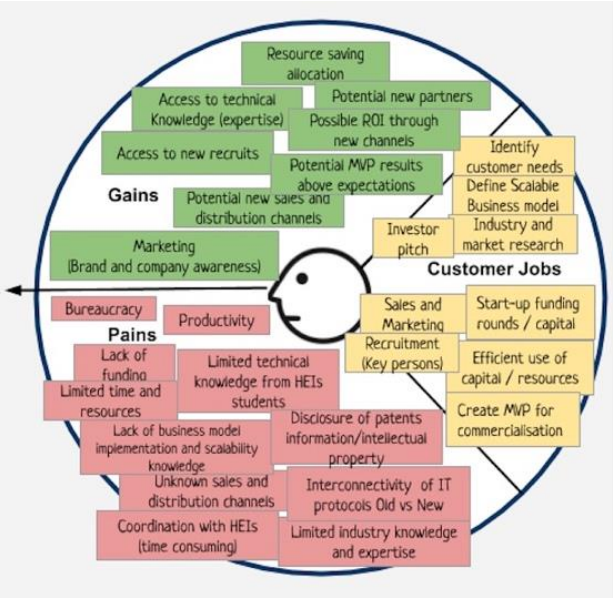


Figure 11. Customer Profile – Start-ups: Interview findings

Start-up jobs

The start-up jobs differ depending the stage on which the start-up is currently situated, as well as its correlations between pains and gains or what is considered as an advantage and disadvantage when engaging in university-industry cooperation. Therefore, start-up-jobs are set in motion depends on the funding round stage they are currently situated. In essence, start-ups usually begin with a seed or angel round, which later progresses to founding Series A to B, C and beyond. These resources (capital, funds and expertise) are offered by investors, usually angel investors or venture capital firms, which then receive a stake in the start-up.

Consequently, as start-ups move along the different phases the needs for different types of jobs arise. When a start-up is at the initial idea stage, or once the founders have a prototype, proof of concept or a business model (MVP for commercialisation) the seed funding round might occur. Therefore, if MVP are developed there might be the appearance of a potential market demand which could be offered for different customer segments.

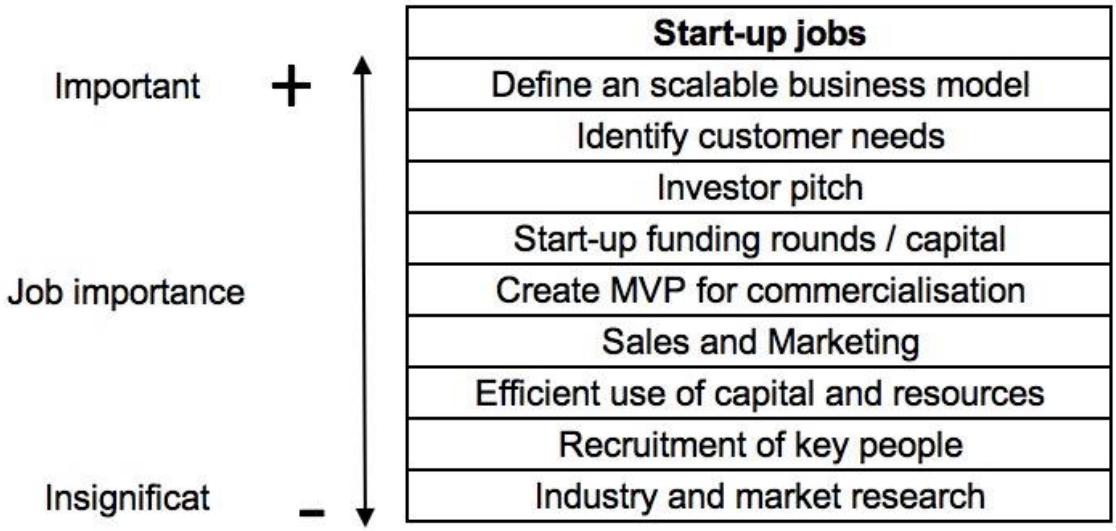


Figure 12. Start-up jobs ranking

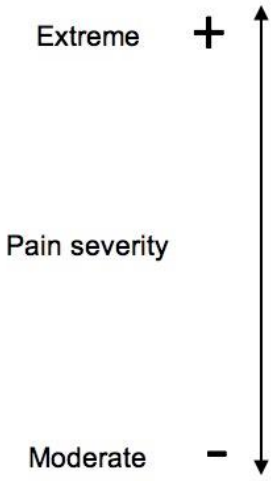
Henceforth, after start-ups demonstrated a feasible MVP the changes that investment is needed to support the business might increase. Therefore, subsequent funding rounds might happen to support the day-to-day running costs as the company will not be generating a big enough cash flow.

As figure 12 illustrates, interviewees seem to prioritise functional jobs above other types of jobs, as the mere idea of a start-up is to prove or disprove a business idea might work as well of the importance of capital for business operations. Hence, these functional jobs are trying to perform or complete a specific task or solve a problem.

On the other hand, within the context of university-industry cooperation these start-ups appear to accentuate the importance of supporting jobs as described by Osterwalder et al. (2015) in categories of buyers of value and co-creators of value. More precisely, while developing an MVP for commercialisation, they are more likely to engage in feedback, reviews and selecting the steering of a project to select the delivery of a product or service.

Start-up pains

While engaging in a problem-solution dialogue with these interviewees, it was revealed that some of the start-up pains are related to functional jobs (Figure 13), as other pains are linked to obstacles and risks when engaging in university-industry cooperation. In other words, pains define anything that frustrates these start-ups before, during, and after trying to get a job done or in specific funding round or start-up growth stages.



Start-up pains
Lack of funding
Limited time and resources
Lack of business model implementation and scalability
Disclosure of patents information / intellectual property
Bureaucracy
Unknown sales and distribution channels
Limited industry knowledge an expertise
Interconnectiviy of IT protocols Old vs New
Coordination with HEIs (time consuming)
Limited technical knowledge from HEIs students
Productivity

Figure 13. Start-up pains ranking

Additionally, these pains also describe the risks and potential negative consequences which can come as results of being engaged in university-industry cooperation. These include technical issues such as interconnectivity in IT protocols, a security breach, as well as emotional pains or preconceptions while having a cooperation with HEIs (time consuming efforts, bureaucracy, limited technical knowledge). Moreover, most of the interviewees highlighted the potential risks of disclosing patents and intellectual property information to students, HEIs staff and other people involved in the project implementation.

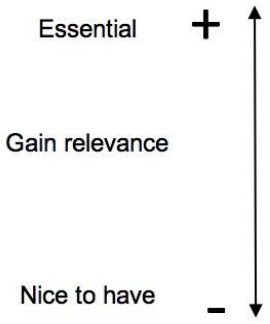
Start-up gains

As Figure 14 illustrates, the interviewees underlined some of the advantages to engage in university-industry cooperation, more specifically to be part of the IoT Rapid-Proto Labs project. These start-ups seem to perceive as an added value, gains that contribute and enhance their absorptive capacity aiming to raise start-up's knowledge and connecting organisational learning and innovation with HEIs resources.

In other words, these start-ups consider valuable to gain access to technical knowledge and related benefits such as access to laboratories and equipment, scientific and technological knowledge and to establish networks with university researchers.

In addition, these start-ups measure the credibility of their prospective HEIs partner based on reputation and word of mouth recommendations from other firms. They also highlighted that university-industry cooperation and involvement with projects such as IoT Rapid-Proto Labs seem to be a good arena for accessing new recruits.

As these start-ups consider the recruitment of key persons as part of their pains, accessing to new recruits (students) might compensate the lack of professional expertise in the short term. However, they emphasised that new recruits (students) need a vast amount of time and training for high skilled jobs and expertise. Therefore, the return of investment (time invested and resources) might be analysed and considered carefully.



Start-up gains
Access to technical knowledge (expertise)
Resource saving allocation
Potential MVP results above expectations
Potential new partners
Access to new recruits
Potential new sales and distribution channels
Possible ROI through new channels
Marketing (brand and compay awereness)

Figure 14. Start-up gains ranking

Furthermore, the interviewees denoted the importance of getting to know potential partners throughout the implementation of multidisciplinary teams and involvement of several companies in rapid-prototyping and creation of the MVP. For start-ups, it is important to lengthen their network reach as they have limited capabilities and limited knowledge within their field. Therefore, start-ups interviewees consider these projects as a good initiative to meet with potential new partners and to discover new sales and distribution channels for their products and services.

Moreover, these interviewees indicated that some of these gains might go beyond their expectations and desires, especially while creating MVP for commercialisation. As described before, while engaging in university-industry cooperation these start-ups initial plans about products and services might be adjusted with a superior view as an outcome of the interaction and cooperation with HEIs, students, technical experts and activities with other companies.

3.3.2 The value map: Start-ups

As described in section 2.5.1 – Value Proposition Canvas Osterwalder et al. (2015) structured the value proposition into three sections named: product and services, gain creators and pain relievers. These are correlated to the customer profile and intend to provide a solution to the respective gains, pains and customer jobs within the customer profile.

Further, it was mentioned in section 3.1 that the current IoT Rapid-Labs value proposition has been extracted from the business model canvas used in the project's foundation plan. Thus, these value propositions were included as product and services for developing an enhanced value proposition as a suggestion within the value map (Figure 15). Consequently, the value proposition has been enhanced and includes two different components: a) cost effective rapid-prototyping and; b) co-creation of the MVP, rapid deployment for commercialisation.

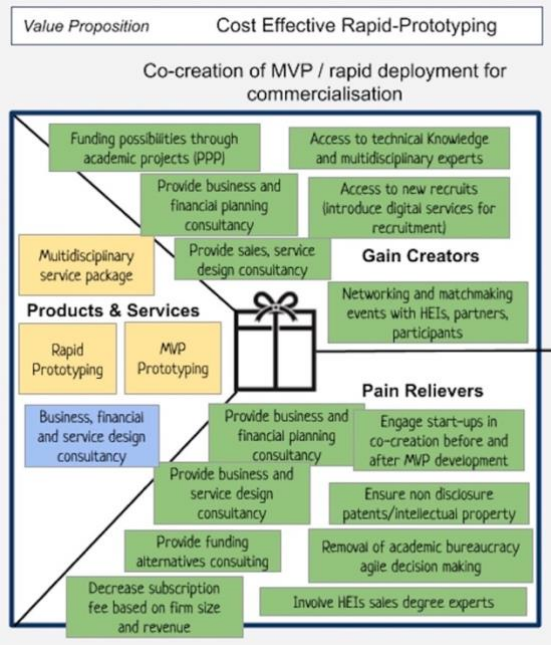


Figure 15. Value map – Start-ups: Interview findings

Products and services

As part of the conversation held with the interviewees, it was suggested that the project would provide an additional bundle of services aiming to help start-ups in the areas of business and financial planning during the prototyping and co-creation of MVPs for commercialisation. These interviewees highlighted that these are important, since the start-ups are often at different stages of development, and these services could assist in decision making related matters especially for those start-ups in the seed phase.

The interviewees referred specifically to the obstacles while developing business plans and business modelling, setting up financial forecasts for the MVP planning as well as the shortages of capital and resources. As a result of these conversations with the firms, a new product bundle has been added to the products a services section within the value map. As depicted in Figure 16, this new service or service package is called: business, financial and service design consultancy. Thus, this new service has been suggested by some of the interviewees as a service package targeting start-ups pains and offer an added value in the long run.

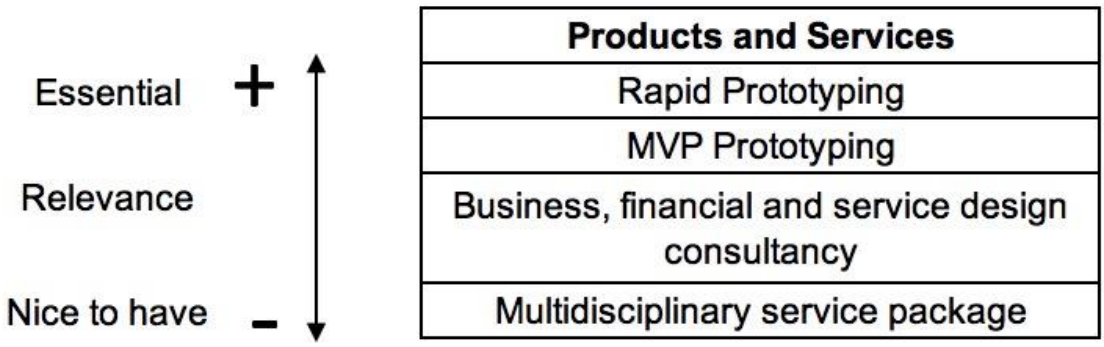


Figure 16. Products and services: Start-ups value map

In addition, to the business and financial planning; some of these interviewees suggested that would be useful to receive consultancy in service design and its specific implications during the planning and implementation stage of rapid-prototyping and MVP co-creation with HEIs.

Gain creators

This section contains the elements that would make start-ups work life easier, these describe how the IoT Rapid-Proto Labs bundle of service could potentially create customer gains. More specifically, the goal of these gain creators for start-ups is to provide accessibility to technical knowledge, business and service design consultancy as well as developing digital recruitment platform for hiring new recruits (Figure 17).

Based on the interviewees feedback and solution problem conversations, these gain creators capture how the IoT Rapid-Proto Labs project intends to produce outcomes and benefits that start-ups are expecting. These can include social gains, positive emotions, and cost savings as well as exploring new possibilities for university-industry collaboration e.g. private public partnerships, academic spin-offs, etc.

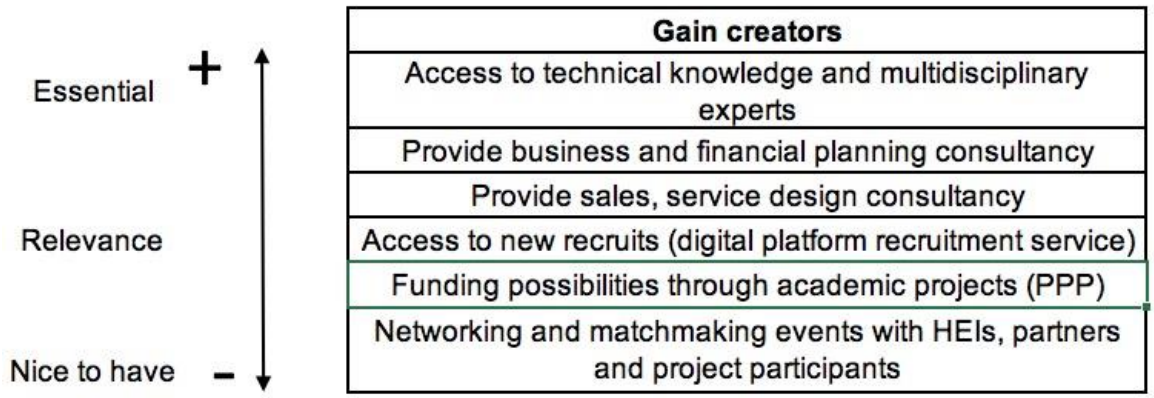


Figure 17. Gain creators: Start-ups value map

Pain relievers

The elements described within this section are directly interconnected to the start-up pains and are meant to act as relievers. These pain relievers describe how exactly the IoT Rapid-Proto Labs bundle of services would ease start-ups pains, obstacle or difficulties while engaging in university-industry cooperation. As Figure 18 illustrates, these are suggested based on the problem solution conversations held with the interviewees. These pain relievers goals are meant to ease the obstacles experienced by start-ups while engaging in university-industry cooperation.

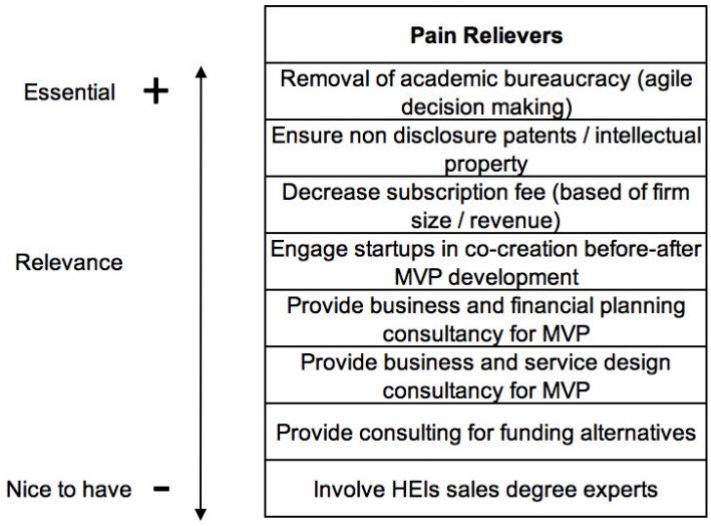


Figure 18. Pain relievers: Start-ups value map

Moreover, some of the interviewees have consider as HEIs are currently operating in their own calendar year (studying period and holidays), there is not a synchronisation between HEIs and companies operative and decision-making calendar. Hence, it would be feasible for IoT Rapid-Proto Labs to adjust somehow the prototyping schedule to provide support for companies all the year round.

Additionally, start-ups consider important the removal of academic bureaucracy since the nature of start-up operations aims to be agile and dynamic. The interviewees highlighted that academics tend to work in a different pace and the commercial-oriented projects tend to have a extremely fast pace to MVP commercialisations. Hence, the interviewees commented that there exists a large gap between what the private sector IoT consultancy firms provide to start-ups and what the deficiencies of academic projects are. These shortages are concentrated in two specific points: agile decision making and academic bureaucracy.

In order to find a solution for these deficiencies while providing gain creators and pain relievers, Osterwalder et al. (2015) stated that a fit between the section of the value map and the section of the customer profile must be sought. The elements within these sections must provide a solution or serve as a remedy for the customer. A pain reliever and gain creators can function together; hence a pain reliever can have a role of both solving customer jobs.

3.3.3 The customer profile: SMEs

The elements in the SMEs customer profile consist of jobs, pains and gains and these are described from the SMEs perspective. These establish the starting point for a value creation strategy and to propose a set of value proposition benefits designed by the IoT Rapid-Proto Labs appealing to its customers.

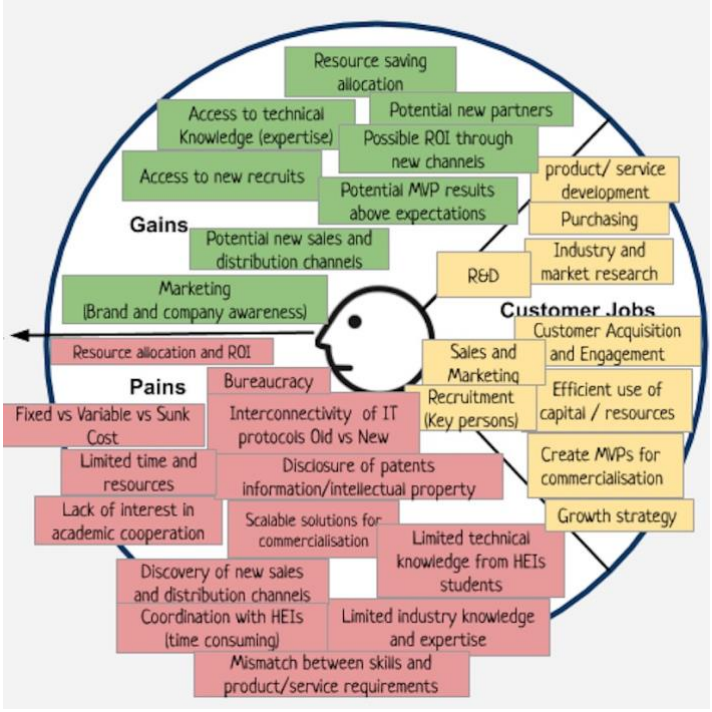


Figure 19. Customer Profile –SMEs: Interview findings

The interviews with the SMEs company representatives revealed that many types of customer jobs, pains and gains includes the day-to day activities on which firms engage in order to generate revenue and eventually profit. The findings seem to demonstrate the SMEs share some of the same concerns with start-ups, mainly in subjects related to funding, operating capital, scalability, access to knowledge, and recruitment of highly skilled experts. The outcomes of these interviews revealed significant elements to be considered within the sections of start-ups jobs, pains and gains which are summarised in Figure 19. In order to uncover the remedies for such customer profile the findings related to SMEs jobs, pains, and gains are discussed separately below.

SMEs jobs

The SMEs jobs are associated with normal day-to-day business activities which purpose is to generate increased sales, generate revenue, cash flows and potentially a profit. As normal business activities take most of the time for managers and on the field employees time available for non-related profit generating activities are an issue. It was a common subject among interviewees to mention that their activities are focused on sales, customer acquisition and product and service development aiming to increase customer engagement and sales.

The SMEs similarly than start-ups have expressed that efficient use of capital and resources is a key component of their jobs, since their mere existence as a company depends on good decision making in financial aspects. Consequently, as the SMEs move along the different phases of growth, needs for different types of jobs arise. When these SMEs are developing prototypes, proof of concept or an MVP for commercialisation, they expect a short time frame for the results and outcomes if they hired a third-party company to help in MVP development.

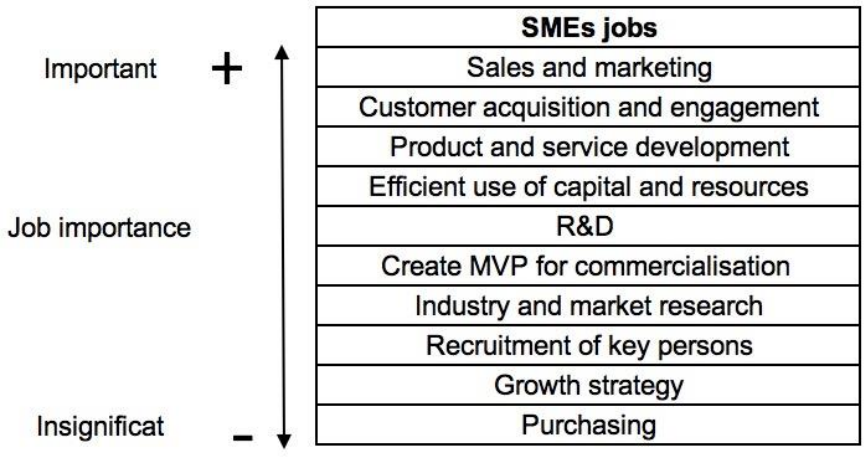


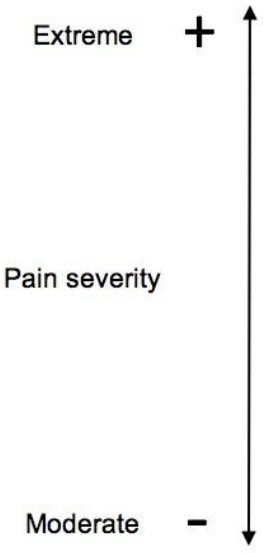
Figure 20. SMEs jobs ranking

As illustrated by Figure 20, the interviewees seem to prioritise functional jobs above other types of jobs, as these include normal day-to-day business activities. Hence, these functional jobs are trying to perform or complete a specific task or solve a problem for generating profit or to use profit maximisation strategies.

On the other hand, the interviewees mentioned that within the context of university-industry cooperation SMEs are more likely to engage in feedback, reviews and selecting the steering of a specific project to choose the delivery of a product or service. On selecting the steering, they highlighted the importance of time management, time allocating efforts and resources given by management to collaborate, engage in training with students of HEIs.

SMEs pains

During the dialogue held with the SMEs company representatives, some ideas emerged on what they consider great obstacles and risks when engaging in university-industry cooperation. In other words, these troubles define anything that frustrates these SMEs before, during, and after trying to get a job done, as well as during SMEs growth stages and normal day-to-day business activities. These are represented in Figure 21, which symbolises a ranking which may vary depending on several factors such as: different SMEs growth stages, time availability and overall workload during business activities.



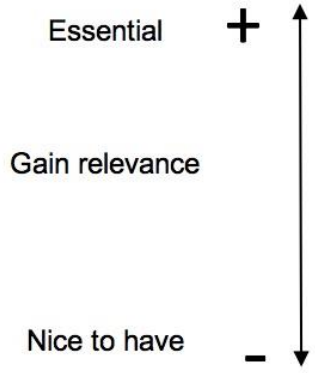
SMEs pains
Fixed vs Variable vs Sunk cost
Limited industry knowledge and expertise
Disclosure of patents information and intellectual property
Limited time and resources
Discovery of new sales and distribution channels
Resource allocation and ROI
Lack of interest in academic cooperation
Limited technical knowledge from HEIs students
Coordination with HEIs (time consuming)
Mismatch between skills and product / service requeriments
Bureaucracy
Scalable solutions for commercialisation
Interconnectiviy of IT protocols Old vs New

Figure 21. SMEs pains ranking

Additionally, these pains describe risks and potential negative concerns which can come as the consequences of being engaged in university-industry cooperation. These include technical issues such as interconnectivity in IT protocols, a security breach, as well as emotional pains or preconceptions while having a cooperation with HEIs (time consuming efforts, bureaucracy, limited technical knowledge). Moreover, most of the interviewees highlighted the potential risks of disclosing patents and intellectual property information to students, HEIs staff and other people involved in the project implementation.

SMEs gains

As Figure 22 illustrates, the SMEs interviewees emphasised prospective advantages to engage in university-industry cooperation, more precisely these benefits could enhance their absorptive capacity aiming to increase their capabilities, industry knowledge, organisational learning and leverage innovation through HEIs resources. In other words, these SMEs highly value access to scientific and technological knowledge, equipment, and establishing linkages with university researchers and other firms working in similar fields.



SMEs gains
Access to technical knowledge (expertise)
Resource saving allocation
Potential MVP results above expectations
Potential new sales and distribution channels
Potential new partners
Potential ROI through new channels
Access to new recruits
Marketing (brand and company awereness)

Figure 22. SMEs gains ranking

In addition, these firms highlighted that university-industry cooperation and involvement with projects such as IoT Rapid-Proto Labs seem to be a good arena for accessing new recruits. Moreover, SMEs interviewees have considered that accessing to new recruits e.g. students might have a good impact for tasks which does not involve a high degree of technical skills. However, they emphasised that new recruits e.g. students, need a vast amount of time and training for high skilled jobs and expertise. Therefore, time invested, and resources allocated must be analysed and considered carefully.

Furthermore, SMEs interviewees consider university-industry projects as a good initiative to meet with potential new partners and to discover new sales and distribution channels for their products and services. They commented that their involvement in projects, including various companies, multidisciplinary teams to develop rapid-prototyping and creation of the MVP might carry an added value.

More explicitly, some of these interviewees could potentially demonstrate more interest towards existing business cases or projects where their products and services would solve complex problems, or partly provide a solution to an existing problem-discovery project. Moreover, these interviewees indicated that development of MVPs for commercialisation might go beyond their expectations and desires, if a cooperation with HEIs is correctly guided.

3.3.4 The value map: SMEs

As it was mentioned before, the current IoT Rapid-Labs value proposition was obtained from the business model canvas used in the project's foundation plan. Therefore, a proposal for a new value proposition it is presented based on interviewees suggestions, including two different components: a) cost effective rapid-prototyping and; b) co-creation of the MVP, rapid deployment for commercialisation. Similarly, Figure 23 illustrates the components of such value proposition, including a new service called: Business, financial and service design consultancy.

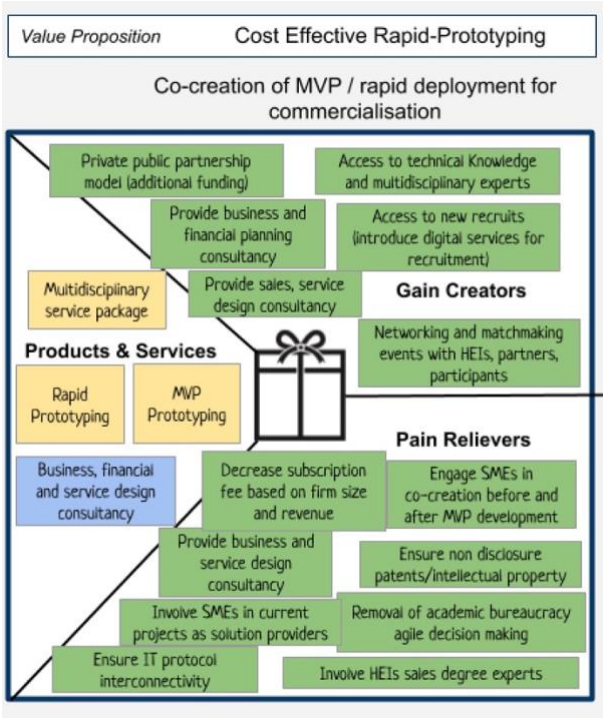


Figure 23. Value map – SMEs: Interview findings

Products and services

As part of the conversation held with SMEs interviewees, it has been suggested that the project would provide an extra package of services aiming to help firms in the areas of business and financial planning during the prototyping and co-creation of MVPs for commercialisation.

Moreover, the interviewee from case company 7, working as technology advisor has suggested that the IoT Rapid-Proto Labs could offer modular services. This signifies, that a firm must be interested in prototyping, but not interested in other services provided by the IoT Rapid-Proto Labs. Hence, these modular services approach could potentially bring solutions to firms in an efficient way by only selecting services which are relevant to them.

In addition, several SMEs interviewees recommended to complement the IoT Rapid-Proto Labs offering with a service package which might include business and financial planning and service design consultancy. By adding such service package, firm's possibility to succeed while creating MVPs for commercialisation might increase substantially. Therefore, producing some expected positive results to HEIs and SMEs, and introducing the MVP to the marketplace in an efficient way.

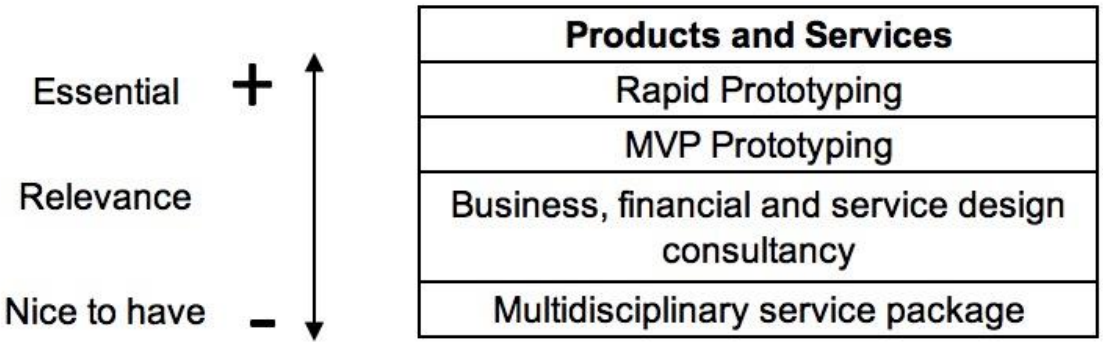


Figure 24. Products and services: SMEs value map

Gain creators

This section contains elements which could potentially synchronise the SMEs and HEIs motivations while engaging in university-industry collaboration. Based on the interviewees feedback, these gain creators encapsulate how the IoT Rapid-Proto Labs project expects to produce benefits for SMEs. These can include savings in time and resource allocation, as well as provide new openings for university-industry collaboration in the context of private public partnerships, academic spin-offs, etc.

Similarly, the goal of these gain creators is to deliver for SMEs accessibility to technical knowledge, business and service design consultancy as well as developing a digital recruitment platform for hiring new recruits as it is illustrated in Figure 25.

Furthermore, some interviewees denoted the importance of discovering new funding possibilities through academic projects, more specifically using Public Private Partnerships (PPP) as these can produce openings to combine the competencies of multiple actors (large companies, HEIs, start-ups and SMEs) and generate new solutions and services.

However, the companies observed that the involvement of the public sector is a high risk due to bureaucratic issues, as well as slow decision making resulting in undesirable results from the commercial nature of these projects; therefore, impacts negatively operating practices and benefits of such partnership.

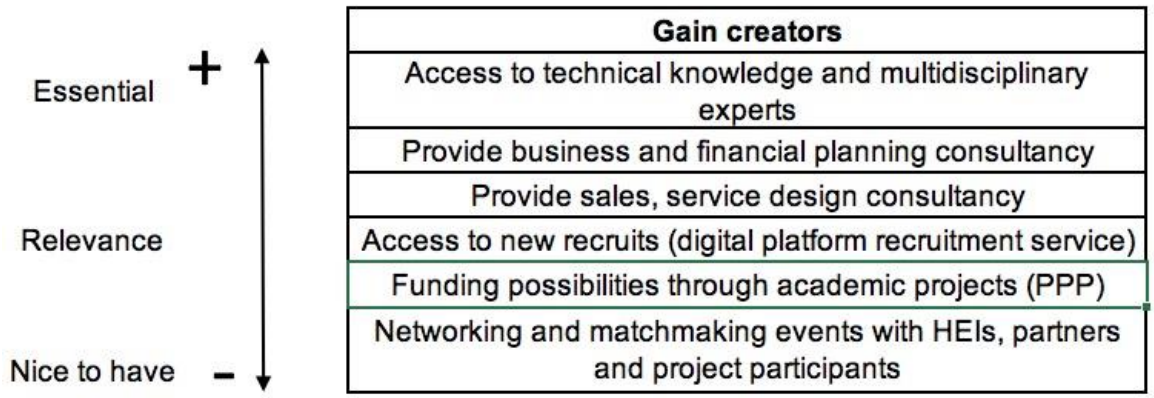


Figure 25. Gain creators: SMEs value map

Pain relievers

As Figure 26 illustrates, these pain relievers are interconnected to the SMEs pains and are meant to act as relievers. According to Osterwalder et al. (2015) these relievers must find a solution for the deficiencies depicted in Figure 21, while providing a fit between the section of the value map and the section of the customer profile.

Hence, a fit can only be achieved is pain relievers genuinely reduce the SMEs pains, as wells as gain creators target gains from the customer profile section. In other words, these pain relievers are meant to ease the obstacles experienced by SMEs while engaging in university-industry cooperation, specifically while interacting with the IoT Rapid-Proto Labs project.

Additionally, SMEs tend to consider that the removal of academic bureaucracy a great improvement to achieve an agile and dynamic cooperation with the project. The interviewees highlighted that academics tend to work in a different pace and the commercial focus projects tend to have a very fast pace to MVP commercialisations. Hence, rapid-prototyping and rapid MVP deployment for commercialisation is a requirement sought from a potential HEIs partner.

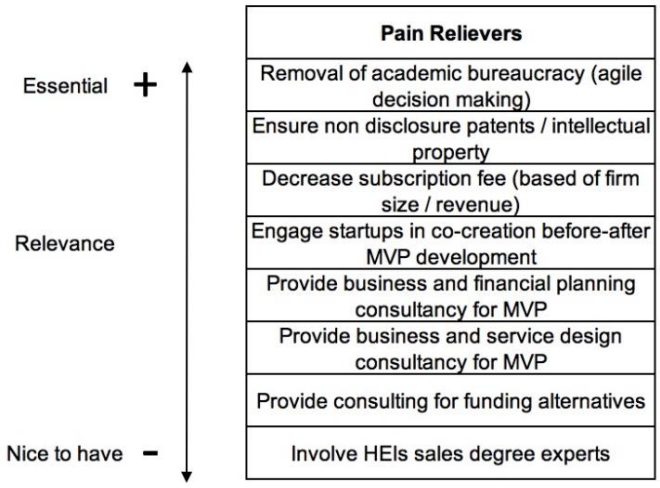


Figure 26. Pain relievers: SMEs value map

Moreover, some of the interviewees highlighted the absence of synchronisation between the company's decision-making schedule and the HEIs own study calendar year. Hence, it would be feasible for IoT Rapid-Proto Labs to adjust the prototyping and the bundle of services timetable to support in an effective way firms all the year round.

4 Research findings

As mentioned before, the main research problem and objective of this study is to identify and suggest relevant elements of value on which the IoT Rapid-Proto Labs will focus to correctly structure, define and create a value proposition for the start-ups and SME's segments.

In order to find these elements, the study focuses on one main research question. This main research question described how the IoT Rapid-Proto Labs would provide an added value for the start-ups and SME's during rapid-prototyping and the creation of minimum viable product concepts. This main question is analysed at the end of this section, while at first the research sub- questions are answered.

The results of the semi-structured interviews provided the basis for constructing two different value proposition canvases targeted for each customer segment. Hence, these canvases are used for comparing and contrasting the interview findings against other value proposition academic theories. A such comparison process is called triangulation and it is discussed below.

The first research sub-question aimed to explore what are the motivations of start-ups and SMEs to engage in collaboration with the IoT Rapid Proto Labs and how these would align with their organisational goals?

The interviews and the value proposition canvases revealed that start-ups and SMEs engage in university-industry collaboration if they see benefits and only if certain conditions are met. Based on the interviewees feedback, these motivations can include time savings and resource allocation, new funding possibilities through academic projects (private public partnerships, academic spin-offs, etc.) as these can produce openings to combine the competencies of multiple actors (large companies, HEIs, start-ups and SMEs) and generate new solutions and services.

Similarly, interviewees revealed that start-ups and SMEs are motivated to engage on university-industry cooperation to get access to scientific and technical knowledge and to establish networks with university researchers.

These findings are supported by Johnston & Huggins (2018) illustration on why small companies might benefit from engaging in university-industry cooperation. Further, Johnston & Huggins (2018) depicted that small companies could benefit from university-industry cooperation because they would be adding resources, increasing innovativeness and competitiveness while pursuing the development of new ideas.

In addition, interviewees remarked that their companies measure the credibility of their prospective HEIs partner based on reputation and word of mouth recommendations from other firms. Hence, this phenomenon can be explained further as Johnston & Huggins (2018, 24) depicted that small companies analyse the credibility of their potential university partners around the practicality, capacity and precision of their knowledge.

Likewise, these firms measure such cooperation in terms of how well it can be harmonised with their organisational goals and objectives, as well as the degree on which a potential partner can outline a plan of action, and the completeness for such cooperation.

The interviewees also mentioned that another motivation to engage in cooperation with the IoT Rapid-Proto Labs is accessing to new recruits. As these start-ups consider the recruitment of key persons as part of their troubles, accessing to new recruits e.g. students might compensate the lack of professional expertise in the short term. However, they emphasised that new recruits e.g. students need a vast amount of time and training for high skilled jobs and expertise. Therefore, the investment in time and resources need to be considered and analysed cautiously.

Further, the interviewees stated that their companies identify the involvement of the public sector as a risk due to bureaucratic issues, as well as slow decision-making makes university-industry cooperation not attractive. Hence, this would have a negative impact on the operating practicalities and benefits of such partnership with HEIs.

Contrasting the aforementioned, Franco & Haase (2015, 42) depicted that the main barriers obstructing university-industry cooperation are bureaucracy, legal framework and lack of organisational support.

In addition, Johnston & Huggins (2018,16 -19) depicted about how HEIs and firms respond to different incentives, hence tensions between these might appear since firms are seeking knowledge for commercial reasons and academics are looking for research while increasing a status in a particular field. Secondly, tensions between companies and HEIs may result from their different logics and methods of working.

The interview findings seem to demonstrate that SMEs motivations to engage in such collaboration with the IoT Rapid-Proto Labs projects include some of the same concerns which start-ups are trying to solve. These are mainly subjects related to funding, operating capital, scalability, access to knowledge, and recruitment of highly skilled experts.

Therefore, it can be observed that exist positive motivations for start-ups and SMEs for engaging in university-industry cooperation. However, these motivations must be must be aligned with the firm's organisational goals. The interviewees implied that their normal day-to-day business activities targets to generate sales and profit, therefore time and resources available for non-related profit generating activities are a concern and university-industry cooperation is not seen as a high priority.

The second research sub-question aimed to answer how a value creation and value proposition strategy would effectively offer a solution for start-ups and SMEs obstacles and challenges?

The interview findings shown precise and significant items when setting a value creating strategy and creating a value proposition for these market segments. It is relevant to take into consideration what is illustrated in the customer profiles of the start-ups and SMES (Figures 11 and 19), as those described essential customer jobs, pains and gains of the target market segments.

Subsequently, as (Osterwalder et al. 2015; Strategyzer.com 2020) depicted value creation requires to target customer pains (anxiety) and make the customer life easier while creating a fit between the customer profile and value map. Therefore, a value creation strategy must consider the drawings of these customer profiles (Figures 11 and 19) as basis. In other words, a value creating strategy must explain how the IoT Rapid-Proto Labs services can ease, and eradicate the customer pains while creating added-value for the start-ups and SMEs.

Based on Anderson et al. (2006), the IoT Rapid-Proto Labs value proposition should be located somewhere along the lines of favourable points of difference and a resonating focus value proposition. Therefore, these relevant points of difference would offer a superior or inferior bundle of services compared to its competitors. Subsequently, the project should contemplate the points of contention on which the start-ups and SMEs disagree about how the performance or functionality competes with those from the rivals.

On the other hand, the interviewees mentioned that within the context of university-industry cooperation SMEs are more likely to engage in feedback, reviews and selecting the steering of a specific project to choose the delivery of a product or service. On selecting the steering, they highlighted the importance of time management, time allocating efforts and resources given by management to collaborate, engage in training with students of HEIs.

The interview findings seem to support Ikävalko, Turkama & Smedlund (2018) illustration regarding value co-creation, the roles of the receivers of value and the three service exchange roles in IoT ecosystem. As these seems to exemplify in a nutshell different phases of value creation within the process on which firms might engage in the IoT Rapid-Proto Labs project. Such roles are depicted by Ikävalko et al. (2018, 7) ideators, designers, and intermediaries; therefore, presenting similarities with the interview findings.

Such phases are similar to the three roles depicted by Ikävalko et al. (2018, 7), and these can be depicted as: a) selecting the steering of a specific project to choose the delivery of a product or service; provide general feedback on performance; b) developing solutions in existing business cases; c) possibility to meet with potential new partners and to discover new sales and distribution; d) suggest new product and services to complement existing IoT Rapid-Proto Labs services offering.

Consequently, based on Sheth (2019) it can be observed that in order to exist value co-creation, both the firms (start-ups and SMEs) and the IoT Rapid-Proto Labs project should be involved in providing resources that are complementary to value creation. Therefore, value co-creation it is valuable for the IoT Rapid-Proto Labs project, the firms and the final user who benefits of such university-industry cooperation.

In addition, the interviews highlighted the importance of value co-creation by suggesting some of the types of types of value co-creation proposed by Sheth (2019, 3). As some of the interviewees denoted the importance of discovering new funding possibilities through academic projects, more specifically using Public Private Partnerships (PPP) as these can produce openings to combine the competencies of multiple actors (large companies, HEIs, start-ups and SMEs) and generate new solutions and services.

Hence, it would be beneficial for the IoT Rapid-Proto Labs project to focus on two types of the value propositions illustrated by Table 4. More precisely, growing the customer business or also called customer business development (CBD) and establishing a public-private-partnerships.

Furthermore, the interview findings uncover some interesting activities on which the IoT Rapid-Proto Labs would tackle the start-ups and SMEs obstacles while adding value. The interviewees believe that such cooperation would increase the possibility to meet with potential new partners and to discover new sales and distribution channels for their products and services.

As for these firms, it is important to lengthen their network reach as they have limited capabilities and limited knowledge within their field. Hence, it can be deduced that these firms consider valuable to use strategic alliances as the key method for enhancing internal operations, expanding into new market segments, and prosper within a fast-moving business environment. (Zhao 2014, 888).

The last sub-research question aimed to answer if a collaboration with the IoT Rapid-Proto Labs would increase the possibility for start-ups and SMEs to commercialise IoT developments while using cross-border multidisciplinary teams?

As the goal of the start-ups and SMEs is to commercialise their business ideas, it becomes a significant to know how a cooperation with the IoT Rapid-Proto Labs can lead to commercialisation. Within the context of university-industry cooperation start-ups and SMEs seem to accentuate the importance of supporting jobs as described by Osterwalder et al. (2015) in categories of buyers of value and co-creators of value. More precisely, while developing an MVP for commercialisation, they are more likely to select the steering of a project to select the delivery of a product or service.

The start-up interviewees referred specifically to the obstacles while developing business plans and business modelling, setting up financial forecasts for the MVP planning as well as the shortages of capital and resources. Further, it was suggested by the interviewees that the project could provide an additional bundle of services aiming to help companies in the areas of business, financial and service design consultancy during the prototyping and co-creation of MVPs for commercialisation.

These findings provided by the interviews with start-ups and SMEs, seems to support the arguments stated by Perkmann et al. (2013) regarding academic engagement and its relations to commercialisation. Since, academic engagement (informal technology transfer) as a collaboration and commercialisation might happen while performing academic entrepreneurship. In other words, academic engagement often leads to commercialisation, and in some cases might also complement commercialisation, for example, when spin-off companies work collaboratively with the university labs they originated from.

Furthermore, based Johnston & Huggins (2018, 24) and the interview findings and it can be concluded that start-ups and SMEs would measure such cooperation on the degree harmonisation with their organisational goals and objectives, as well as the degree on which a potential HEIs partner can outline a plan of action, and the completeness for such cooperation.

Hence, it can be observed that within the context of the IoT Rapid-Proto Labs ecosystem; value creation and value capture involve a specific mindset for developing innovative business models and value propositions. As this mindset involves the anticipation of the user and client needs, the decline of the one-and-done assumption about products, and a wide degree for product and service personalisation (Metallo et al. 2018, 300)

Thus, these sub-research questions help to answer the main question of this study, which focuses on how the IoT Rapid-Proto Labs would provide an added value for the start-ups and SME's during rapid-prototyping and the creation of minimum viable product concepts?

In a nutshell, the IoT Rapid-Proto Labs project would provide added value for these market segments by removing obstacles and sources of anxiety for the start-ups and SMEs, as well as enhancing the decision-making process, establishing a priority for fast and agile rapid-prototyping for companies as well as providing additional services such as business, financial and service design consultancy.

Hence, rapid-prototyping and rapid MVP deployment for commercialisation is a requirement sought from the IoT Rapid-Proto Labs as a partner. In order to achieve that, it is suggested to create of a new value proposition, including two different components: cost effective rapid-prototyping and co-creation of the MVP, rapid deployment for commercialisation. Moreover, the current four IoT Rapid Proto Labs value propositions were included as product and services within the value proposition canvas aiming to build an improved value proposition. (Figure 15, Figure 23, Appendix 1 and Appendix 2)

5 Conclusions

This study has been focused on identifying and suggesting relevant elements of value on which the IoT Rapid-Proto Labs will focus to correctly structure, define and create a value proposition for the start-ups and SME's segments. Hence, the study developed further on the idea of value creation in the context of university-industry cooperation, and established what the start-ups and SMEs customer segments consider to be valuable elements while engaging in collaboration with the IoT Rapid-Proto Labs.

The semi-structured interview goals were achieved and allowed to identify, suggest and create a value proposition for the start-ups and SMEs market segment. The sections of the value proposition canvas include the results gathered from all the answers given by the companies and suggestions for a better collaboration with the IoT Rapid-Proto Labs.

Moreover, the interviews with start-ups and SMEs representatives revealed that many types of customer jobs, pains and gains includes anxieties around activities such as funding, scalability, lack of operational capital, access to technical knowledge and other day-to day activities on which firms engage in order to generate revenue and eventually profit. More precisely, within the customer profile section in the value proposition canvas there exist similarities in the customer jobs, pains and gains for both start-ups and SMEs segments.

The interview findings seem to demonstrate the SMEs share some of the same concerns with start-ups, mainly in subjects related to available capital for operations, access to knowledge and recruitment of highly skilled workers. Furthermore, SMEs interviewees emphasised that time available for non-related profit generating activities are a concern and university-industry cooperation is not seen as a high priority.

The interviewees referred specifically to the obstacles while developing business plans and business modelling, setting up financial forecasts for MVP planning as well as the shortages of capital and resources. Consequently, it has been suggested to include a new package of services: business, financial and service design consultancy. (Figure 15, Figure 23, Appendix 2 and Appendix 3)

Furthermore, these firms perceived that the involvement of the public sector is a risk due bureaucracy matter. Thus, it is suggested to ease the burden of academic bureaucracy as well as working in synchronisation between the HEIs academic year and the companies operative and decision-making calendar.

Subsequently, interviewees highlighted that HEIs have different working pace compared to the private commercial consultancy firms. Hence, rapid-prototyping and rapid MVP deployment for commercialisation is a requirement sought from a potential HEIs partner.

In the context of gains, start-ups and SMEs seem to consider valuable accessibility to technical knowledge and related cooperation benefits with HEIS such as: access to laboratories and equipment, scientific and technological knowledge and to establish networks with university researchers. Moreover, if SMEs engage in university-industry cooperation, they are more likely to select carefully how a specific project would concentrate its efforts allocating time and resources wisely.

These interviewees also commented that their involvement in projects such as the IoT Rapid-Proto Labs seem to be a good arena for accessing new recruits, possibility to meet with potential new partners and to discover new sales and distribution channels for their products and services.

Additionally, SMEs interviewees mentioned that their companies could potentially demonstrate more interest towards the IoT Rapid-Proto Labs, if some conditions were met. In essence, when approaching these companies, it is relevant to introduce concrete existing business cases or projects where their products and services would solve complex problems, or partly provide a solution to an existing problem-discovery project.

Furthermore, the value proposition canvases allowed to compare and contrast in a triangulation process how they represent the reality and how they are structured within academic theory. The relationships between the research questions, the value proposition canvas and the academic theories are described in Appendix 1.

The current IoT Rapid-Labs value proposition was obtained from the business model canvas used in the project's foundation plan. Within the value proposition section of this business model canvas, the project proposed four separated value propositions described as: a) cost effective rapid-prototyping, b) lowering risk, c) multidisciplinary bundle of services and, c) MVP prototype. These current value propositions are not linked to the customer segments properly, and they lack synchronisation between the customer jobs, pains and gains of the start-ups and SMEs customer segments.

Hence, this study recommends a new value proposition based on interviewees suggestions, including two different components: a) cost effective rapid-prototyping and, b) co-creation of the MVP, rapid deployment for commercialisation.

Moreover, the current four IoT Rapid-Proto Labs value propositions were included as product and services, and an additional bundle of services aiming to help companies in the areas of business, financial and service design consultancy during the prototyping and co-creation of MVPs for commercialisation. (Figure 15, Figure 23, Appendix 1 and Appendix 3)

5.1 Recommendations and implementations

It is worthwhile for the IoT Rapid-Proto Labs project management and project coordinators reflect on the recommendations suggested by this study; since it constitutes an outsider's viewpoint, analysis process and unbiased assessment of the results. These suggestions are summarised into two categories: Value proposition extra bundle of services, and service offering in a modular form.

As it was mentioned before, the enhanced value proposition will include in the products and services section of the value proposition canvas a new service called business, financial and service design consultancy. These would aim to solve specific anxieties around activities such as funding, scalability, lack of operational capital, access to technical knowledge and other day-to day activities on which firms engage in order to generate revenue and eventually profit.

Similarly, it has been suggested by the interviewee company number 7 that the IoT Rapid-Proto Labs could offer modular services. Therefore, if a firm is interested in prototyping, but not in other services; these modular services could provide solutions in an efficient way to these firms by only selecting services which they consider relevant.

Furthermore, it is suggested to ease the burden of academic bureaucracy as well as working in synchronisation between the HEIs academic year and the companies operative and decision-making calendar.

Since, rapid-prototyping and rapid MVP deployment for commercialisation is a requirement sought from a potential HEIs partner it is highly advised to increase the pace while working with these IoT project to match the speed on which private commercial consultancy firms operate. Hence, it would be beneficial for the IoT Rapid-Proto Labs project to focus on two types of the value propositions illustrated by Table 4. More precisely, growing the customer business or also called customer business development (CBD) and establishing a public-private-partnerships.

Lastly, it is suggested by the interviewees that the IoT Rapid-Proto Labs project should showcase existing business cases or projects where start-ups and SMEs products and services would solve complex problems, or partly provide a solution to an existing problem-discovery project. Therefore, increasing the interest of these firms to join the IoT Rapid-Proto Labs as members.

The suggestions described above should be implemented rapidly prior to end of the EU funding, as they would increase the probabilities for sustainability of the IoT Rapid-Proto Labs project in the long-run.

5.2 Suggestions for further research

This study serves as the basis for further research on the topic of the value proposition and service development for the start-ups and SMEs market segment. Although, the sample size of the companies which were interviewed represents a small fraction of the IoT firms available in the market, the added value that these companies perceive seems to indicate some beliefs and expectations around university-industry cooperation.

It its suggested to increase the sample size of the companies involved, as well as testing and iteration of the value proposition canvases proposed by this study. While, validating and testing these canvases directly with company partners seeking further clarifications and justifications for value proposition and business model. Hence, presenting a targeted and useful value proposition for these market segments certifying steadiness of the IoT Rapid-Proto Labs in the long run.

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Attachments

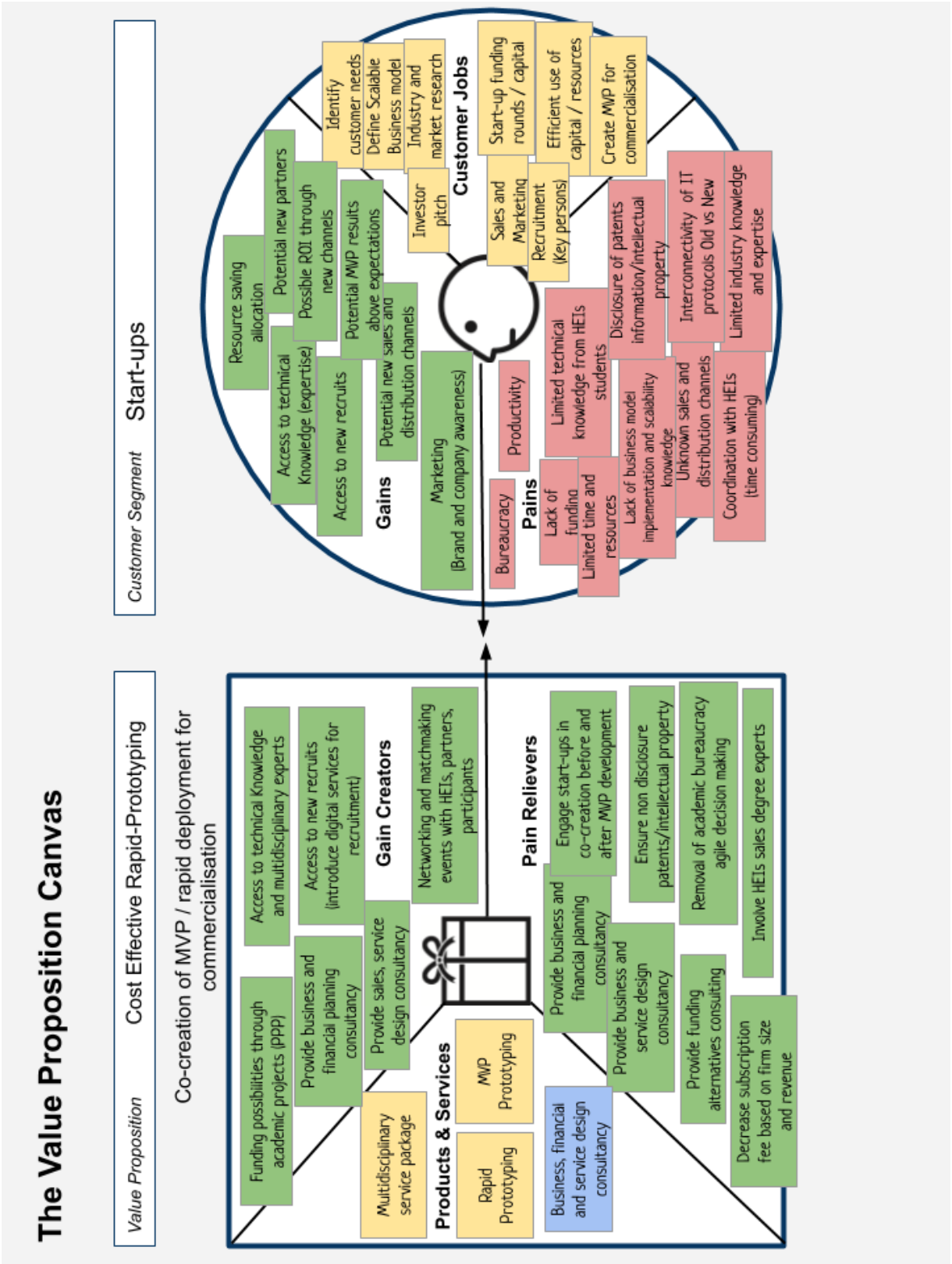
Appendix 1. Overlay matrix – sub questions of the study

Sub questions	Theories / Models	Research methods	Results
What are the motivations of start-ups and SMEs to engage in collaboration with the IoT Rapid-Proto Labs and how these would align with their organisational goals?	Value proposition canvas (Osterwalder et al. 2015) University-industry linkages and partner selection (Johnston & Huggins 2018) University–industry cooperation (Franco & Haase 2015)	Semi-structured Interview questions	Start-ups and SMEs are motivated to engage on university-industry cooperation in obtaining access to scientific and technical knowledge and to establish networks with university researchers. Motivations such as time saving efforts and resource allocation, new funding possibilities through academic projects (private public partnerships, academic spin-offs, etc.) can produce opportunities to combine the competencies of multiple actors (large companies, HEIs, start-ups and SMEs) and generate new solutions and services. These motivations must be aligned with the organisational goals, since normal day-to-day business activities are focused on generating sales and profit. Therefore, time and resources available for non-related profit generating activities are a concern and university-industry cooperation is not seen as a high priority. Involvement of the public sector is seen as a high risk due to bureaucratic issues, as well as slow decision-making makes university-industry cooperation not attractive.
How a value creation and value proposition strategy would effectively offer a solution for start-ups and SMEs obstacles and challenges?	Value proposition Canvas (Osterwalder et al. 2015) Three kinds of value proposition (Anderson et al. 2006) Types of value co-creation (Sheth 2019)	Semi-structured Interview questions	A value co-creation strategy must explain how the IoT Rapid-Proto Labs services can ease, and eradicate the start-up-s and SMEs pains while creating added-value. It is important to use as the basis for this strategy the interview findings related to customer profiles (Figures 11 and 19)

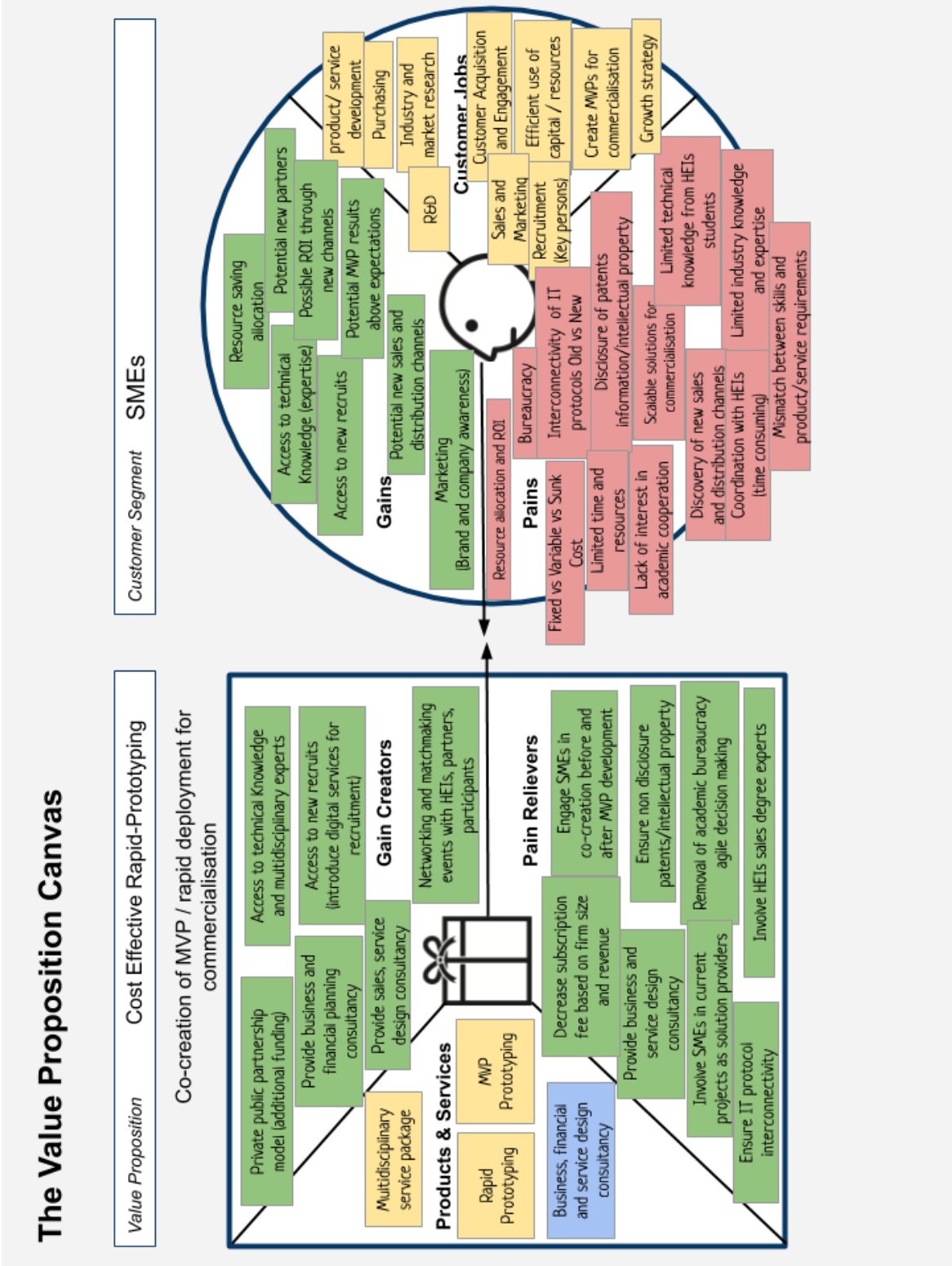
	Elements for mapping roles in IoT ecosystem business model (Ikävalko, et al. 2018, 8)		An improved value proposition would aim to solve the anxieties around activities such as funding, scalability, lack of operational capital, access to technical knowledge and other day-to day activities on which firms engage in order to generate revenue and eventually profit. In order to tackle this problem, a new package of product and services is suggested, which includes business, financial and service design consultancy. The findings seem to exemplify in a nutshell different phases of value creation or roles (ideators, designers and intermediaries) on which firms might engage while cooperating with the IoT Rapid-Proto Labs project. These roles describe aspects such as selecting the steering of a specific project, choosing the delivery form of a product or service; developing solutions in existing business cases; possibility to meet with potential new partners; discovering new sales and distribution channels; suggesting new product and services to complement existing IoT Rapid-Proto Labs services offering. Hence, it would be beneficial for the project to focus on value propositions such as customer business development (CBD) and establishing public-private-partnerships (Table 3, page 22).
Would a collaboration with the IoT Rapid- Proto Labs increase the possibility for start-ups and SMEs to commercialise IoT developments while using cross-border multidisciplinary teams?	Value proposition canvas (Osterwalder et al. 2015) Mindset for the IoT industry. (Metallo et al. 2018, 300) Key considerations for creating an IoT value proposition. (Hudson 2017, 8)	Semi-structured Interview questions	The start-up interviewees referred specifically to their obstacles while developing business plans and business modelling, setting up financial forecasts for the MVP planning as well as the shortages of capital and resources. It was suggested by some interviewees that the project could provide an additional bundle of services aiming to help companies in the areas of business, financial and service design consultancy during the prototyping and co-creation of MVPs for commercialisation.

	Collaboration with higher education institutions (Moon et al.2019) Academic engagement and commercialisation (Perkmann et al., 2013)		Since, rapid-prototyping and rapid MVP deployment for commercialisation is a requirement sought from a potential HEIs partner it is highly advised to increase the pace while working with these IoT projects to match the speed on which private commercial consultancy firms operate. An interviewee has suggested an implementation of modular services provided by IoT Rapid-Proto Labs. Since, a firm might be interested in prototyping, but not in other services; these modular services could provide solutions in an efficient way to these firms by only selecting services which they consider relevant increasing the possibilities for MVP commercialisations.

Appendix 2. Value proposition Canvas: Start-ups



Appendix 3. Value proposition Canvas: SMEs



Appendix 4. Interview Questions

Themes	Interview Questions
1. Company's Outlook (Introduction)	1.1 Can you briefly introduce yourself and what do you do in the company? 1.2 Can you briefly introduce your company? products and services, what they do? 1.3 What are your target customers?
2. Company's Outlook (Value Proposition)	2.1 What can you tell me about your value proposition? 2.2 Could you say something more about your company's value proposition offer? 2.3 How your product or service solves/improves problems? 2.4 What benefits customers can expect?
3. Company's jobs (Start-up & SMEs jobs).	3.1. Could you name and describe some job-related and non-job-related tasks that you or your company does while performing or providing products, services or solutions to your clients? How important are these? 3.2 Are these problems you are trying to solve or company's needs?
4. Company's challenges (pains)	4.1. What are the main challenges your company is experiencing? 4.2. What does your company or yourself find too costly? 4.3 What does your company consider as risks? 4.4 What are the barriers for buying solutions and cooperating with other firms, partners or universities?
5. Ecosystem – Value chain (Collaboration with HEs)	5.1. Can you described interesting partners that could be part of your business model for enhancing the total value created for your customers? 5.2 Have you considered HEs as potential partners for your IoT development? Some examples how? 5.3 Do you consider important for your company's IoT/AI developments to get acces to crossborder multidisciplinary teams' 5.4. Could these teams help you with co-creating IoT design, product development and make rapid-prototyping? 5.5. Would a collaboration with HEs give to your company exposure and increase company's recognition?
6. Advantages for companies (gains)	6.1 What would make your job life and your company's life easier? (e.g. flatter learning curve, lower cost of ownership) 6.2 How does your measure success and failure? (e.g. performance, cost, …) 6.3 What outcomes does you or your company consider that would go beyond expectations? 6.4 What would increase the likelihood of adopting a solution or buying a service from a partner / university? 6.5 What you consider to be the benefits of engaging on collaboration with HEs? Would you describe some details? 6.6 How a collaboration with HEs would increase your customers' likelihood of buying from your company? Would this collaboration lower costs, lower risk, or provide a better quality?