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Partner Selection and Value Network Analysis for Internet of Things Vendors – Defining a Smart City Strategic Alliance

Helsinki Metropolia University of Applied Sciences

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The objective of this research was to identify Internet of Things (IoT) use cases related to Smart Cites in the City of Helsinki, select appropriate Internet of Things partners from the different areas involving an IoT implementation and create a value network analysis in the scope of Smart Kalasatama area in Helsinki, Finland. The research output should support the target organization in developing similar partner network in other Smart City scenarios.

The study was conducted through a series of literature reviews including available Internet of Things business models and technologies, Smart Cities concepts and their needs for Internet of Things use cases, Partner Selection methods and Value Network Analysis methods. The purpose of the literature review was to draft the current state analysis and provide scientific grounding for developing the conceptual framework of this Master Thesis.

Following the conceptual framework, an empirical part is initiated including two phases. The first phase included choosing Internet of Things partners that are developing use cases in the different areas such as hardware sensors and actuators, Internet of Things gateways, software platform for Internet of Things device management and Internet of Things applications. The chosen partners are analyzed through the partner selection criteria defined in the conceptual framework. In the second phase, a network value analysis was performed so that a value network map was created as the result.

The feedback from the stakeholders involved in the partner business and Internet of Things area in the target organization was given so that to refine the selection criteria and the value network development. The result contributes in creating future strategic alliances for the target organization business development in Smart Cities.

In conclusion, this research aimed at producing a consistent and tested partner evaluation and selection framework for Internet of Things vendors, as well as an analysis for potential vendors within a value network context. The outcome was to ensure that the target organization will be strategically positioned in the Smart City market.

Keywords	Internet of Things, Smart Cities, Partnerships, Value Chain, Value Network, Supply Chain Management, Partner Management, Partner Selection, Value Creation Management

Table of Contents

List of Figures

List of Terms and Abbreviations

API	Application Programming Interface
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
CERN	European Organization for Nuclear Research
EC-GSM-IoT	Extended Coverage-GSM-IoT
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
ERP	Enterprise Resource Planning
GCHQ	Government Communications Headquarters
GSM	Global System for Mobile Communication
GSMA	GSM (Groupe Spéciale Mobile) Association
HRI	Helsinki Region Infoshare
HVAC	Heating, ventilation and air conditioning
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
ISPs	Internet Service Providers
ITU-T	International Telecommunication Union – Telecommunications Sector
ICT	Information and Communication Technology
LPWA	Low-Power Wide Area
LTE	Long Term Evolution (4G)
MQTT	Message Queue Telemetry Transport
MCDM	Multi-criteria Decision Making
MWC	Mobile World Congress
MaaS	Metering as a Service
M2M	Machine to Machine Communication
NFV	Network Function Virtualization
NB-IoT	Narrow Band Internet of Things
NSA	National Security Association
RFID	Radio Frequency Identification
SMEs	Small and Medium Size Enterprises
SDN	Software Defined Networking
SWOT	Strengths, Weaknesses, Opportunities and Threats
SaaS	Software as a Service
ROI	Return of Investment
VNA	Value Network Analysis
WSNs	Wireless Sensor Networks

1 Introduction

1.1 Company Background and Motivation

The target organization of this research study is a Finnish multinational telecommunications vendor, focused on mobile network infrastructure, developing mobile connectivity technologies such as GSM, 3G, LTE, 5G, Cloud Computing and Internet of Things (IoT). The company has a respectable history dating back to 19th century when its business strategy focused on different markets and products such as paper mills, rubber boots and tyres. However, it was on late 1980’s that the company started to be known globally as a technology disruptor by developing mobile communications, mobile phones and services. The target organization was the first company to execute a commercial GSM call. Today, the company remains strong in the telecommunications market and it is determined to remain a leader in developing new technologies for a programmable world in a connected society.

The target organization has recognized that the evolution of the mobile communication infrastructure goes beyond of that where the mobile data is restricted only to mobile phones and tablets. With the continuous increase in mobile data speeds, different types of devices, supporting a connected society could be integrated to the network so that to improve the quality of life. Wearables, Connected Cars, Connected Buildings and Connected Appliances are just some examples of new paradigms in the data communications, but among other devices, mostly everything could be connected to the Internet via a mobile network. In these new scenarios, multiple business opportunities are emerging and all of them require increased data speeds and lower data latency in the mobile networks or local wide area networks. In addition to that, a new concept called the Industrial Internet, **Internet of Things**, or Internet of Everything, has been dominant in the communications market. **The target organization** is supporting the development of standards that makes the **Internet of Things** a reality, as well as involved in the development of technologies such as Cloud Computing, Network Function Virtualization (NFV), Telco Cloud, Software Defined Networking (SDN) and 5G mobile networks. These technologies are an initial step towards a connected world.

The motivation of this Master Thesis is to bring the **Internet of Things** concept forward and consider it in a specific business scenario where a city infrastructure advantages from multiple connected "things" to the Internet through the mobile networks, such as GSM, LTE or 5G. In this specific technological context, this research study focus on Internet of Things use cases, partnerships, and a partner selection criterion for connected cities, hereinafter referred as "Smart Cities" or "Smart City". The Internet of Things partner selection criteria is finally considered in a bigger context, a value network. The value network analysis (VNA) of the selected partners is also realized as an option for partner business development in the target organization.

1.2 Internet of Things

The concept of the Internet has evolved from early proprietary packet networks connecting laboratory computers already in the 1950's to standardized and robust communication networks in the 1980's. The standardization of communication networks through the Internet Protocol (IP) stack brought the possibility for major launchings of Internet Service Providers (ISPs) in the late 1980's and the development of the World Wide Web (WWW) by CERN in Switzerland. The lowering costs of personal computers and the standardization of a Web interface allowed a rapid expansion of the Internet in the mid-1990's, resulting in growing amount of data shared by the continuous interconnection of computers around the world. In the 2000's, services such as Google, Facebook, E-bay, Skype and Alibaba emerged creating a more "Social" Web, where common people engaged online. "By 2011, over 2 billion global users were already connected to the Internet …" (ITU World Telecommunication / ICT indicators database, 2016). Electronic mail, chat applications, online voice, video calls and online shopping contributed to the increase of data exchange. Nowadays, "there are over 3.4 billion global users …" (Internet Live Stats, 2016) connected through the Internet using Personal Computers, Smartphones and Tablets. Although Personal Computers initiated the growth of data exchange, Internet data solid growth has been mainly dependent on smartphones and tablets in the last decade. According to IDC, "by 2017, 87% of the Internet connected devices sales will be based on tablets and smartphones …" (IDC, 2012). One of the main reasons for the growth of smartphones and tablets is the ability to connect to mobile networks such as GSM, 3G or LTE, since people could connect to the Internet from almost everywhere.

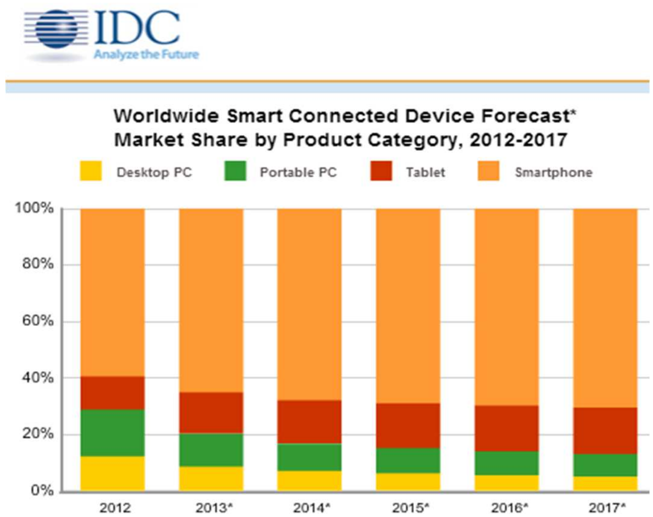


Figure 1, Smart Connected Device Forecast (IDC, 2012)

However, while the Internet data continues to increase, mobile phones and tablets will not be the only source of solid growth due to its market saturation in the developed and developing countries. Advancements in electronics allowed the ability to develop mobile connectivity to almost **any physical object**, regardless of its functionality. These objects, or **"things"**, can become smart physical components containing hardware, microprocessors, sensors, actuators, software, an embedded system, controls and most importantly, wireless **connectivity**. Examples of these objects can be a watch containing an embedded system that can measure a person's health, through the heartbeat. Such a smart product becomes a new type of connected device to the Internet. In case of a home appliance, a fire alarm can be built with a sensor that detects temperature and smoke levels and provides the needed information through its wireless connection for the fire department in real time. As the connectivity options expand to several types of applications, the Internet model advances towards an **Internet of "Things"**, where "**ubiquitous wireless connectivity** can be present in any physical object …" (Porter, M. 2014).

Home appliances, buildings, health equipment, parking spaces and cars are more examples of the additional things that will contribute to the Internet data growth in the next decade and shift the way society and businesses operate. In 2016, "there are already 6.4 billion connected "things" …" (Gartner, 2016) that go beyond of traditional communication devices sometimes unknown by common people and businesses, and "there will be around 20.8 billion connected "things" by 2020 …" (Gartner, 2016). The **Internet of**

Things technology covers a wide variety of applications, such as energy efficiency management, healthcare and automotive. The Internet of Things concept is business critical to continue enabling the data growth and drive the needs for future communications networks, such as the 5G, in which the target organization is working. Therefore, the Internet of Things is an extreme important business opportunity that must be analysed in all different business verticals.

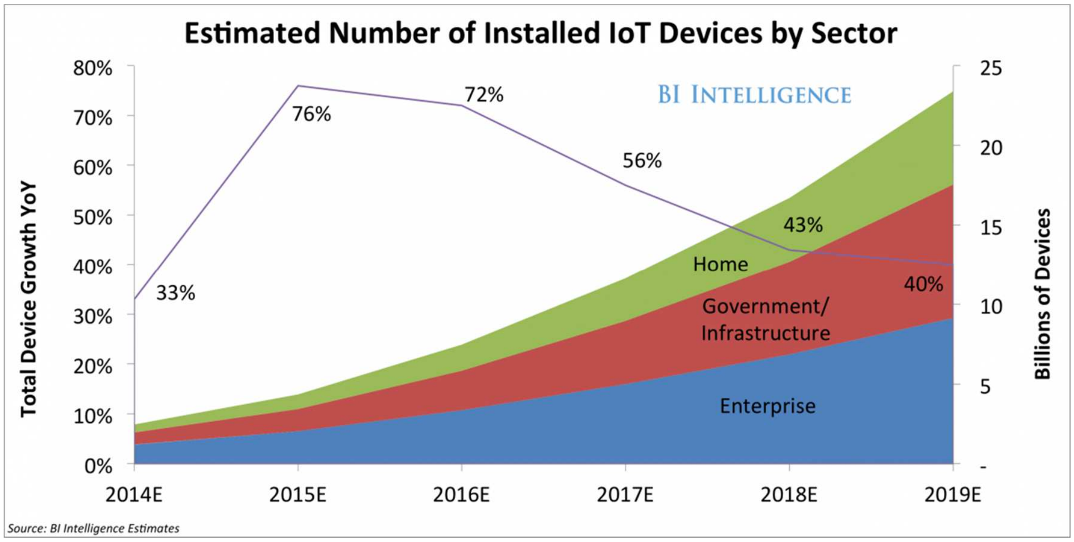


Figure 2, Internet of Things Device Growth by Sector (BI Intelligence, 2014)

In the next chapter, the Smart City IoT business vertical is introduced.

1.3 Smart Cities

The technologies associated with the **Internet of Things** raised a myriad of use cases and applications that can be deployed. One of the promising applications of the Internet of Things is to **transform a city** into being interconnected and digital. “A city is comprised of its citizens, visitors, local businesses and government, together with the services and infrastructure available to help them go about their daily business ...” (GSMA, 2016) and “… to create opportunities for economic growth, a city needs to build the right operating environment for its businesses, engage its citizens with meaningful local services and attract new visitors and new investment into the city boundaries …” (GSMA, 2016). As cities continue to grow, mainly due to continuous flux of immigration, challenges to keep their services in the proper level to citizens arise. Traffic jams, pollution, overcrowding, high living costs caused by inefficient service planning can all be caused by the increased urbanization that is being observed in the past decades. The **Internet of Things can**

support public governments in being more efficient and transparent to its citizens, so that the living quality is preserved as cities grow and become more active. For example, public governments can use hardware sensors to monitor the air and water quality to pro-actively react to these issues and provide improvements. Sensors can also be used to indicate the level of waste in garbage bins, to optimize the waste collection. Smart cameras can be deployed in major areas of the city to control the crowds and avoid overcrowding in subway stations, by increasing the frequency of subways in a specific line. Parking areas can be monitored so that citizens can be aware of available spaces in advance, being able to plan their rides and the adequate transportation. Hospitals can be interconnected to provide fast response to emergency situations. Software platforms can be implemented to centralize all the information and data available from the city, so that all citizens can access in real time, replacing or enhancing traditional Enterprise Resource Planning Systems. Considering this short, but enlighten list of applications, it already becomes clear that the **Internet of Things is a key enabler of a Smart City** and must be addressed by public governments, technology partners, mobile infrastructure vendors, mobile operators and regulators to allow a better and connected living. “The Internet of Things (IoT) is enabling a world of limitless potential – a world where we can connect anything and everything. This is fanning innovation across all sectors, creating new business opportunities and improving everyday life for millions of people ...” (GSMA, 2016).

1.4 Business Challenge, Research Objective and Output

Business Challenge

In the future, businesses will be influenced by the “**Internet of Things**” (IoT) and its applications. IoT is the network of physical objects or “things” embedded with electronics, software, sensors, and network connectivity, which enables the collection and exchange of data. As an example, Cisco predicts that, by 2020, there can be almost 50 billion devices connected to the Internet and the value of the IoT business will be worth almost USD 14.4 trillion for companies and industries worldwide. Together with Big Data, Cloud Computing and 5G, IoT is an enabler of, for example, a new trend called “**Smart Cities**”. Governments around the world, including the Helsinki Municipality, are working towards connected automated and more efficient cities.

The target organization, as a mobile network infrastructure vendor, **is pursuing business opportunities in the IoT area and will seek a position as a leading IoT integrator for "Smart Cities"**. However, the overall business model in becoming an Internet of Things integrator significantly differs from the current target organization models. This is also the case when considering the configuration of the target organization's future potential and needed partner network.

Research Objective and Output

Accordingly, this **Master's Thesis objective** is to:

- Identify the specific IoT needs of a Smart City in the context of the City of Helsinki (Smart Kalasatama) and the potential external partners for **the target organization**.
- Define a **partner selection framework** and create a **value network framework** for the **target organization's** potential Smart City partners.

This **Master's Thesis output** will be:

- The **network value analysis** and a **value network map** for the selected IoT partners in the Smart City (Smart Kalasatama) business case.

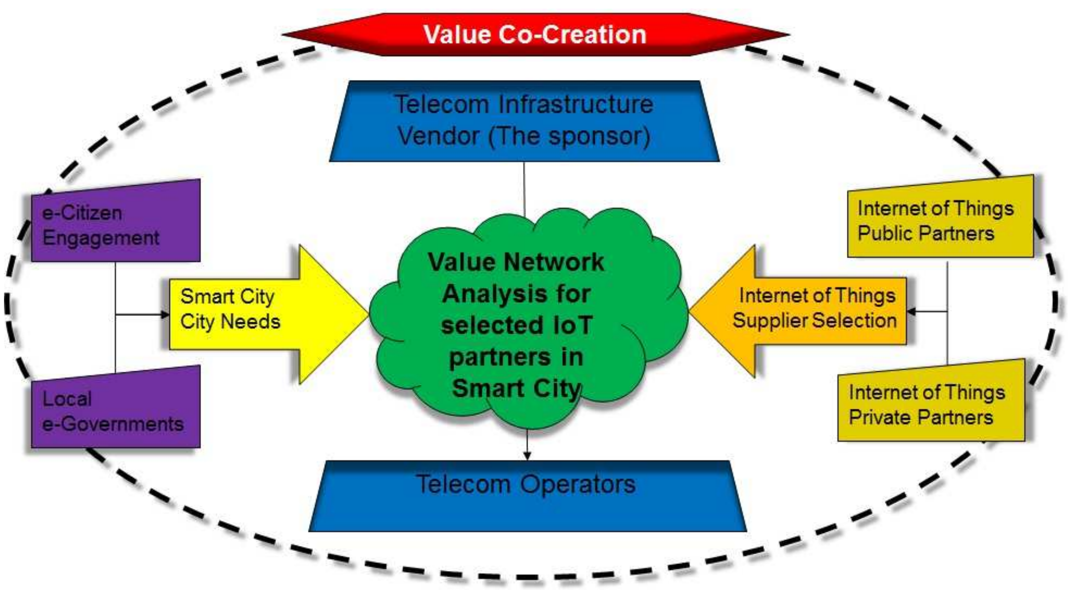


Figure 3, Research Objective and Output (Medyk, 2016)

2 Research Design

2.1 Structure of this Research Project

The study will be conducted through a series of literature reviews including available Internet of Things business models and technologies, Smart Cities concepts and their needs for Internet of Things use cases, Partner Selection methods and Value Network Analysis methods. The literature review consists in understanding the current state and provide scientific grounding for developing the conceptual framework of this Master Thesis. Following the conceptual framework, an empirical process model is initiated including 2 phases: 1) **choosing Internet of Things partners** that are developing use cases in the different areas such as hardware sensors and actuators, IoT gateways, software platform for IoT device management and IoT applications. **The chosen partners are assessed through the partner selection criteria** defined in the conceptual framework as well as 2) **a value network analysis is created** as the result.

Feedback from stakeholders involved in partner business and Internet of Things area in the target organization is taken so that to refine the selection criteria and the value network development. 3 data collections are executed: 1) via interviews with Nokia stakeholders, 2) via interviews with Forum Virium of the City of Helsinki and 3) project meetings with the organization experts in partner selection and Internet of Things.

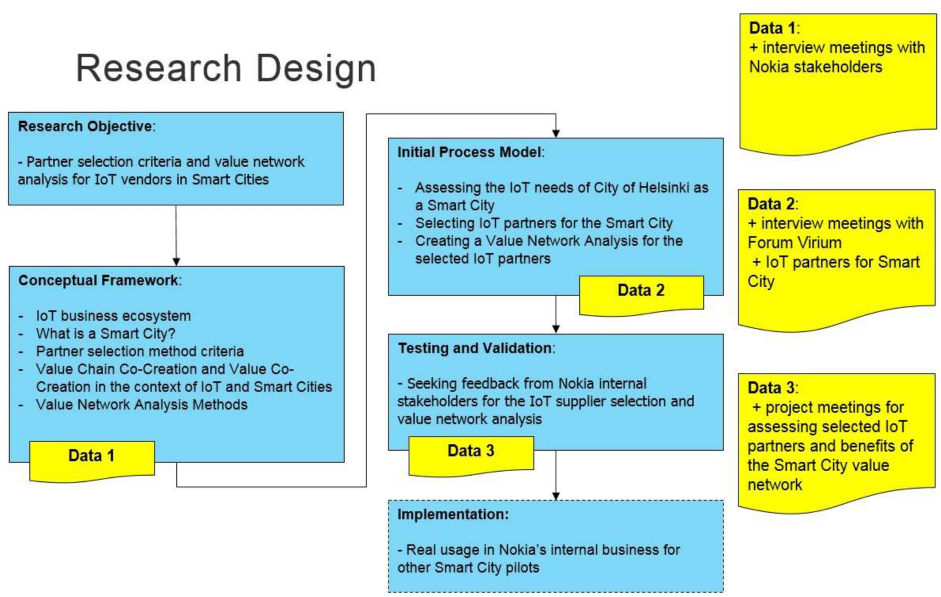


Figure 4, Master Thesis Research Design (Medyk, 2016)

2.2 Research Methodology

This Master Thesis provides an applied research with the following steps:

1. A Smart City is selected as a Use Case for Internet of Things key partner selection and value network analysis. The selected Smart City is the Smart Kalasatama in the Helsinki Region. The Smart Kalasatama development is managed by the Forum Virium Helsinki as described in Chapter 3.2
2. Three Smart City applications are selected based on the study done in Chapter 3.2.
3. For each Smart City application in the Smart Kalasatama area, 3 partners are chosen in each specific IoT area (Hardware and Embedded Systems, Platforms and Applications). For each partner, the analytic network process for partner selection is used as described by (Wann, Y. W., Hsi-An S., Hui-Chun C., 2008).
4. Finally, a value network analysis based on (Biem, A., Caswell N., 2008) is performed.

3 Literature Review

3.1 Internet of Things Ecosystem

The Internet of Things is a result of the evolution in the Information, Technology and Communications (ICT) industry. As already described in Chapter 1.2, the ICT-based transformation dates to 1960's and 1970's when computers were introduced to execute human tasks which previously were done manually, mainly in the supply chain and manufacturing world. Additional developments to the ICT industry added more intelligence, power and robotics to the computers as well as introduced connectivity between these machines. Communication networks developed in the 1980's and 1990's created the Internet as we know today, providing ubiquitous connectivity all around the world.

The Internet of Things concept can be related to legacy Radio Frequency Identification (RFID) technologies developed in 1980's or to Wireless Sensor Networks (WSNs) developed in 1990's. However, it was the introduction of mobile broadband in the 1990's and 2000's, such as GSM, 3G and LTE by large telecommunication infrastructure vendors, such as the target organization, that allowed a growing number of computers to connect to the Internet. These computers were no longer legacy desktops or laptops, but also smartphones and tablets. Companies such as Nokia, Apple and Samsung, disrupted the market by creating new products able to connect to the Internet, taking a competitive advantage over traditional vendors such as Microsoft, HP, Dell and IBM.

Mobile networks allowed billions of devices to be connected to the Internet, rising the concept of the Internet of Things. As the concept become clear to businesses around the world, innovative and disruptive ideas were brought by creating new physical elements that could be connected to the Internet, such as Wearables, Cars and Cities. The International Telecommunications Union (ITU) suggested that the “Internet of Things will connect the world's objects in both a sensory and intelligent manner” (ITU-T, 2005). Therefore, the Internet of Things is not only a new technology, but it is a powerful tool to bring new business opportunities in different verticals.

Instead of providing only connectivity to a specific element, the Internet of Things also can provide a set of value added services by monitoring, controlling, optimizing and bringing autonomy to physical things. Everything can be managed everywhere, anytime, through ubiquitous and real time connectivity empowering humans to have a better and more efficient way of living.

Predictions related to the amount physical devices connected to the Internet, forming the Internet of Things, arise all the time by different researchers. According to Cisco and DHL, “even though there are only 15 billion devices on the Internet of Things today, a new report found there will be 50 billion devices by 2020 …” (Cisco, 2013). “Cisco predicts the Internet of Things market will be worth of $14.4 trillion by 2022 …” (Cisco, 2013). The increased number of devices will “allow automation in several industries, with applications in healthcare, building automation, utility management, traffic management, and Smart Cities …” (Gubbi et al., 2013).

Figure 5 describes the Internet of Things architecture. “Things” is a broad term, which refers to a variety of physical objects, which can be connected to the Internet. Physical devices are equipped with sensors, such as temperature sensors, vibration sensors, location-based devices, etc. These sensors provide “life” to “things”, so that physical attributes can be sensed and monitored. Additionally, physical objects are equipped with an embedded processor that can can report the sensed and monitored data to a mobile network in real time, which is consequently connected to the Internet.

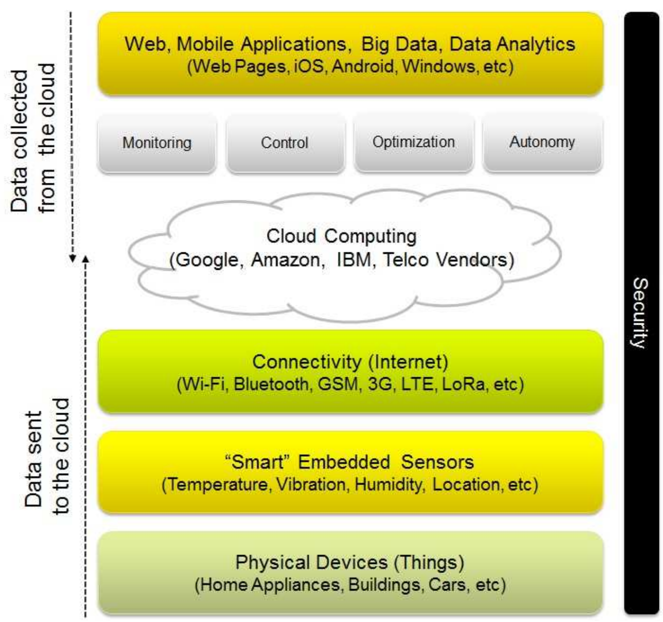


Figure 5. Internet of Things Architecture

In a Harvard Business Review, (Porter M., 2015) defines a group of capabilities for smart devices divided in four areas, where capability builds on the preceding capability or set of capabilities. “First, **monitoring** of products condition, the external environment, and the products operation and usage is enabled by IoT, including alerts and notifications of changes. Second, software embedded either in the cloud or the physical object enables **control** of product functions as well as the user experience, e.g. through personalization. Third, **optimization** of product operation, e.g. by applying algorithms in combination with monitoring and control capabilities, can enable predictive diagnostics of needs as well as enhance the performance of the product. Fourth, combining the preceding three capabilities allows for degrees of autonomy, e.g. self-coordination with other products or systems, **autonomous** product operation and enhancement, as well as self-diagnosis” (Porter M., 2015). Figure 5 adds these four capabilities on top of the Cloud where the data is retrieved.

The data collection can be seamlessly reported to Cloud Computing databases, such as Google Cloud Platform, Amazon Web Services, Microsoft Azure, IBM IoT Watson or even specialized Cloud for Telecommunication applications as the one developed by the target organization. The potential applications that can surge to monitor and analyse the information available in the Cloud is critical for developing new business opportunities.

The Internet of Things “brings cost reduction and efficiency to applications and businesses are pursuing the advantages of this technology. For example, Internet of Things is associated with ongoing transformation in the manufacturing, also known as Industry 4.0. Industry 4.0 involves several technological innovations, but ultimately depends upon adding intelligence to things using sensors, connectivity and cloud computing. This allows better transparency and agility, more responsive to customer needs and self-monitoring products and services …” (Forbes, 2013). “Firms must understand how new business models are created by the Internet of Things and the challenges that it brings. Internet of Things is transforming business and it is critical for the success of any organization. **Internet of Things is not a technology, but a business initiative** …” (Vodafone, 2016).

Figure 6 shows examples of Business Verticals that the Internet of Things can introduce divided into three use cases, where Wearables, Cars and Cities have the ability to sense the environment and provide such information to the Internet, turning them into "intelligent assets that can communicate with people, applications and each other …" (Vodafone, 2016). Typically, the information is stored in databases using Cloud technologies, from where Internet of Things platforms can act as a middleware of applications and analytics to extract the value of monitoring the intelligent assets.

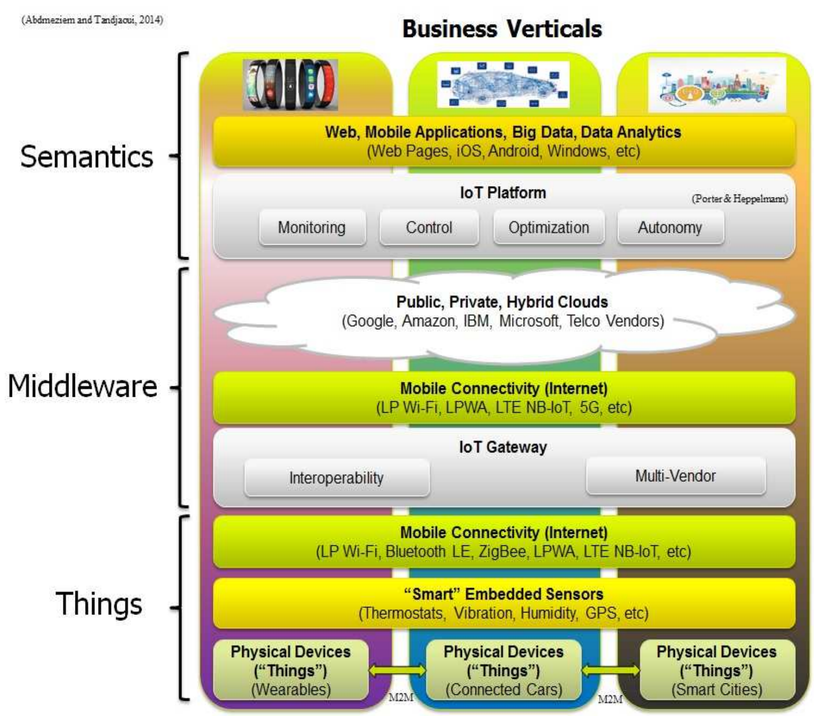


Figure 6. Internet of Things Business Verticals, Examples (Medyk, 2016)

In case of Smart Cities, "Internet of Things systems can transmit real-time information about natural processes (e.g. temperature, wind, vibration of structures, rain, water level of rivers, etc.) and such information can be used in an integrated way with information and decision making systems for different purposes. The combination of remote sensing for monitoring with alert and action mechanisms can compose a complex system to notify authorities and citizens. Another real-world scenario that requires the seamless integration of heterogeneous devices is related to the monitoring of urban infrastructures. In the context of smart cities, the traffic jam problem regarding public and private transport in the urban conglomerates may be drastically minimized through the real-time monitoring of public infrastructure information. Several urban data can be collected and disseminated through communication infrastructures that require integrated, heterogeneous, smart wireless communication ways and that may encompass a wide range of networked devices, such as sensors embedded in vehicles or installed on the streets and roads, as well as several citizens' mobile devices (e.g. smartphones, tablets, laptops, etc.)" (Delicato et. all, 2013). These real-life examples indicates that businesses must understand the Internet of Things ecosystem and its components.

Furthermore, "the value created by a system involving IoT needs to be greater than the value which competing systems are capable of creating. Systems can be created by combining multiple smart, connected products and their services into a unified solution, i.e. a product system. By combining multiple product systems, systems of product systems can be developed. Perceiving IoT through this perspective, as an aggregation of product systems into systems of product systems, can advance the understanding of how disparate product systems could be optimized and create more value. For example, by analysing IoT on the level of smart homes, buildings, districts or cities rather than by the individual products and services which comprise these entities …" (Högnelid P., Kalling T., 2015).

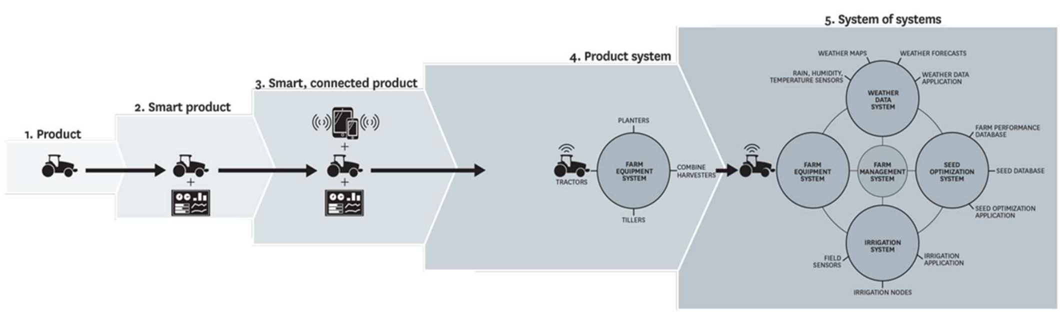


Figure 7. Internet of Things Systems of Systems (Porter M., 2014)

In the next decade, business model innovation will disrupt how the Information, Communication and Technology (ICT) industry creates and capture the value of its products. "The changing nature of products is also disrupting value chains, forcing companies to rethink and retool nearly everything they do internally. Companies who do not adapt their traditional product-based business models to new innovative product and service models, will lose competitive advantage against new and disrupting startups. Smart, connected products let companies switch to product-as-a-service models and have full transparency about how customers use products helps companies develop entirely new business models …" (Porter M., 2014). That is why it is so important for companies to understand the business models for the Internet of Things, as the core of its concept lies in the smart products.

The next chapter describes some of the **Internet of Things business models**.

3.1.1 Internet of Things Business Models

To understand the commercial opportunities of the new applications that can be created with the Internet of Things, the main objective of this Chapter is to summarize Internet of Things Business Models available in the literature so that the target organization can realize the potentials of an Internet of Things based value creation process. **Business models** for Internet of Things were researched using ScienceDirect, IEEE, SpringerLink and ACM databases. The identified models are composed into a single business model that will support this Master Thesis along its research process. There is a growing academic knowledge for Internet of Things business models and applications, especially on how these differ from business models for other applications. Business models helps defining ways to create value for the Internet of Things. “Business models enabled by smart, connected products can create a substitute for product ownership, reducing overall demand for a product. Product-as-a-service business models, for example, allow users to have full access to a product but pay only for product they use” (Porter, M., 2014).

(Chan, Hubert C. Y., 2015) proposes a business model based on (Holler et all., 2014) with four dimensions: “**Who**” which describes the **collaborating partners** building a so-called “**Value Network**”, “**Where**” which describes **source of value co-creation**, “**Why**” which describes “**How**” **partners** will benefit being part of the value network. These dimensions derive from (Gassmann et al., 2014). Figure 8 associates these dimensions with following business parameters: value proposition, revenue model and value chain.

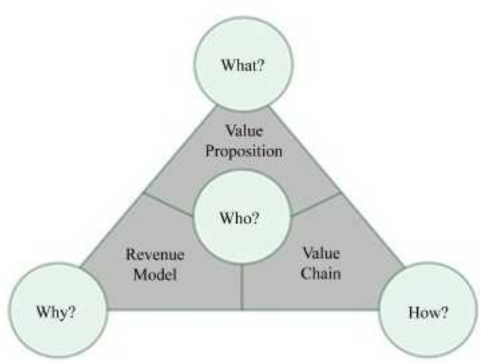


Figure 8. “The archetypal business model” derived from (Gassmann et al., 2014) as described in (Chan, Hubert C. Y., 2015)

(Kindström D., 2010) adds two new elements to (Gassmann et al., 2014) business model: **value network** and **competitive strategy**. This gives a service based business model for the Internet of Things, with parameters that helps a firm understanding the elements that can influence to the firm's strategy.

Table 1. Service based business model parameters (Kindström D., 2010).

Business model parameter	Key issues
Value proposition	• Articulated offering • Visualization • Closer customer interaction • A dynamic offering portfolio
Revenue mechanisms	• New revenue model
Value chain	• Dedicated roles for service development • A structured service development process • A new reward system • Extending the resource base
Value network	• Finding partners that can add value to the new offerings
Competitive strategy	• Branding • Differentiation
Target market	• New customer segmentation

Finally, (Chan, Hubert C. Y., 2015) creates a **two-dimensional business model framework** containing parameters to analyze how a firm's collaborator provide value in the network. "Traditional business models are designed on a firm-centric basis; however due to the nature of the **Internet of Things ecosystem** in which firms must collaborate with competitors and across industries, it is easy to see why traditional business models are not adequate. Moreover, fast changing market environments in technology-related industries implies that companies must quickly adjust to market challenges to succeed" (Chan, Hubert C. Y., 2015).

(R.M. Dijkmana, et all, 2015) developed a business model framework for Internet of Things applications using an empirical research methodology, based on a literature review and interviews with 300 respondents using a structured business model canvas. From the literature review, the article highlights nine components of IoT business models: **key partners**, key activities, key resources, **value propositions**, customer relationships, channels, customer segments, cost structure and revenue streams. Comparatively with (Chan, Hubert C. Y., 2015), (R.M. Dijkmana, et all, 2015) also points out the importance of **key partners** which can be related to the **value network** highlighted in (Chan, Hubert

C. Y., 2015). The interviewed persons belonged to 11 different companies in the different sectors of Internet of Things applications, such as smart home, smart buildings, healthcare, transportation, agriculture, energy and supply chain.

Table 2. Business model framework for IoT Applications (R.M. Dijkmana, et all, 2015)

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Hardware producers Software developers Other suppliers Data interpretation Launching customers Distributors Logistics Service partners	Customer development Product development Implementation; Service Marketing; Sales Platform development Software development Partner management Logistics	Newness Performance Customization „Getting the job done" Design Brand/status Price Cost reduction Risk reduction Accessibility Convenience/usability Comfort Possibility for updates	Personal assistance Dedicated assistance Self-service Automated service Communities Co-creation	Mass market Niche market Segmented Diversified Multi-sided platforms
	Key Resources		**Channels**	
	Physical resources Intellectual property Employee capabilities Financial resources Software Relations		Sales force Web sales Own stores Partner stores Wholesaler	

Cost Structure	Revenue Streams
Product development cost IT cost Personnel cost Hardware/production cost Logistics cost Marketing & sales cost	Asset sale Usage fee Subscription fees Lending/renting/leasing Licensing Brokerage fees Advertising Startup fees Installation fees

"The survey indicated that the **value proposition** is the most important building block in Internet of Things business models …" (R.M. Dijkmana, et all, 2015), besides the value proposition, the "**customer relationships** and **key partnerships** are also considered to be important building blocks in Internet of Things business models. Taking the key partnerships results, software developers, launching customers, hardware partners and data analysis partners are the most important partnerships types to shape in Internet of Things business models …" (R.M. Dijkmana, et all, 2015). This Master Thesis considers that partnership is a key aspect to create value in the technological area of the Internet of Things, as it drives fast development and innovation cycles, allowing the target organization to keep its competitiveness. However, it is important to understand the value proposition of each partner to ensure they are creating value in the network or in the strategic alliance.

(Högnelid P., Kalling T., 2015) proposes another theoretical framework to understand the different types of business models and value creation for Internet of Things so that firms can remain competitive, because of the external changing environment caused by a technology disruption. This business model framework analyses the Internet of Things based on resourcing, transaction costs, value chain analysis, strategic networks, and Schumpeterian innovation, for examining how value is created. (Amit, R., Zott, C., 2001) argues that there are four sources of value creation, namely **efficiency**, **complementarities**, **lock-in** and **novelty**, from which (Högnelid P., Kalling T., 2015) adopted as perspectives to understand value creation in the Internet of Things business.

Table 3. Empirical Illustrations of the Business Model construct based on capabilities of Smart, Connected Products (Högnelid P., Kalling T., 2015)

		Capabilities of smart, connected products			
		Monitoring	*Control*	*Optimization*	*Autonomy*
Business model construct	*Transaction Structure*	• General Electric fuel-use analysis for Alitalia • Just-in-time deliveries (conceptual) • Uber	• Remotely control enforce speed limits for cars (conceptual) • Road pricing (conceptual)	• Remote software upgrade of "Insane mode" in Tesla S P85D	• NFC payments in public transport (conceptual)
	Transaction Content	• Jawbone UP • Pebble Time • Vattenfall Energy Watch	• Pebble Time • Vattenfall Energy Watch	• General Electric fuel-use analysis for Alitalia • Farm equipment system (conceptual) • Farm management system (conceptual)	• Smart Home systems (conceptual) • Smart Grids (conceptual)
	Transaction Governance	• Ownership and control of data generated in Smart Home systems (conceptual)	• Security solutions, verification (conceptual) • Green and trimmed lawn product-as-a-service (conceptual)	• Interoperability between systems (conceptual) • AllSeen Alliance • Open Interconnect Consortium • Self-driving car fleets (conceptual	• Prosumer implications (conceptual) • Distributed generation of energy in Smart Home systems (conceptual) • Smart Grids (conceptual)

Based on the reviewed Internet of Things business models, this Master Thesis concludes that the concepts of supply chain and value chain alone are not sufficient to describe the Internet of Things business models for the target organization, instead key partnerships and Innovation capabilities are extremely important to truly create value through value networks and strategic alliances.

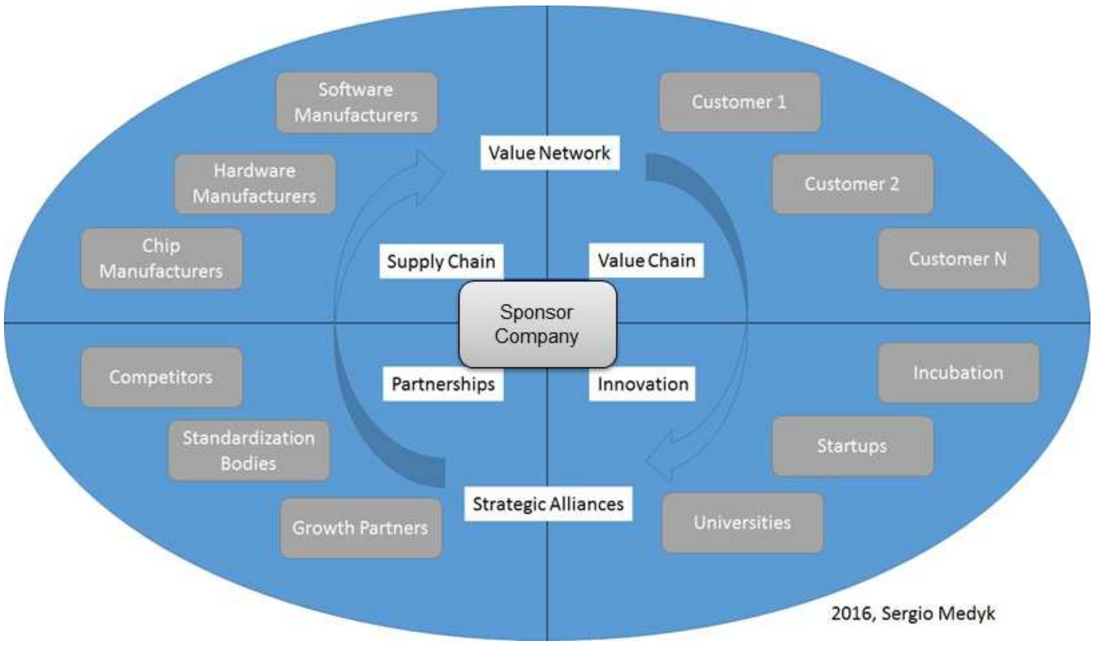


Figure 9. Internet of Things Business Model Summary

3.1.2 IoT Hardware and Embedded Systems

The selection of appropriate **IoT hardware and embedded systems** partners to participate in the value network of the target organization is fundamental to drive some of the most important criteria for the IoT functionality: **standardization**. Standardization is important to ensure **interoperability**, **compatibility of products**, **security** and to **prevent complex integration issues**. The lack of open standards can delay an IoT project and affect the company's ability to deliver its solutions. Therefore, standardization is relevant in defining business models with IoT hardware and embedded systems partners, as it can facilitate and enable value creation through collaboration and innovation. This chapter highlights the technological aspects of the IoT, which will enable **standardization** and allow companies to provide integrated solutions.

One of the main areas that must be considered when developing IoT solutions is the availability of connectivity in the embedded hardware and sensors that are monitoring the physical devices. Several connectivity standards have been developed throughout the years and the following ones have been widely used for IoT:

Table 4. IoT connectivity options

	ZigBee is an open technology standard for 10-100 meters. It provides low-power with low-cost technology. It is used in Wireless Sensors Networks (WSNs). It allows long battery life devices.
	Bluetooth Smart is a low energy version of Bluetooth for short-range communication (up to 50 m), but suitable for low-power, control and monitoring applications.
	Low power, long-range Wi-Fi HaLow^{TM} standard extends the application of Wi-Fi networks to meet the IoT requirements (e.g., smart grids, industrial automation, environmental monitoring, healthcare, fitness systems).
	Low Power Wide Area (LPWA) networks focus on low-end IoT applications, with low cost devices, long battery lifetime, small amounts of data exchanged, and an area for which traditional cellular systems are not optimized. It operates in unlicensed spectrum, and it is currently available in many different solutions (LoRa Alliance, Sigfox, Weightless, EC-GSM-IoT, NB-IoT, etc). The LoRa Alliance, Sigfox, Weigthless, the target organization, mobile operators and 3GPP are engaged in LPWA standardization activities, aiming towards licensed spectrum, to overcome interoperability issues. LPWA will allow interconnecting a large number of low-cost devices, making the IoT business profitable. EC-GSM-IoT and NB-IoT are especially important as it allows IoT applications to connect via cellular telecommunications networks using GSM and LTE respectively.
	The evolution of 2G, 3G and 4G was mainly driven by voice, increased data and broadband experiences such as video calls. The evolution of 5G will instead be driven by connected machines, which power the concept of the Internet of Things. This cellular network will be IoT ready to support a wide variety of applications in all business verticals. Standard is expected to be ready by 2020.

	ZigBee	BLE	LP-Wifi	LPWA	3GPP Rel8	LTE Rel13 & NB-IoT
Scalability	✗	✗	✓	✗	✓	✓
Reliability	✗	✓	✓	✗	✓	✓
Low Power	✓	✓	✓	✓	✗	✓
Low Latency	✗	✓	✓	✗	✓	✓
Large Coverage	✗	✗	✓	✓	✓	✓
Low module cost	✓	✓	✓	✓	✗	✓
Mobility support	✗	✗	✗	✗	✓	✓
Roaming support	✗	✗	✗	✗	✓	✓
SLA support	✗	✗	✗	✗	✓	✓

Figure 10. Comparison of IoT Connectivity Options

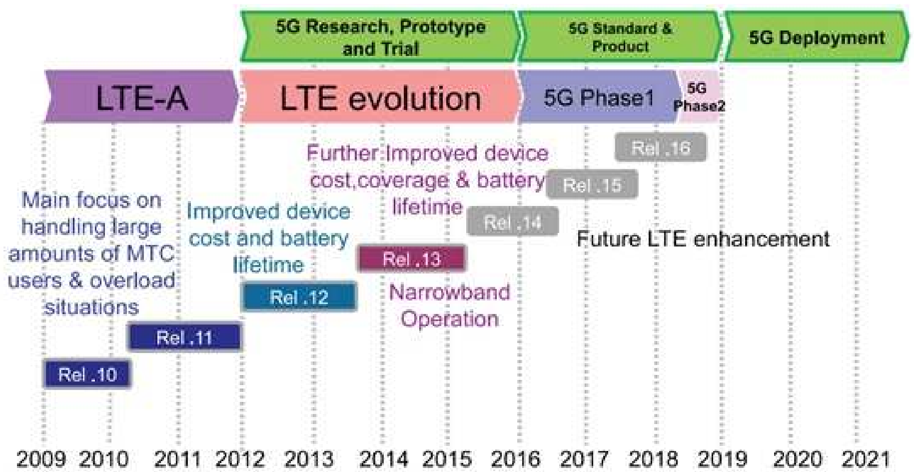


Figure 11. LTE to 5G evolution (3GPP)

True Internet of Things connectivity is likely to be enabled by Low-Power Wide Area (LPWA) standards such as NB-IoT and the future 5G cellular networks. IoT hardware and embedded systems partners must demonstrate their capabilities with these standards to succeed. Furthermore, “to enable the ubiquitous connectivity required for many of the IoT applications, many more features and functionalities will need to be added. This inherently leads to a strong heterogeneous networking (HetNet) paradigm with multiple types of wireless access nodes (with different MAC/PHY, coverage, backhaul connectivity, QoS design parameters, among others). HetNet’s will offer the required seamless connectivity for the emerging IoT through a complex set of mechanisms …” (Palattella, M. R. et. all, 2016).

In addition to connectivity capability and standard protocols, hardware partners must demonstrate their capabilities for the battery duration. “A battery lifetime of 10 years is already feasible for infrequent data transmissions with both LPWA technologies and in LTE Rel-12; the challenge for 5G may be to allow battery lifetime of more than one decade also for more frequent data transmissions …" (Palattella, M. R. et all, 2016).

Finally, hardware partners must be compatible with a variety of sensors, which will monitor the physical attribute of a certain device. For example, "in the smart city market, the city hall could use smart parking sensors, smart garbage bin sensors and/or smart street-lighting sensors. The smart parking sensors are not only able to guide drivers to vacant parking spots (and thereby reducing driving time, pollution, etc.) but also correlate the occupancy data with the payment data; the latter allows infringements to be spotted more efficiently and thus improve the city's financial income from parking. The smart bin sensors can detect when exactly the bin needs to be emptied, thereby improving pick-up schedules and saving money to the city hall. The smart street lighting sensors are able to regulate the usage of the lamps according to ambient light conditions, as well as movement in the street (i.e. if nobody passes at 3am in the night, they switch off); this yields an estimated saving of 30% in the electricity bill in cities …" (Palattella, M. R. et all, 2016).

3.1.3 IoT Platforms

The Internet of Things ecosystem consists of a vast amount of hardware partners, embedded software and software partners, cloud infrastructure partners, application and analytics partners, mobile infrastructure and mobile operator's partners, which provide a wide variety of products and solutions through several business verticals as discussed in the previous chapters. Therefore, the Internet of Things market generates a huge amount of data that is collected and analysed to produce the expected value. At the heart of the Internet of Things architecture is the **IoT Platform**. The IoT platform, as defined by ThingWorx (an IoT platform partner), "exists independently between the hardware and the application layers of the IoT technology stack. The ideal platform will integrate with any connected device and blend in with device applications, and enable implementation of IoT features and functions into any device in the same way".

Without a standard definition, the IoT platforms should provide and be evaluated based on the following (at minimum) (Krell M.; Forbes, 2015):

- Network and device connectivity
- Cloud-based capabilities
- Monitoring, controlling, optimization, automation

- Data collection
- Data aggregation
- Ensure that data collection is performed securely
- Manage devices and sensors from a wide variety of vendors
- Localized analytics
- Integrate with 3rd party systems
- Provide standard and open APIs for interoperability
- Support for at least standard IoT MQTT, HTTP/HTTPS protocols
- Security
- Management and automation
- Application enablement
- Big Data Analytics
- Dashboard generation

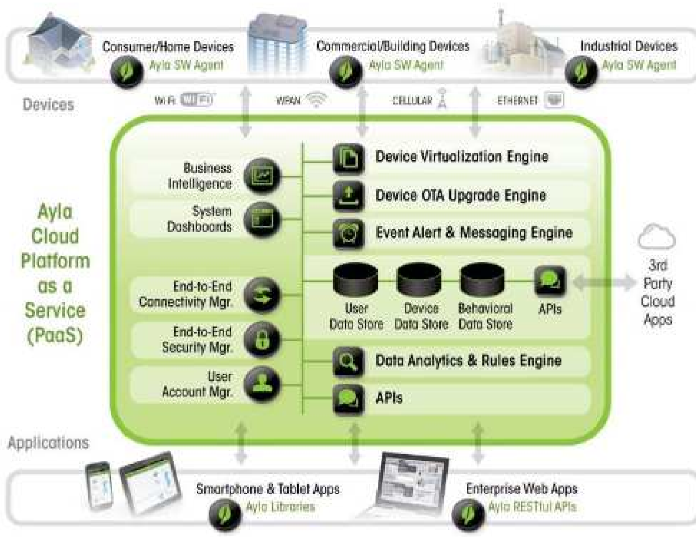


Figure 12. IoT Platform Requirements in General (Ayla Networks, 2016)

Some of the components forming an IoT platform are: “connectivity & normalization, device management, database, processing & action management, analytics, visualization, additional tools and external interfaces …” (Scully P., 2016). These components are described in Figure 13.

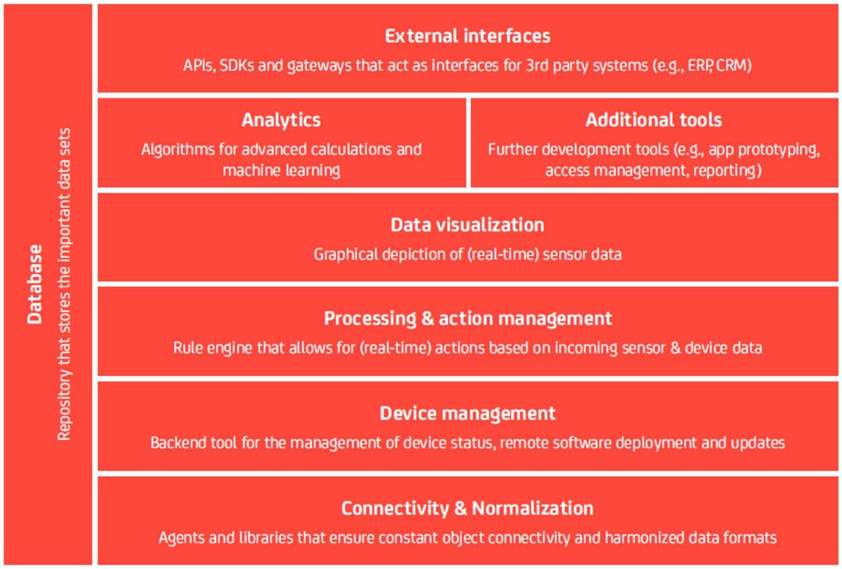


Figure 13. IoT Platform Architecture (Scully P., 2016)

From a business perspective, “there are several companies entering the IoT Platform market. Amazon Web Services, IBM Bluemix, ThingWorx, Bosch IoT Suite, EVRYTHNG IoT Platform, etc, are among the many entrants on this market, which is expected to generate $1.6 billion …” (IoT Analytics, 2016).

3.1.4 IoT Applications

Several businesses around the world are adopting the Internet of Things because there are **clear benefits** and **true business opportunities**. Internet of Things data enables businesses to be more competitive, as data gets integrated into enterprise resource planning (ERP) systems more effectively. There are great potentials for return on investments (ROI), thus the Internet of Things is expected to go from hype to solid growth and to gain awareness among public and private sectors, consumers and companies all around the world. “New connected solutions are a top priority for future development in the society …” (Vodafone, 2016). Therefore, the target organization of this Thesis shall ultimately understand its position in the IoT application market. As a mobile infrastructure vendor, it is most likely not acting directly to consumers, so it does not take a traditional position as a hardware or software vendor. In the Internet of Things business model, the target organization is likely to take a position as an Internet of Things service aggregator or system integrator. This means that “the organization is responsible to ensure the end-to-end quality and security of an Internet of Things project …” (Vodafone, 2016). To do so, it has also to understand all the IoT business verticals and applications that can be derived. Vodafone's Barometer from 2016, identified six main projects which have been launched by companies who have been actively delivering IoT solutions:

1. **Optimization of the usage of assets and vehicles (56%)**: fleet management and remote machinery monitoring
2. **Reducing facilities operating costs (48%)**: smart buildings and automation
3. **Improved safety (46%)**: connected security cameras, worker tracking or pipeline monitoring
4. **Supply-chain automation (42%)**: asset tracking, connected vending machines and digital signage
5. **Build new connected products and services (41%)**: connected home, usage-based insurances and remote health
6. **Improving efficiency of public spaces (40%)**: smart bins, connected street lighting or other smart cities applications

Also, a report from (IoT Analytics, 2016) indicates that the top priorities of the IoT application development are the connected industry, smart city, smart energy and connected car applications.

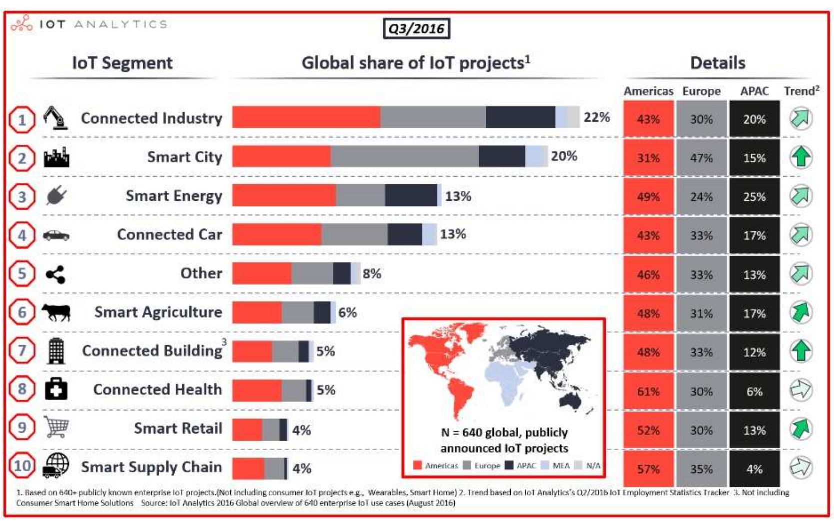
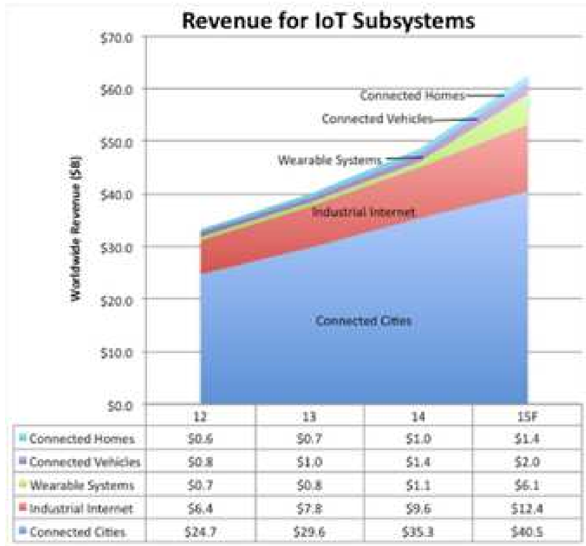


Figure 14. IoT Application Segments (Bartje J., 2016)

In this Master Thesis, the Smart City IoT application is selected for further research and is described in Chapter 3.2. The reason for the selection is based on the revenue stream that it can produce to the target organization as seen in Figure 15.



	12	13	14	15F
Connected Homes	$0.6	$0.7	$1.0	$1.4
Connected Vehicles	$0.8	$1.0	$1.4	$2.0
Wearable Systems	$0.7	$0.8	$1.1	$6.1
Industrial Internet	$6.4	$7.8	$9.6	$12.4
Connected Cities	$24.7	$29.6	$35.3	$40.5

Figure 15. Revenue for IoT Applications, Smart Cities dominance

3.2 What is a Smart City? How do we identify its IoT needs?

"The world population in 2015 is 7.3 billion people and it prospects to raise to 9.7 billion by 2050. Globally, over half of the world's population is living in urban areas. By 2050, 66% of the world's population is projected to be urban. As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities" (UN Department of Economic and Social Affairs, 2015). "Cities face a variety of urban problems such as bad ecology, insufficient transportation, high unemployment statistics, increasing criminal activity rates and others. Many local authorities are making steps towards resolving these issues in a traditional manner: urban development programs, policy regulation, penalty measures, etc. Some of the governments are making an extra step by developing an idea to make a city "smarter" …" (Sashinskaya M., 2014). In the book City 2.0 with The Atlantic Cities, sponsored by TEDCity2.0, "…cities are hubs of human connection, fountains of creativity, and exemplars of green living. Yet at the same time, they still suffer the symptoms of industrial urbanization: pollution, crowding, crime, social fragmentation, and dehumanization. Now is the time to envision what cities can be and to transform them". Taking these challenges into context, a smart city could be defined as follows: "A smart city is an urban area where people live in harmony, in healthy conditions, in an economic environment surrounded by green sustainable mobility, and by a city government making transparent and righteous bi-lateral decisions" (Gonçalves, 2016). Because of the growing importance in urban development, the Smart Cities concept has been introduced in the agenda of a growing number of cities around the world.

In Europe, an initiative has been established to bring together cities, industry, banks, small and medium size enterprises (SMEs), academics and other smart city actions named *European Innovation Partnership on Smart Cities and Communities* (EIP-SCC).

The objectives of the initiative are to (EIP-SCC, 2016):

- Improve citizens' quality of life
- Increase competitiveness of Europe's industry and innovative SMEs
- Make cities more competitive and better places to live
- Share knowledge to prevent mistakes being repeated
- Reach energy and climate targets
- Support in finding the right partners and solutions

EIP-SCC defines six action clusters for smart cities, such as Business Models, Finance and Procurement, Citizen Focus, Integrated Infrastructures and Processes (including Open Data), Policy & Regulations / Integrated Planning, Sustainable Districts and Built Environment and Sustainable Urban Mobility.

The Vienna University of Technology created a smart city model to benchmark Smart Cities "in cooperation with different partners and in the run of distinct projects financed by private or public stakeholders and actors" (EIP-SCC, 2016). According to their Smart City model as defined in a so-called European Smart Cities 4.0 project, a city is defined as "smart" when it performs well in six key fields of urban development, each key field including 27 domains. Domains are given an indicator level that accounts for the final data result.

Table 5. Smart City Key Fields of Urban Development (European Smart Cities 4.0, 2015)

Key Fields	**Urban Development Domains**
Smart Economy	Innovative spirit
	Entrepreneurship
	City image

	Productivity
	Labour Market
	International integration
Smart Mobility	Local Transport System
	International accessibility
	ICT-Infrastructure
	Sustainability of the transport system
Smart Environment	Air quality (no pollution)
	Ecological awareness
	Sustainable resource management
Smart People	Education
	Lifelong learning
	Ethnic plurality
	Open-mindedness
Smart Living	Cultural and leisure facilities
	Health conditions
	Individual security
	Housing quality
	Education facilities
	Touristic attractiveness
	Social cohesion
Smart Governance	Political awareness
	Public and social services
	Efficient and transparent administration

For many years, the concept of cities that utilize digital and smart technology (ICT) has existed, but only during the latest years the attention about this topic has a peek. There are several reasons about this evidence: the **larger diffusion of mobile devices and the Internet** among citizens, the higher dimensions of cities, the need to safeguard the environment from pollution and energy consumption (Dameri R. P., Rosenthal-Sabroux C., 2014). The business vision of a smart city is strongly based on the pivotal role of technology, especially the ICT. It derives from both the previous idea of digital city, and from the strong need to solve concrete problems affecting the life in large metropolis, such as traffic, pollution, energy consumption, waste treatment, water quality. These aspects are also near to the idea of green city and the environmental themes are an important part of the smart city goals. In this smart city vision, initiatives to improve the city smartness are especially focused on some lines such as:

1. Energy production from renewable sources, to reduce energy cost, CO_2 emissions and to satisfy the increasing energy demand in urban areas;
2. Building efficiency, to reduce energy demand and consumption;
3. Local transport quality and greenness, to reduce pollution deriving from transport in cities;
4. And so on.

“A key smart city includes smart transportation, safety, smart healthcare, entertainment and tourism, smart environment, utilities, government and commerce services initiatives. Also, a successful smart city strategy includes building long-term relationships, local or central government commitment, defining a vision for the future, taking a standard based approach, creating investment opportunities and engaging citizens through the use of technology …” (GSMA, 2016).

Table 6. Smart City Services (GSMA, 2016)

Key Fields	**Urban Development Domains**
Transport	Public Transport
	Traffic Management
	Parking
Safety	Street Lighting
	Crowd Control
	CCTV
Healthcare	Disease Control
	Emergency Response
	Patient Authentication
Entertainment and Tourism	Event Management
	Recreation Facilities
	Shopping Malls
Environment	Air Quality
	Weather Sensing
	Flood Control
Utilities	Smart Metering
	Waste Management
	Flood Control
Government	Citizen Engagement
	Municipal Services
	Infrastructure Monitoring
Commerce	Delivery Logistics
	Retail

	Advertising

Helsinki, the capital of Finland, is a significant example of a smart city under development mainly due to its openness and innovative environment. For example, in Helsinki the administrative data of the city has been open to all citizens in digital format through the HRI (Helsinki Region Infoshare) project. This project covers six major cities in Finland (Helsinki, Espoo, Vantaa, Tampere, Turku and Oulu) and it is responsible to open data related to city planning and real estate, construction, culture, economy and taxation, education and training, environment and nature, health, housing, jobs and industries, law and legal protection, information and technology and other general information related to the city. The data is then public published as an Open API using the RESTfull API concept - over 1200 data sets have been published on the Helsinki Region Infoshare platform and numerous hackathons and open app competitions are held annually. This allows developers to create applications, which access this data, and produces some value to the city citizens. Business innovation and entrepreneurship is a result of this large possibility to increase a citizen awareness about its city. Both public and private applications are aimed so that to boost the local economy through the smart city concept itself (City of Helsinki, 2016).

Helsinki, "pilots its smart city projects through its Smart Kalasatama district, a city innovation platform where new solutions can be developed and tested in a living urban environment. Agile development and co-creation are core concepts in Kalasatama – residents are testers and initiators of smart services and new technology. The vision of Kalasatama is to become so efficient that residents will gain an extra hour of time every single day. Some projects include an automated waste collection system that reduces garbage truck traffic by 80-90%, smart grids and real-time energy monitoring to reduce energy consumption by 15%, and parking spaces with electric car charging. Commuters can subscribe to Mobility-as-a-Service packages with an app that plans ideal travel routes using all available modes of transport" (City of Helsinki, 2016).

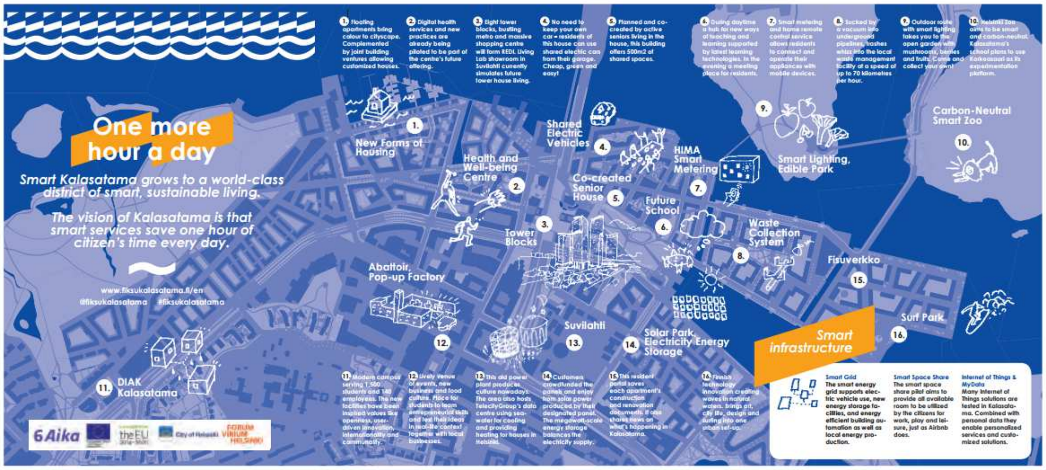


Figure 16. Smart Kalasatama Map in the City of Helsinki

The Smart Infrastructure includes,

1. New forms of housing
2. Health and Well-being Centre
3. Tower Blocks
4. Shared Electric Vehicles
5. Co-created Senior House
6. Future School
7. HIMA Smart Metering
8. Waste Collection System
9. Smart Lighting
10. Carbon Neutral Smart Zoo
11. DIAK Kalasatama
12. Abattoir Pop-up Factory
13. Suvilahti
14. Solar Park and Electricity Energy Storage
15. Fisuverkko
16. Surf Park

Another initiative known as bIoTope is working to build an Internet of Things open innovation ecosystem for connected objects. The project aims to provide open APIs to enable horizontal interoperability for vertical applications, enable value co-creation, improve security, develop smart city pilots and enable governance for the ecosystem orchestration.

The bIoTope project has a partner ecosystem including the BMW Group, Fraunhofer Institute, several universities and open standard bodies.

The bIoTope project is described in Figure 17.

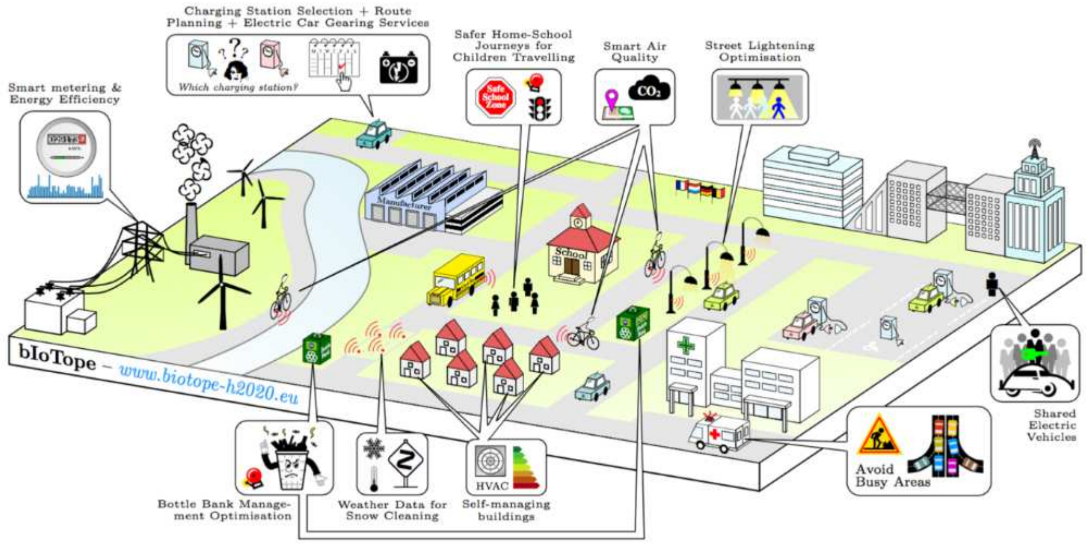


Figure 17. Smart City Concept (bIoTope, 2016)

The bIoTope project considers the following areas relevant for a Smart City:

1. Smart metering and Energy Efficiency
2. Charging Station Selection + Route Planning + Electric Car Gearing Services
3. Safer Home-School Journeys for Children Travelling
4. Smart Air Quality
5. Street Lightening Optimization
6. Shared Electric Vehicles
7. Avoid Busy Areas for Emergency Transportation Vehicles
8. Smart Buildings
9. Smart Weather Data for Snow Cleaning
10. Smart Waste Management

The bIoTope project works in cooperation with Forum Virium Helsinki, who aims to build a Smart City in the Helsinki region in an area called Kalasatama. Forum Virium takes as references six components described by the urban strategist Boyd Cohen:

1. Smart People: citizens participating in decision making

2. Smart Mobility: prevention of traffic jams with the support of IT systems
3. Smart Living: health and safe environment
4. Smart Governance: transparent administration driven by open data
5. Smart Economy: entrepreneurship and innovation
6. Smart Environment: energy efficiency management

Forum Virium and the bIoTope project are developing trials for the Internet of Things in the Smart Kalasatama area in the Helsinki region. The following pilots are ongoing: Smart Building and New Charging Facility Management.

1. **Smart Building**:

The objective of the system is to detect autonomously abnormal behaviours based on pre-defined optimal plans, thresholds, historical data, best practice data from similar installations, online data from IoT sensors, etc. and react in the best possible way according to a pre-defined process. The main benefits are:

1. Better safety and less manual involvement of maintenance personnel
2. Better view and monitoring of the house equipment to react faster and save maintenance costs
3. Less routes and manual work
4. Optimization of asset management, less damages and cheaper insurance

2. **New Charging Facility Management**:

The objective of the system is to add new charging stations with IoT sensors and have them part of a car navigation system, integrated with payment. The main benefits are:

1. Suppliers can add their facility to the charging station system
2. Platform provider can provide the possibility to integrate the facility to the car navigation and payment system
3. Car drivers can choose which charging station to use and receive notifications about the nearest station and best route
4. All of them integrate into an application
5. Save costs for car drivers and a greener environment

3.3 Partner Selection Criteria

3.3.1 Scientific Articles

A typical partner selection, as defined in (Duysters, G.,1999), can be described as "a linear process that will involve identifying the motivation for the strategic alliance, each partner alternative characteristics, the partner selection criteria method and the partner selection result".

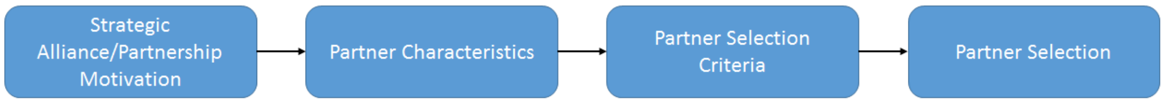
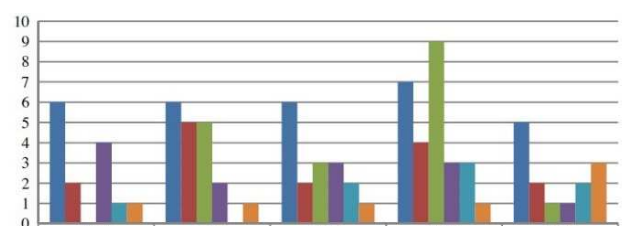


Figure 18. "Rational Partner Selection." (Anne Banks Pidduck, 2006)

"Entering technology intensive emerging markets, such as the **Internet of Things**, requires intense collaboration with external partners …" (Doz, 1998), so a vital question for firms upon entering an emerging market is how to decide whom to ally. "The partner selection can be a factor that influences on the performance of strategic alliances, as the performance of an organization is related to the performance of its collaborated vendors …" (Dyer & Nobeoka, 2000).

Several "partner", "vendor", "supplier" selection processes can be identified from the literature for decision making when building supply chains, partnerships and strategic alliances. Most of the selection processes are based on traditional supply chains, focusing their selection mechanisms and evaluations from a supply chain management perspective for manufacturing and logistics. In manufacturing and logistics, the cost, location, lead-time and other factors may seem relevant. However, when taking a technological perspective from the Internet of Things and the digital transformation that it brings, it is not enough to use typical supply chain selection processes for IoT partners. IoT requires constant and fast-paced innovation as well as a competitive advantage that is not only drive by cost but by the value of the product. Therefore, this chapter provides a summary of scientific articles as part of the literature review for partner selection, which are mainly focused in identifying general criteria that could be applied for Internet of Things partners. The review is limited as (J. Chai et al., 2013) already provides a systematic review of the literature in the article "*Application of decision-making techniques in supplier selection: A systematic review of literature*". The review focus on partner selection methods that could add value from a technological point of view. The purpose is to combine the best practices from the current decision making and partner selection methods adding components for IoT use cases and empirical ideas from the Internet community which could be used to proper select what are the best partners to form a strategic alliance.

According to (J. Chai et al., 2013) literature survey, at least 26 decision making techniques can be identified for partner selection and evaluation. These 26 decision-making techniques are classified into three areas: (1) **Multiattribute decision making** (MCDM) technique, (2) **Mathematical programming** (MP) technique (3) and **Artificial intelligence** (AI) technique. MCDM "is a methodological framework that aims to provide decision makers a knowledgeable recommendation amid of finite set of alternatives" (J. Chai et al., 2013). The most common MCDM methods are the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP) and Technique for order performance organization method for enrichment evaluation (TOPSIS). Among all the literature surveyed by (J. Chai et al., 2013), AHP, ANP and TOPSIS are represented by 63 scientific articles, 51.21% of the whole MCDM literature. Common MP techniques are known as Data Envelope Analysis (DEA), Linear Programming (LP) and Multi Objective Programming (MOP) which are represented by 45 scientific articles, 36.58% of the MP literature. Finally, AI techniques are comprised by another 12 methods being the most common one known as Genetic Algorithm (GA) with 6.5% coverage in the AI literature. Based on (J. Chai et al., 2013) research results, this personal assignment makes an empirical choice to focus on the MCDM technique as it contains the biggest number of representatives in the literature concentrated in specific methods, focusing mainly on the review of TOPSIS, AHP and ANP methods.



	2008	2009	2010	2011	2012
AHP	6	6	6	7	5
ANP	2	5	2	4	2
TOPSIS	0	5	3	9	1
DEA	4	2	3	3	1
GA	1	0	2	3	2
GST	1	1	1	1	3

Figure 19. "Chronological distribution of some major decision-making techniques." (J. Chai et al., 2013)

"Because of the emphasis on outsourcing, strategic partnering, strategic alliances, and relationship marketing, many organizations purchase not only raw materials and basic supplies but also complex fabricated components with very high value-added content and services over the last two decades. Vendor selection or supplier evaluation continues to be a key element in the industrial buying process and appears to be one of the major activities of the professional industrial". This definition by (W.E. Patton 1997), (R. Michaels, A. Kumar, S. Samu, 1995) suits to the current technological and digital companies which are supposed to choose the right partner to form an alliance, not only based on their ability to deliver, but also based on the value of their product. This definition was also a motivation for (H.-J. Shyur, H.-S. Shih, 2005) to define a hybrid MCDM model for strategic vendor selection by evaluating the partner using the multi-criteria decision-making (MCDM) technique. (H.-J. Shyur, H.-S. Shih, 2005) creates a five-step MCDM hybrid process, which incorporates the analytic network process (ANP) and Technique for order performance organization method for enrichment evaluation (TOPSIS) methods. The five-steps in the proposed model includes:

- **Step 1. Identification of necessary criteria for vendor selection.**
    - Selected criteria in (H.-J. Shyur, H.-S. Shih, 2005)
        - On-time delivery (Criterion 1)
        - Product quality (Criterion 2)
        - Price/cost (Criterion 3)
        - Facility and technology (Criterion 4)
        - Responsiveness to customer needs (Criterion 5)
        - Professionalism of salesperson (Criterion 6)
        - Quality of relationship with vendor (Criterion 7)
- **Step 2. Recognition of the interdependence between criteria.**
    - Selected interdependence (H.-J. Shyur, H.-S. Shih, 2005)
        - Price/cost may be influenced by the quality of products and the relationship with vendors. (Criterion 3 influenced by Criterion 2 and 7)
        - Product quality may be influenced by facility and technology. (Criterion 2 influenced by 4)
- **Step 3. Eliciting the weights of criteria based on (Saaty, 1980) using ANP method**
    - Decision maker 1

            - "Which criteria should be emphasized more in a vendor, and how much more?
            - "Which criterion will influence criterion C3 more: C2 or C7? And how much more?"
    - Decision maker N
- **Step 4. Evaluation of vendors using modified TOPSIS method**
    - The pair-wise comparison matrix for criteria
    - The degree of relative impact for evaluation criteria
    - A normalized decision matrix
    - A separation distance of the group
    - A final rank for the partner selection
- **Step 5. Negotiation for the purchase.**
    - Refinement and negotiation process to form the partnership

The above steps are summarized in the flow chart of Figure 20.

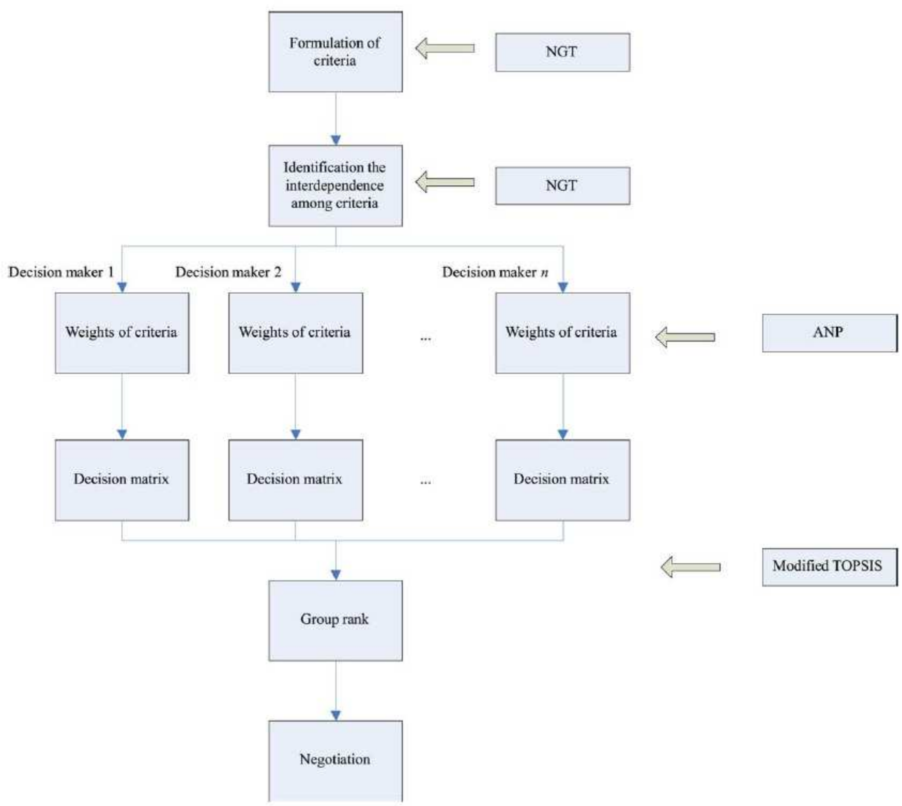


Figure 20. "The proposed framework for vendor selection." (H.-J. Shyur, H.-S. Shih, 2005)

Another partner selection criteria for strategic alliances was modeled by (Wann Yih Wua, Hsi-An Shih, Hui-Chun Chan, 2009) based on the ANP method. The identification of criteria is more detailed and wider than what was covered by (H.-J. Shyur, H.-S. Shih, 2005). (Wann Yih Wua, Hsi-An Shih, Hui-Chun Chan, 2009) provides a set of criteria and sub-criteria as follows:

- **Criteria/Sub-criteria**
  - **Characteristics of the partner**
    - Unique competencies (UC),
    - Compatible management styles (CMS),
    - Compatible strategic objectives (CSO),
    - Level of technical capabilities (TC)
  - **Marketing knowledge capability**
    - Increase market share (IMS),
    - Better export opportunities (BEO), and
    - Knowledge of local business practices (KLS)
  - **Intangible assets**
    - Trademarks, Patents, licenses, or other proprietary knowledge (PK),
    - Reputation (REP),
    - Previous alliance experiences (PAE),
    - Technically skilled (TSE)
  - **Complimentary capabilities**
    - Partners owned managerial capabilities (MC),
    - Wider market coverage (WMC),
    - Diverse customer (DC),
    - The quality of distribution system to those of the strategic partners (QDS)
  - **Degree of fitness**
    - The compatible organization cultures (COC),
    - Willingness to share expertise (ESE),
    - Equivalent of control (EC),
    - Willingness to be flexible of partners compatible with that of strategic partners (WF)

Except for the criteria definition, (Wann Yih Wua, Hsi-An Shih, Hui-Chun Chan, 2009) supplier selection process is very similar to (H.-J. Shyur, H.-S. Shih, 2005) proposed framework as it is still based on analytic network process (ANP).

- **Step 1. Decompose the problem**
- **Step 2. Define criteria for supplier selection**
- **Step 3. Design the hierarchy**
    - The hierarchy contains the strategic issues, criteria, sub-criteria and decision alternatives
- **Step 4. Perform pairwise comparison and prioritization**
- **Step 5. Calculate the weights of the criteria**
- **Step 6. Rate the alternative suppliers**
- **Step 7. Compute the overall score of each prospective partners**
- **Step 8. Make overall decision**

The Figure 21 describes the hierarchy of strategic alliance defined in (Wann Yih Wua, Hsi-An Shih, Hui-Chun Chan, 2009) to list the problem, criteria, sub-criteria and interdependency between each one.

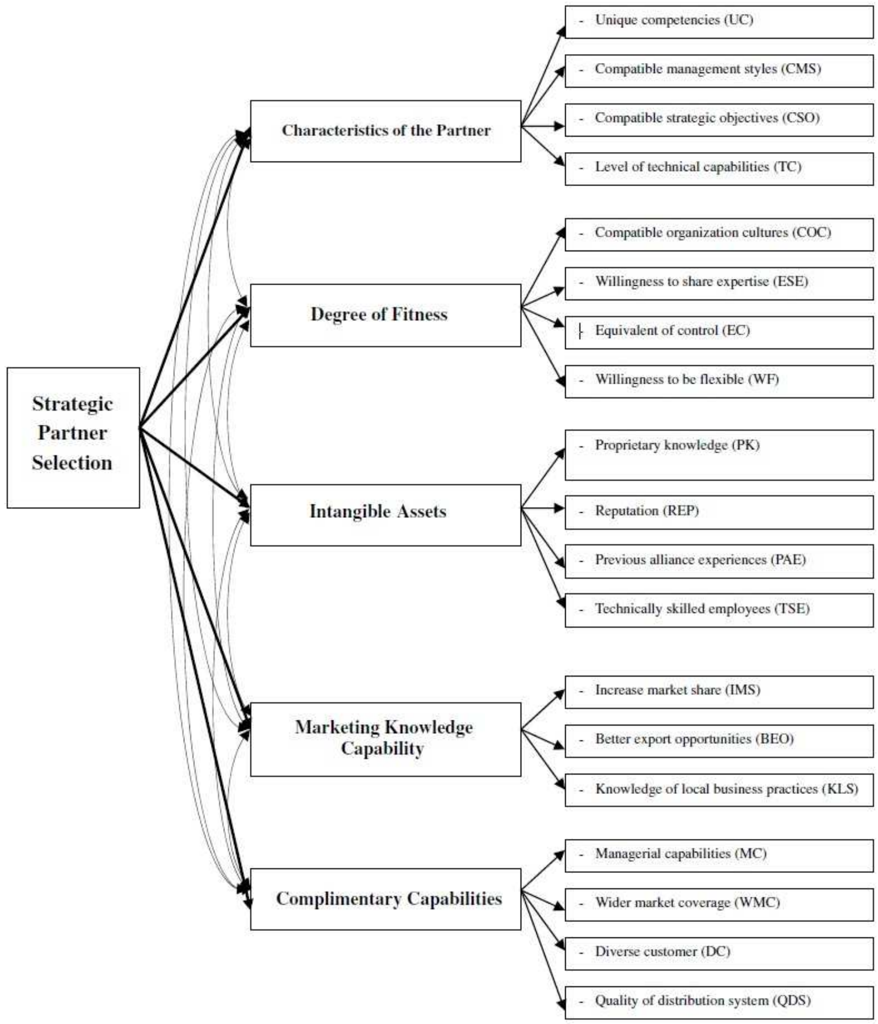


Figure 21. “Hierarchy of strategic alliance.” (Wann Yih Wua, Hsi-An Shih, Hui-Chun Chan, 2009)

The partner selection criteria defined by (Mazaher Ghorbani, Mahdi Bahrami, S. Mohammad Arabzad, 2012) is also based on MCDM, with a two-phased model for partner selection and order allocation. In the article, partners are evaluated to both qualitative and quantitative criteria using SWOT (Strengths, Weaknesses, Opportunities and Threats). Shannon entropy is used to calculate the weight of the criteria instead of previous scientific articles, which have used analytic network process (ANP). Finally, results are used as input for a mathematical technique based on the integer linear programming (ILP) to allocate order to partners. The proposed model in this article includes the following steps:

- **Step 1. Potential Partners are Listed**
  - First using SWOT, criteria are categorized into internal or external
  - Internal criteria

        - Price (C1)
        - Delivery (C2)
        - Quality (C3)
        - External criteria
        - Geographical Location (C4)
        - Financial Stability (C5)
        - Position in the Industry (C6)
        - Management (C7)
- **Step 2. Weight of criteria is defined by Decision Maker**
    - Grading scale
    - 1: Definitely unsatisfactory
    - 2: Almost unsatisfactory
    - 3: Unsatisfactory
    - 4: Average
    - 5: Satisfactory
    - 6: Almost satisfactory
    - 7: Definitely satisfactory
- **Step 3. Construct the decision matrix and apply Shannon entropy to determine to importance of each partner**
- **Step 4. Calculate the benchmark value as an average of the weighted values. Partners with criteria higher than the benchmark value will be identified with strength and opportunity**
- **Step 5. Integer linear programming is applied to determine the quantity of order for each partner**
- **Step 6. Build the SWOT matrix**

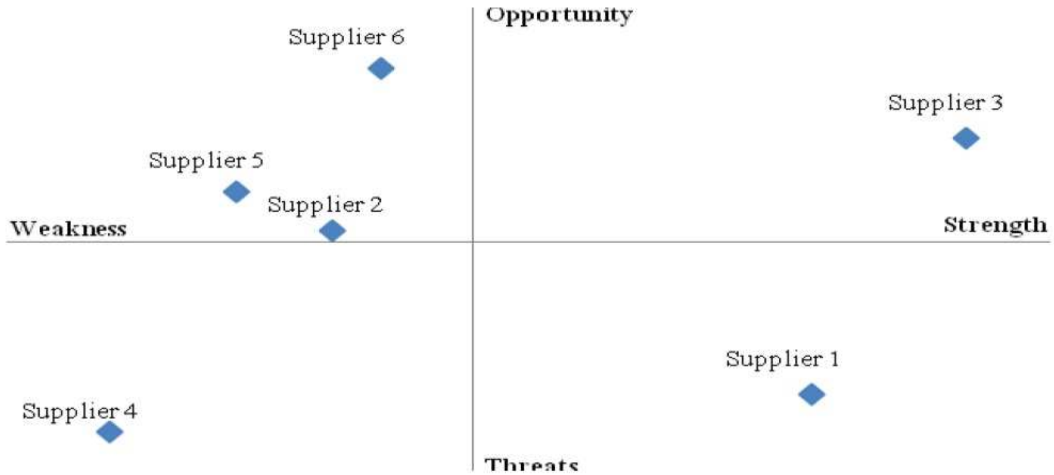


Figure 22. “Comparative analysis based on SWOT matrix.” (Mazaher Ghorbani, Mahdi Bahrami, S. Mohammad Arabzad, 2012)

The last scientific article studied as part of this literature review was (Pidduck, 2006), in which partner selection criteria is summarized. The article highlights the issues in identifying correct criteria, because criteria may change based on the partner resource availability and other factors. Therefore, the study points another important aspect which is related to a partner negotiation model. “A partner selection is a misnomer, but rather companies are dealing with a negotiation process: partner negotiation can begin with a partner, a funding agency, a champion, depending on goals or motivations. For one partner, the goal may be to find a partner or financial support to achieve a specific goal. Simultaneously, the financial supporters are looking for partners to work for them …” (Pidduck, 2006).

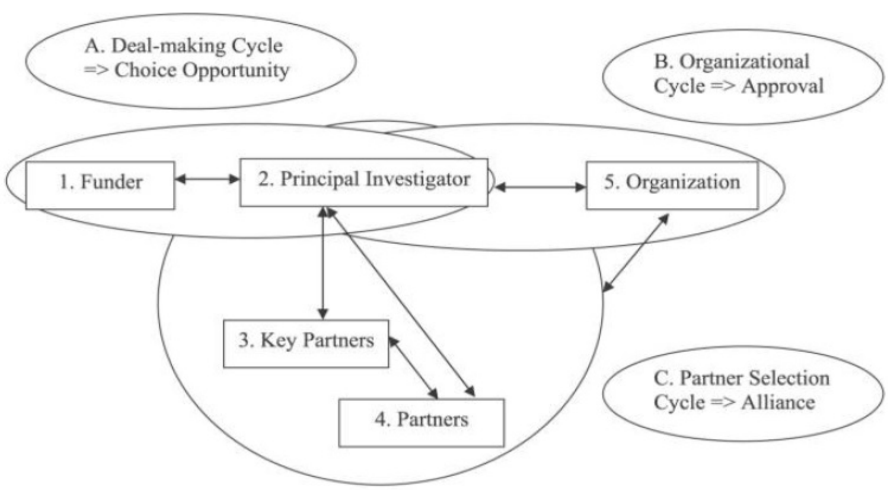


Figure 23. “Partner negotiation model.” (Pidduck, 2006)

In Figure 23, (Pidduck, 2006) divides the partner negotiation model into a deal-making cycle (A), an organizational cycle (B), and a partner selection cycle (C), which finally will form a strategic alliance with several appropriate partners. “There is negotiation and adjustment throughout the alliance formation process. First there is negotiation and adjustment of initial goals until a compatible match is found between the financing organization and the champion. Since both sides generally will want to make a deal, there is good reason to believe that they will find common ground. As part of this process, there is negotiation of the choice opportunity between the two sides. A second negotiation with each organization will finalize the specific deal and identify constraints. Third is the negotiation and adjustment of key partners, as first, second, and sometimes third choice partners are approached and accepted or rejected. Finally, negotiation of lesser partners with both the key partners and the principal investigator completes the partnership ...” (Pidduck, 2006).

3.3.2 Empirical Definitions

In addition to scientific articles, other definitions of partner selection methods have been added to this personal assignment as to highlight the empirical nature of defining a partner selection or negotiation method. Since this personal assignment is aiming at defining a criterion for IoT partners, grounding through scientific articles may not be sufficient since the technology is still emerging. Therefore, it is important to provide the view of the Internet community as this also contributes in creating the partner selection framework.

(Microsoft, 2015) announced key strategic partners for the adoption of the Internet of Things. “*Each of the Partners selected, BizData, CDM, Empired, Ignia, Mexia, Oakton, MOQDigital, RAMP RFID & Readify, is already working with clients in vertical markets including manufacturing, retail, health and defence. They are co-developing client solutions around asset management, smart building facilities, remote monitoring and predicative maintenance to create an ecosystem which integrates devices, connectivity and analytics through a cloud platform*”. Microsoft selected these partners based on their understanding of the digital transformation that is being accelerated by IoT and by the engagement in providing IoT solutions to its clients. It was also highlighted that these partners were able to make business adjustments to take advantage of the fast growing IoT market. It is also remarkable that these partners are small companies or often startups. This contributes to the position given by (Pidduck, 2006) that a fixed set of partner selection criteria would not be valid in this context. The funder company must select a variety of partners without a strong history in the supply chain, but that can adapt to the funders strategic goals. (Hamel, 1989) argue that "when seeking collaborators for technology-related projects, firms should seek partners whose strategic goals converge, while their competitive goals diverge*".*

Finally, (Casani, 2016) described an empirical way to select IoT providers using 3 major topics:

1) **Position in the IoT architecture stack**
    a. Companies offering hardware sensors and devices should create partnerships with software partners who will be able to collect data and develop applications
    b. Companies offering software or telecommunication services should create partnerships with hardware device vendors.
    c. The combination of hardware and software vendors are usually necessary to create a specialized environment for the development of IoT projects. Hardware vendors can provide smart sensors and software vendors can provide IoT platforms to manage back-end cloud services and front-end applications, providing open APIs, connectivity and handling security.
2) **Position as a System Integrator Partner**
    a. Partners should be selected based on their resource expertise which can be used for system integration activities
    b. Partners should have the willingness to share expertise in a strategic alliance by being loyal
3) **Partner Capabilities**
    a. **Experience**: there are partners who have IoT understanding from a business perspective, but few have hands-on experience with the actual technology. To select the correct partner, a company must make sure that it has real case studies and proof of concept demonstrated, for example, in technology events such as MWC (Mobile World Congress in Barcelona) or Slush in Helsinki.
    b. **Completeness**: select a partner who can offer an end-to-end IoT solution.
    c. **Scalability**: when billions of devices are connected, the data load increases will impose challenges. For example, latency or delay or affected user experience, which damages the product and reputation. Scalability is a required capability for IoT partners in hardware and software.

d. **Open API**: To avoid being locked in and building applications that are "isolated" from your business, it is important to select IoT solutions that support open standards and that can be integrated into the company systems.
e. **Trust:** Trust can be a combination of Stability, Reputation and Reliability. **Stability**, the corporate background should describe the capability of the vendor for a growth path; the choice of an IoT provider should be at least a medium-term decision. **Reputation** is checked by analysing the track record for security, privacy of user data, technical solidity and effective support. **Reliability**: IoT applications must be implemented according to specific needs, including required new features and the needed value.

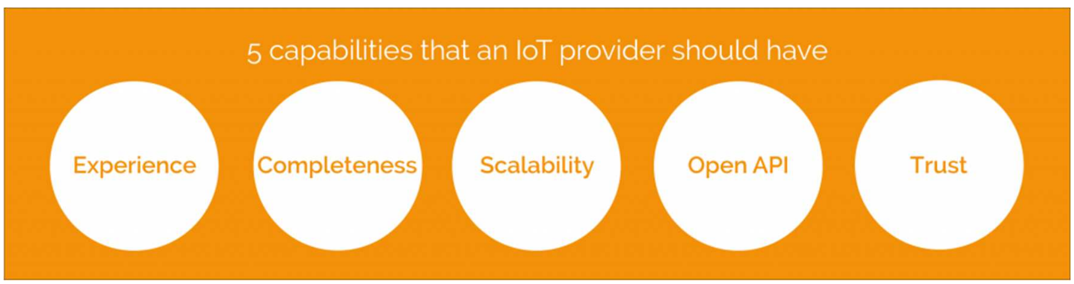


Figure 24. "IoT partner capabilities" (Casani, 2016)

3.4 Creating Value with External Partners

3.4.1 Value Creation

Customer loyalty in the modern economy cannot be relied as the threat of the competition or substitute products and technologies is very high, thus a company must always generate value for its products. Nowadays, an increasing number of corporations have invested in their value creation management models so that value is created along with customers and collaborating partners. It is meaningful to get insights from real customers and other similar companies in new product introduction projects so that the features under development are shaped per the market needs in a pro-active manner. "A value creation process ensures effective investments as well as increases the chance of a customer lock-in, as the technology or a product is created in collaboration. Technologies such as Cloud Computing, 5G and the Internet of Things, introduce new possibilities that must be addressed in innovative business models so that to generate revenues. Navigating through the world of smart, connected products requires that companies understand these rules better than ever …" (Porter M., 2014).

With the Internet of Things, capturing the value is part of the core innovation of this technology. As connected products are constantly sending their data to a Cloud, Big Data and Analytics can play a role in predicting customer requirements from which the value creation process can be started. For example, if a software company develops a platform to collect and centralize data from Internet of Things physical devices, it gains a competitive advantage over the commodity company developing the device itself. As an example, car manufacturers are traditional suppliers in the industry having the power to sell cars. However, software companies can disrupt the sector by developing car monitoring systems that produce more value than the car itself, as the data generated from the car can be used by a variety of other services, such as insurances, rental cars, fleet management, maintenance and repair services, etc. In this type of business model, the software company may generate more value from a car than the manufacturer itself as monitoring is the core element of value creation in this case. Therefore, major companies such as Audi, BMW and Volkswagen have been investing in Service design innovation and Software as a Service (SaaS) applications that can be delivered together with the car, but also separately to be used with any other car brand. However, building new technology stacks for smart and connected products such as Audi, BMW and Volkswagen cars require core competencies in technological areas not dominated by these companies. As a result, external collaboration with partners specialized in the Cloud or Internet of Things development is crucial for a traditional manufacturer to succeed. That is no exception for the target organization, even when it is also developing software applications for telecommunications infrastructure. "As new technologies are often disruptors, fast paced development and open innovation is required to succeed in a highly competitive environment. As value creation in traditional product mindset shifts from solving existing needs in a reactive manner to address real-time and emergent needs in a predictive manner, filling out well-known frameworks and streaming established business models will not be enough …" (Chan, Hubert C. Y., 2015). "Smart, connected products raise a new set of strategic choices related to how value is created and captured, how the prodigious amount of new (and sensitive) data they generate is utilized and managed, how relationships with traditional business partners such as channels are redefined, and what role companies should play as industry boundaries are expanded.

Data is a product. Understanding the value of the data is a competitive advantage" (Porter M., 2014).

3.4.2 Value Network Analysis

(Peppard J., Rylander A., 2006) highlights the value network concept and its value creation logic as a substitute for traditional value chains used by most companies. The article also introduces the network value analysis (NVA) to understand the competitive environments such as the ones mobile operators experience. Mobile operators have the challenge to generate revenues from the data traffic, but its growth has been saturated as already highlighted in Chapter 1.2. Other types of revenue streams, such as content publishing, have been considered by mobile operators while the competition from other broadcasters is extremely high. Therefore, mobile operators must create innovative mobile content and data services to succeed in their revenue models. In this competitive environment, analysing the value network is a key issue to understand the strategic alliances, competitors, partners and other business entities. The value chain and value creation concepts alone are not sufficient to get an entire view of the business ecosystem. Although the article is from 2006, and it was still focused on an earlier gross growth of mobile data through smartphones, it introduces a very important foundation for this Master Thesis. Nowadays, mobile operators do have the opportunity to increase their revenue with the business models that the Internet of Things is bringing in this decade. Therefore, if operators such as Elisa, Telia Sonera or DNA can retain not only consumers, but physical devices into their own networks it will create a huge opportunity to increase the data traffic and consequently revenues. As an example, Elisa has been working in their own Open Innovation challenge projects so that to enable collaboration with external partners, which are developing solutions for the Internet of Things using Elisa's own Internet of Things platform based on PTC's ThingWorx for rapid application development (ThingWorx, 2016).

The target organization, to succeed in this competitive environment, also must step up and introduce new innovations to retain the market value for itself. Despite of being a traditional telecommunications infrastructure vendor, it can also develop similar Internet of Things platforms to get market share in the Software as a Service area. To understand these business opportunities and needs, the organization needs to place itself in a networked business model where value is created in understanding the value of partner relationships. "We must therefore extend any analysis away from viewing value creation from the perspective of an organisation as an isolated unit to looking at how the organisation creates value within the context of the network. It is this network of relationships that provides the key to understanding the competitive environment in the network economy" (Peppard J., Rylander A., 2006). To understand this networked relationships, the articles uses the Network Value Analysis (NVA) method consisting of creating an overview (value network map) with all networking entities of the value network. Conclusions are taken based on the linkages and dependencies between the entities.

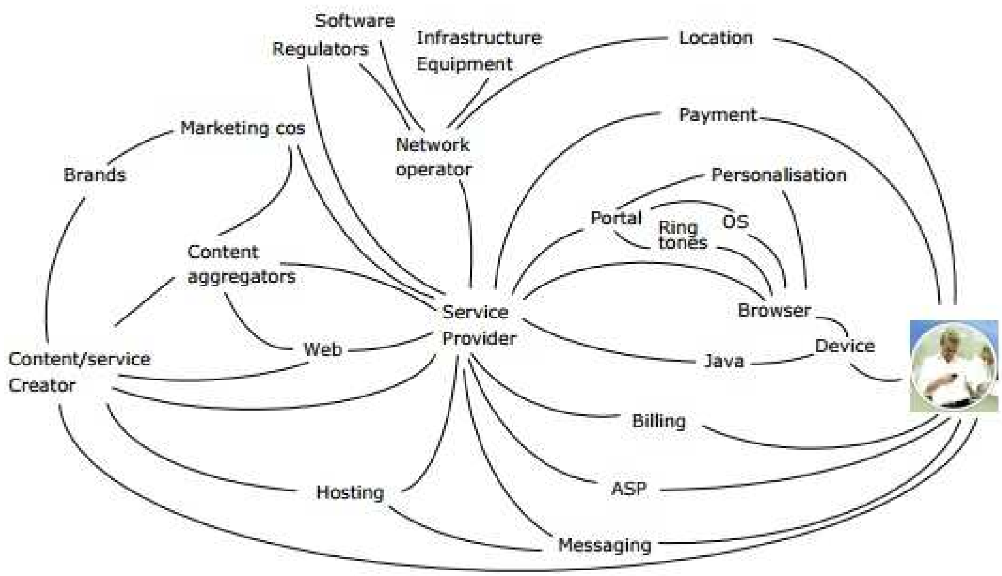


Figure 25. "Partial network value map for mobile content" (Peppard J., Rylander A., 2006)

3.5 Conceptual Framework

The conceptual framework of this Thesis is grounded in the Internet of Things business models described by (Chan, Hubert C. Y., 2015) and (R.M. Dijkmana, et all, 2015). In these business models, key partners are described as the major stakeholders in the Internet of Things ecosystem. Two elements of the described business models are highlighted in this Thesis: **value network** and **competitive strategy**. As described in Chapter 3.4.2, the key partners involved in the Internet of Things ecosystem are not linked to each other through a Value Chain but rather through a Value Network where value creation can be originated in many different relationships. Therefore, to maintain a company competitive strategy, a strategist must understand the value network involving the key partners generating value in the Internet of Things businesses. In addition to the value network awareness, a strategist must also understand how to properly select key partners through elaborated criteria so that to participate on its company's value network. From the literature research, there are not observations to how Internet of Things partners are selected so that to participate in one company value network. Furthermore, specific applications such as how Internet of Things partners are selected in the Smart City context is also not available. The Master Thesis process model includes two key areas: 1) **identifying Internet of Things partners for a Smart City using the partner selection framework** proposed in Chapter 3.5.1 and 2) **analyzing the value network using the network value analysis framework** proposed in Chapter 3.5.2.

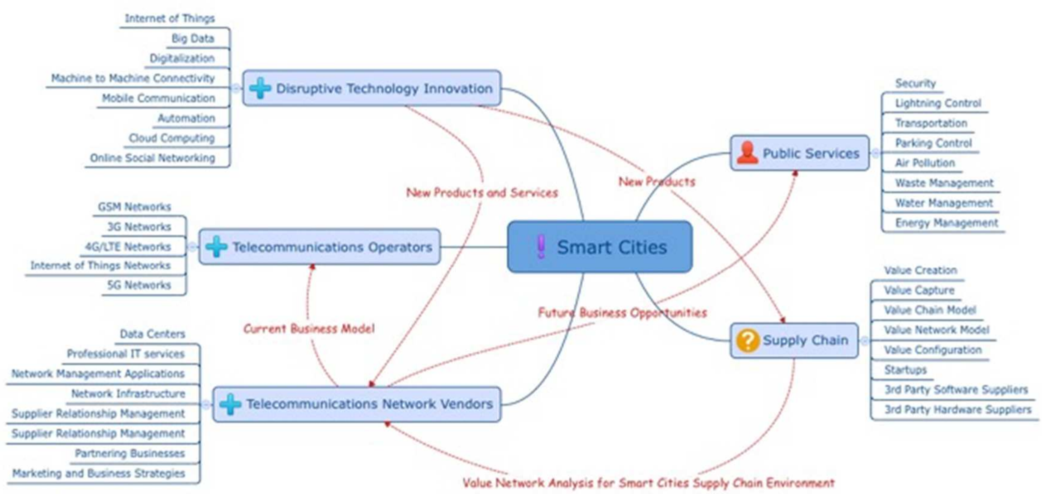


Figure 26. Conceptual Framework Mind Map

3.5.1 Partner Selection Framework

The partner selection framework developed based on the literature review starts with the identification of partner selection criteria that are applicable for Internet of Things partners and vendors. The selected criteria are grounded on scientific articles based on partner selection methods in supply chain as well as empirically defined based on business management reviews from a wide variety of sources. After having the definition of the partner selection criteria, each criterion is classified in a proper hierarchy so that the strategic alliance with partners can be formed based first on higher priority and interdependent criteria. Finally, each criterion is given a quantitative weight as defined in the Analytic Partner Selection Framework from (H.-J. Shyur, H.-S. Shih, 2005). The weight is defined based on interviews with major stakeholders from the target organization, here defined as the Decision Makers for the criteria weight. The weight is ranked based on (Saaty, 1980). This base ANP framework is used to conduct the evaluation of chosen Internet of Things partners for each area: hardware and embedded systems, platforms and applications in a Smart City context. Benchmarking and ranking is created based on the Integer Linear Programming (ILP) method (Mazaher Ghorbani, Mahdi Bahrami, S. Mohammad Arabzad, 2012). The partner negotiation model (Pidduck, 2006) is the final step, but is not included in this Master Thesis and will be considered suggestion for further developments.

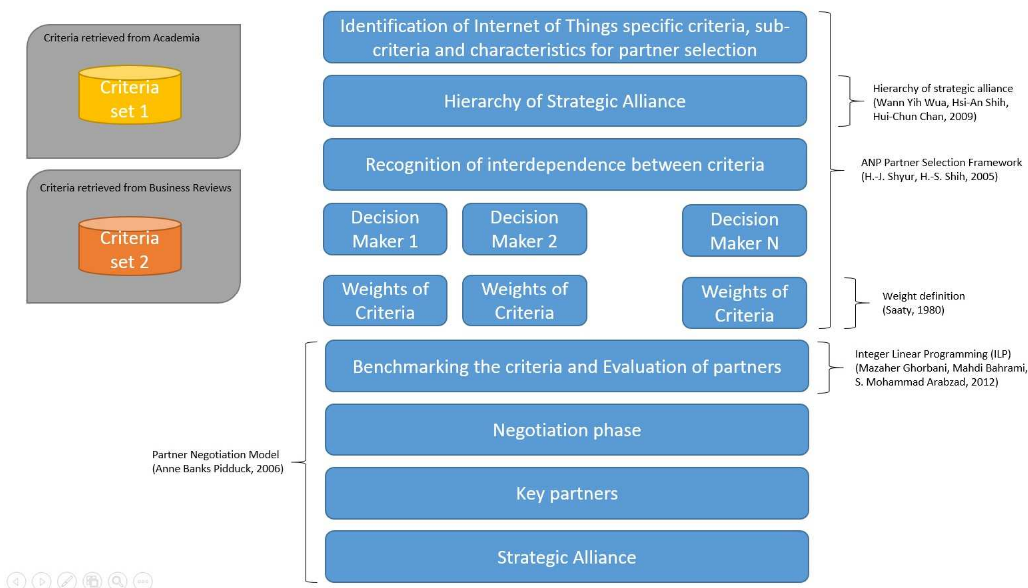


Figure 27. Partner Selection Framework for this Master Thesis

A total of 31 criteria are selected for the partner selection categorized in 5 areas:

Table 7. Strategic Value Network for Smart City IoT Partners, Criterion

Classification	Criteria for Multi-Criteria Decision Making	Code	Description
General Characteristics	On-time delivery	OTD	Delivers the product on the agreed schedule, without delays
	Price/cost	PC	Product cost is lower than competition
	Hardware Product quality	HWPQ	Hardware functionality is according to requirement, no faults
	Software Product quality	SWPQ	Software functionality is according to requirement, no faults

	Fault Correction Time	FCT	Product faults are corrected fast
	Responsiveness to customer needs	RCN	Always available to support
	Quality of relationship	QR	Partner / customer relationship
	Geographical location	GL	R&D, Factory locations
	Financial Stability	FS	Ability to invest in new product development and proper resources
	Service Level Agreements	SLA	SLA properly defined between partner and customer
Technical Capabilities	Trademarks, Patents, licenses, or other proprietary knowledge	IPR	Capability to develop patents and create new licenses
	Reputation	REP	Positive feedback from other customers
	Previous alliance experience	PAE	Participation in strategic alliances
	Level of Technical capabilities	LTC	R&D experience, coding, testing, architecture, SCM, etc.
	Position in the industry	PI	Market share, portfolio and product offering
Degree of Fitness	Willingness to share expertise	WSE	Able to collaborate and share expertise in the value chain
	Compatible strategic objectives	CSO	Willing to cooperate in technological areas for producing the highest value
	Willingness to be flexible of partners compatible with that of strategic partners	WFP	Able to collaborate with fair competition with partners within the value chain
Core Innovation Quality	Core competences	CP	Partner core competences are able to drive innovation
	Open Innovation capabilities	OIC	Partner collaborate in the ecosystem and investigate open innovation possibilities, via Living Labs or Startups to new product development
	Value Co-creation capabilities	VCC	New product development is done in collaboration with customers
	Awards	AW	Partner has acquired awards for best in class product design
	Technology Scouting	TS	Partner shares technology by scouting developers to adopt their solutions
	Service and Content Innovation	SCI	Partner creates new services and content, not only physical products
Internet of	Experience	EXP	Partner has proven experience in delivering Internet of Things products and services

Things Capabilities	Completeness	COM	Partner provides the needed Internet of Things features for a Smart City
	Scalability	SCA	Partner is able to scale their solutions in a scope of a Smart City
	Open standards, Open data and Open APIs	OPEN	Partner use open standards, open data and open APIs
	Stability	STA	Internet of Things devices, SW platforms, application behave as expected
	Security	SEC	Privacy and security of all products is a pri-ority
	Interoperability	IOT	Interoperability with other Internet of Things devices (M2M) and usage of stand-ard protocols

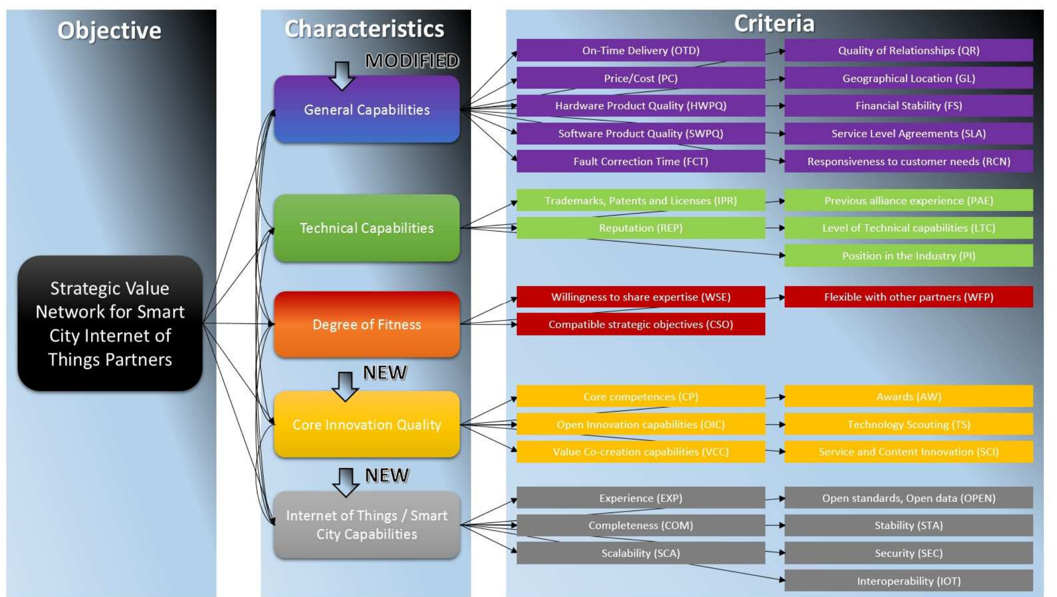


Figure 28. Analytic Hierarchy Process / Partner Selection Criteria Definition

The first key area of the conceptual framework can be summarized as in Figure 29.

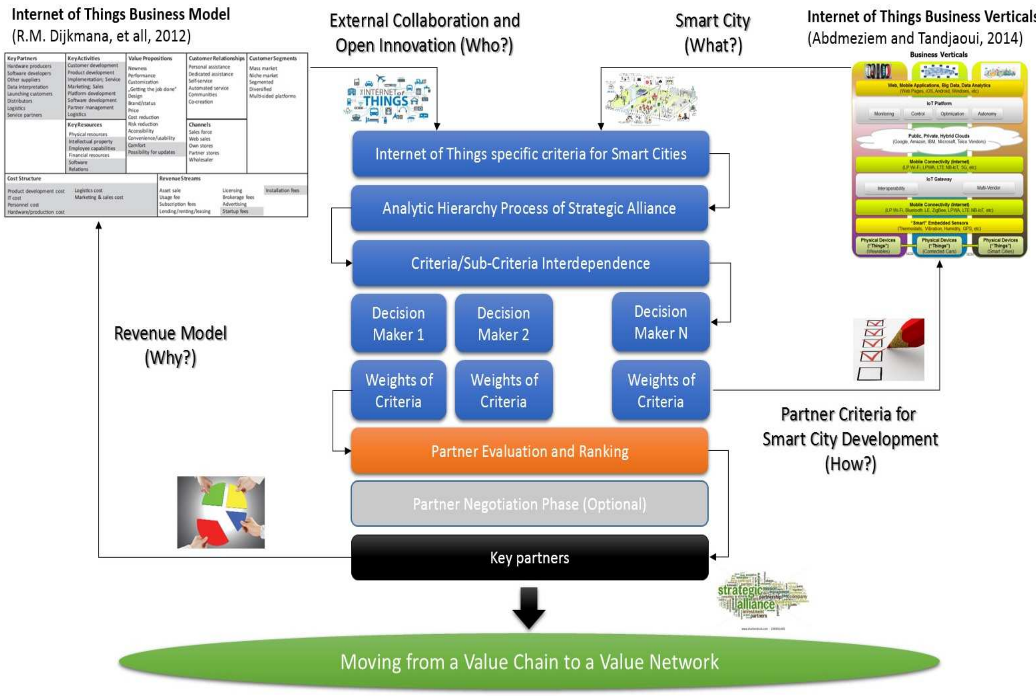


Figure 29. Conceptual Framework (Part 1)

3.5.2 Value Network Analysis Framework

The value network analysis framework is based on (Peppard J., Rylander A., 2006) as described in Chapter 3.4.2. The network value analysis (NVA) is used as the analysis method through the following sequence:

1) **Defining the network objectives**: aim to generate a description of where the value lies in a network, where the focal point will be the target organization and its key partners selected from the partner selection framework described in Chapter 3.5.1
2) **Identifying and defining network entities**: identifies the partners that have influence in the value proposition that the target organization delivers. Partners can be hardware and software vendors, technology regulators and competitors.
3) **Identify the value each entity perceives from being a network member**: capture the perceived value of the network participants regarding being part of the network. This is important and every entity should know what value is expected to be delivered from it.

4) **Identify a map network influences**: influences can impact to the perceived value, so it is important to know the different types of influences that different entities in the network may have such as ideas of new service offerings coming from developers, power coming from regulators, etc.
5) **Analyse and shape**: create a value network map with the overview of the network and analyse the value dimensions of the focal point and its links. Identify the challenges that can be extracted from the value network map in creating true value in a networked economy.

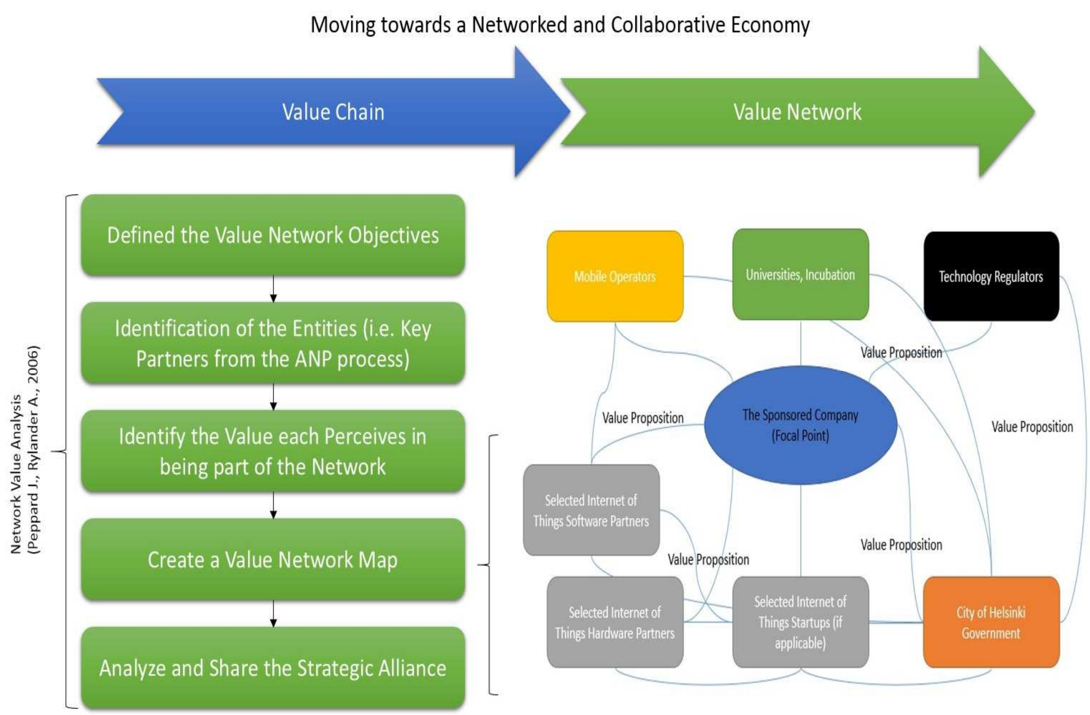


Figure 30. Conceptual Framework (Part 2)

3.5.3 Summary of the Conceptual Framework

The summary of the conceptual framework is shown in Figure 31.

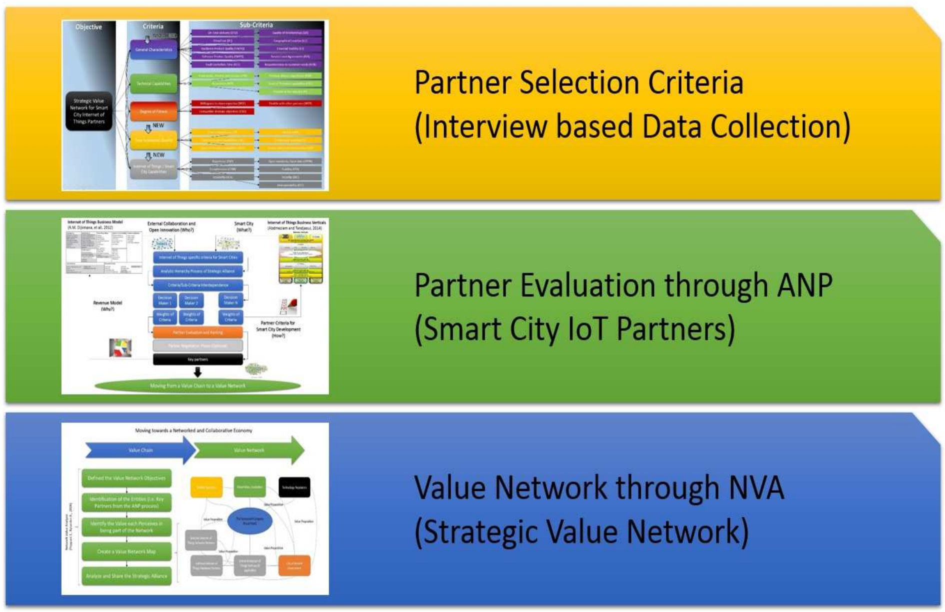


Figure 31. Conceptual Framework (Overview)

4 Internet of Things Partner Selection for Smart Kalasatama

4.1 Introduction

This chapter describes how to apply the partner selection criteria in practice and executes the selection of potential partners in different Internet of Things use cases. The chosen use cases are based on the Smart Kalasatama area in Helsinki, which focus on the smart urban development. Smart Kalasatama already has some IoT pilots ongoing in collaboration between Forum Virium and the bIoTope project. In this chapter, the potential partners of three (3) use cases are listed and the evaluation criteria is applied to every single one. The use cases are: Smart Metering, Smart Home and Smart Car Charging. The selected partners of each use case will be added to the value network of the target organization for further evaluation. In order to pursue a larger list of partners for further evaluation in the value network, a unique partner for each use case will be potentially list. This is to increase the visibility to several partnership options to draw an Internet of Things alliance. This Master Thesis does not intend in defining an exact best partner for each use case, but selecting a unique partner adds value to the value network analysis done in Chapter 5.

4.2 Eliciting the Weights of the Partner Selection Criteria

After the partner criteria definition in Chapter 3, the first step of the execution in this Thesis is to perform an interview within the target organization so that the weights of the partner selection criteria can be available for the partner evaluation and ranking. The interview was done with the Head of Collaborated HW Design, who has extensive experience and knowledge of working with partners across the telecommunication's ecosystem. The R&D department head the interviewee is responsible by several external collaborators that are managed by 'partner project managers', with the responsibility to manage partners across the development cycles in ODM/OEM modes. Therefore, this Thesis considers that the weight definition has a proper credibility – except that the R&D department referred here is not developing Internet of Things products. For eliciting the weights of the partner selection criteria, the interview used the criteria scaling as defined by (Saaty, 1980) as shown in Figure 31.

Intensity of Importance	*Definition*	*Explanation*
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity *i* has one of the above non-zero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
1.1–1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

Figure 32. Saaty Criteria Scaling (Saaty, 1980)

In the Table 7, five classification areas are available. They contain their specific partner selection criteria and a pair-wise comparison as defined by (Saaty, 1980). The pair-wise comparison is based on the question: "Which criteria should be emphasized more in a vendor, and how much more?". This question guided the interviewee to elicit the weight for each pair comparison. The relevant influence weights are defined in a matrix. The resulted matrix is normalized so that the weight for each criterion is defined, resulting in a rank.

Table 7. Result of the Partner Selection Criteria Weighting (Interview Data 1)

Classification	Criteria	Question: "Which criteria should be emphasized more in a vendor, and how much more?"											
General Characteristics		OTD	PC	HWPQ	SWPQ	FCT	RCN	QR	GL	FS	SLA	Weight	Ranking
	OTD	1.00	0.14	0.17	0.20	0.17	0.14	0.33	2.00	0.50	0.17	0.020578673	9
	PC	7.00	1.00	1.00	2.00	1.00	1.00	3.00	7.00	4.00	1.00	0.138207688	4
	HWPQ	6.00	1.00	1.00	3.00	0.50	0.50	3.00	8.00	4.00	0.30	0.110854154	5
	SWPQ	5.00	0.50	0.33	1.00	0.20	0.33	3.00	8.00	3.00	0.20	0.066583097	6
	FCT	6.00	1.00	2.00	5.00	1.00	0.50	4.00	8.00	6.00	1.00	0.162006977	3
	RCN	7.00	1.00	2.00	3.00	2.00	1.00	5.00	6.00	5.00	2.00	0.1877723	1
	QR	3.00	0.33	0.33	0.33	0.25	0.20	1.00	3.00	0.50	0.20	0.035948134	7
	GL	0.50	0.14	0.13	0.13	0.13	0.17	0.33	1.00	0.25	0.13	0.014856258	10
	FS	2.00	0.25	0.25	0.33	0.17	0.20	2.00	4.00	1.00	0.14	0.035773169	8
	SLA	6.00	1.00	3.00	5.00	1.00	0.50	5.00	8.00	7.00	1.00	0.17519775	2
Technical Capabilities		IPR	REP	PAE	LTC	PI	Weight	Ranking					
	IPR	1.00	2.00	0.17	0.50	0.33	0.076356054	4					
	REP	0.50	1.00	0.17	0.33	1.00	0.066471805	5					
	PAE	4.00	6.00	1.00	2.00	0.25	0.223735152	1					
	LTC	2.00	3.00	0.50	1.00	4.00	0.223735152	1					
	PI	3.00	1.00	4.00	0.25	1.00	0.169559539	3					
Degree of fitness		WSE	CSO	WFP	Weight	Ranking							
	WSE	1.00	2.00	0.33	0.229433354	2							
	CSO	0.50	1.00	0.20	0.12190466	3							
	WFP	3.00	5.00	1.00	0.647715158	1							
Core Innovation Quality		CP	OIC	VCC	AW	TS	SCI	Weight	Ranking				
	CP	1.00	0.50	0.50	6.00	2.00	2.00	0.171093434	3				
	OIC	2.00	1.00	0.50	8.00	3.00	1.00	0.215564219	2				
	VCC	2.00	2.00	1.00	9.00	4.00	2.00	0.326167147	1				
	AW	0.17	0.13	0.11	1.00	0.50	0.20	0.031450497	6				
	TS	0.50	0.33	0.25	2.00	1.00	0.33	0.069848602	5				
	SCI	0.50	1.00	0.50	5.00	3.00	1.00	0.158202501	4				
Internet of Things / Smart City Capabilities		EXP	COM	SCA	OPEN	STA	SEC	IOT	Weight	Ranking			
	EXP	1.00	0.50	0.50	0.50	0.25	0.50	0.33	0.0579991	7			
	COM	2.00	1.00	0.50	1.00	0.33	0.50	0.33	0.081219247	5			
	SCA	2.00	2.00	1.00	2.00	1.00	0.50	1.00	0.149835843	4			
	OPEN	2.00	1.00	0.50	1.00	0.33	0.25	0.50	0.078061	6			
	STA	4.00	3.00	1.00	3.00	1.00	1.00	2.00	0.226433333	1			
	SEC	2.00	2.00	2.00	4.00	1.00	1.00	2.00	0.222655207	2			
	IOT	3.00	3.00	1.00	2.00	0.50	0.50	1.00	0.152378333	3			

The rounded result is as follows:

1. **General Characteristics**
    a. (1) Responsiveness to Customer Needs (Weight: 18%)
    b. (2) Service Level Agreements (Weight: 18%)
    c. (3) Fault Correction Times (Weight: 16%)
    d. (4) Price/Cost (Weight: 15%)
    e. (5) Hardware Product Quality (Weight: 12%)
    f. (6) Software Product Quality (Weight: 8%)
    g. (7) Quality of Relationships (Weight: 4%)
    h. (8) Financial Stability (Weight: 4%)
    i. (9) On-time Delivery (Weight: 3%)
    j. (10) Geographical Location (Weight: 2%)

2. **Technical Capabilities**
    a. (1) Previous alliance experience (Weight: 30%)
    b. (1) Level of Technical capabilities (Weight: 30%)
    c. (3) Position in the industry (Weight: 25%)
    d. (4) Trademarks, Patents, licenses, or other proprietary knowledge (Weight: 10%)
    e. (5) Reputation (Weight: 5%)

3. **Degree of Fitness**
    a. (1) Willingness to be flexible of partners compatible with that of strategic partner (Weight: 65%)
    b. (2) Willingness to share expertise (Weight: 25%)
    c. (3) Compatible strategic objectives (Weight: 10%)

4. **Core Innovation Quality**
    a. (1) Value Co-creation capabilities (Weight: 34%)
    b. (2) Open Innovation capabilities (Weight: 23%)
    c. (3) Core competences (Weight: 17%)
    d. (4) Service and Content Innovation (Weight: 16%)
    e. (5) Technology Scouting (Weight: 7%)
    f. (6) Awards (Weight: 3%)

5. **Internet of Things / Smart City Capabilities**
    a. (1) Stability (Weight: 24%)
    b. (2) Security (Weight: 23%)
    c. (3) Interoperability (Weight: 17%)
    d. (4) Scalability (Weight: 15%)
    e. (5) Completeness (Weight: 8%)
    f. (6) Open standards, Open data and Open APIs (Weight: 7%)
    g. (7) Experience (Weight: 6%)

4.3 Formula for Selecting the Best Partner for Each Use Case

For each potential partner, the selection criteria are evaluated with an integer value between 0 – 10. The value 0 represents the worst condition and the value 10 represents the best condition of the evaluated criteria of the specific partner. With the result of each criteria, its selection criteria weight is applied to properly distinguish high priority criteria. The formula is simply based on a weighted average calculation.

Example:

General Characteristics of Partner X:

a. (1) Responsiveness to Customer Needs (Weight: 18%)
    i. Result: 8
b. (2) Service Level Agreements (Weight: 18%)
    i. Result: 7
c. (3) Fault Correction Times (Weight: 16%)
    i. Result: 9
d. (4) Price/Cost (Weight: 15%)
    i. Result: 7
e. (5) Hardware Product Quality (Weight: 12%)
    i. Result: 8
f. (6) Software Product Quality (Weight: 8%)
    i. Result: 6
g. (7) Quality of Relationships (Weight: 4%)
    i. Result: 9
h. (8) Financial Stability (Weight: 4%)
    i. Result: 10
i. (9) On-time Delivery (Weight: 3%)
    i. Result: 10
j. (10) Geographical Location (Weight: 2%)

i. Result: 10

Formula: (8 x 18% + 7 x 18% + 9 x 16% + 7 x 15% + 8 x 12% + 6 x 8% + 9 x 4% + 10 x 4% + 10 x 3% + 10 x 2%) / (8 + 7 + 9 + 7 + 8 + 6 + 9 + 10 + 10 + 10) = **Score = 7,89**

Partner X		
General Characteristics	Evaluation Result	Weight as per Selection Criteria
Responsiveness to Customer Needs	8	18%
Service Level Agreements	7	18%
Fault Correction Times	9	16%
Price/Cost	7	15%
Hardware Product Quality	8	12%
Software Product Quality	6	8%
Quality of Relationships	9	4%
Financial Stability	10	4%
On-Time Delivery	10	3%
Geographical Location	10	2%
Score	7,890	

Medyk, Sergio:
=SUMPRODUCT(E4:E13;F4:F13)/SUM(F4:F13)

All the partner sub-criteria are weighted as above, but the main criteria have all the same weight. Meaning that 7,89 for general characteristics will be summed up with all remaining criteria. For general characteristics 7,89 score is within the linear range of 0 – 10 as proposed for the evaluation. As this number is a result of a weighted average, this gives a strong evidence of the partner performance.

4.4 Potential Partners for Smart Metering

IoT Stack	Potential Partner 1	Potential Partner 2	Potential Partner 3
Hardware and Embedded Systems	Sierra Wireless Canada	Gemalto Netherlands	Aclara USA
IoT Platforms	Telit England	CyanConnode England	Capgemini France
IoT Applications	Siemens Germany	Oracle USA	IBM USA

4.4.1 Partner Selection Result – IoT Hardware and Embedded Systems

Sierra Wireless is a top vendor of M2M cellular modules. It has strong characteristics as an IoT focused partner, such as interoperability and Open APIs. It also supports Open Source initiatives to promote open standards. Sierra Wireless solutions are considerably scalable, covering a wide range of cellular modules for 2G, 3G and 4G technologies. In terms of Smart Metering solutions, Sierra Wireless is strong a player with a decent portfolio – clearly enabling greener and socially responsible environment. Perhaps, the only 2 concerns are its financial capabilities and the affected reputation due to a security breach found in its IoT devices, which were attached by the Mirai Virus (DDoS attack).

Sierra Wireless scored 8,706 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Gemalto is a global leader in the mobile, M2M industry. It has a strong focus to grown in the Internet of Things sector, also covering government sector. In general, Gemalto is very well positioned as a leader in the IoT field and will pursue to be a very cost competitive, also covering markets such as Latin America. Gemalto's financial stability is also showing growth in a new market, thus it should have strong quarter results as the Internet of Things technology gets more mature. In terms of IoT device security, Gemalto was in fact hacked in 2010 and 2011 by NSA and British spy agency GCHQ, allowing intrusion to 3G/4G SIM cards. The same SIM cards that could be used for phone calls or IoT devices. In terms of security, Gemalto is global leader, but this hack affected the Security rate for Gemalto in this selection. Anyhow, the rate of the security for Gemalto was particularly high due to its engagement in joining different alliances for security (Secure Technology Alliance, McAfee, Bridge Alliance, etc). In terms of smart metering solutions, Gemalto Cinterion M2M solutions enable secure connectivity for smart meters with flexible pricing models and new business models.

Gemalto scored 9,202 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Aclara

Aclara's residential smart meter bring accuracy and clarity into power usage across an electric utility's distribution network. Aclara offers Smart Energy Meter products with robust, flexible and configurable technology - with multiple communication technologies. Aclara is considered one of the top 10 vendors in Smart Grid technologies, though not as namely famous than Gemalto or Sierra Wireless. Aclara has however, a clear Smart Grid vertical market and its growth continues with the acquision of Smart Grid Business from Tollgrade.

Aclara scored 8,126 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

gemalto security to be free

Gemalto

4.4.2 Partner Selection Result – IoT Platforms

Telit

Telit is a global leader in Internet of Things (IoT). The company offers integrated products and services for end-to-end IoT deployments – including cellular communication modules in all technologies, GNSS, short-to-long range wireless modules, IoT connectivity plans and IoT platform services. Through the IoT Portal, Telit makes IoT onboarding easy, reduces risk, time to market, complexity and costs for asset tracking, remote monitoring and control, telematics, industrial automation and others, across many industries and vertical markets worldwide. Telit has successfully delivered successful stories of integrated smart meters solutions with their own IoT platform for several customers around the world. Although the revenue

Telit scored 9,348 in the average of all selection criteria based on the evaluation carried out in this Thesis.

CYANCONNODE

CyanConnode is a leader in the design and development of Narrowband RF mesh networks that enable Omni Internet of Things (IoT) communications. With expertise and experience in smart technology, the Group provides customers with long-range, low-power, end-to-end networking solutions and high-performance applications to improve business efficiency and save energy. CyanConnode portfolio also includes Smart Meter solutions with the possibility to deliver an end to end Internet of Things system, with the smart meters being connected through the communications networks. CyanConnode has recently signed a major deal with the Indian company Tata Power to provide some 4700 smart meters. This is a major deal for CyanConnode. In terms of strategic partnerships, CyanConnode also has an agreement with Enzel Global Ltd to collaborate in the delivery of narrowband mesh technology to the Internet of Things market in Ireland. CyanConnode's communication platform will enable Enzen to deliver Metering as a Service (MaaS), offering utilities an outsourced smart metering solution and reduced costs. CyanConnode will provide hardware and its Head End Software (on a recurring revenue basis) and Enzen will provide system integration to deliver this MaaS model.

CyanConnode scored 8,634 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Capgemini provides planning, implementing and management of smart metering services. Capgemini's SES Platform is an end-to-end integrated solution that manages the entire smart metering lifecycle, from program planning and meter rollout to operations and maintenance. Capgemini's long term experience in the Nordics, Europe and North America, as well as to its engagement in CyberSecurity alliances makes it a great partner for smart meters. It does not only provide IoT platforms, but it can provide the hardware and the analytics application on top of it.

Capgemini scored 9,522 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

Capgemini

4.4.3 Partner Selection Result – IoT Applications

Siemens is well-know for transforming its business from telecommunications to vertical markets which focus on digitalization, thus it stands in a strong position for the Internet of Things business models. For example, it has a strong portfolio for Smart Grid and Smart Health solutions which can all integrate an end-to-end Internet of Things solution. Specifically for the Smart Grid environment, smart meters are offered by Siemens with an innovative Cloud platform known as MindSphere. MindSphere, is a centerpiece of a powerful IoT operating system with data analytics and connectivity capabilities, tools for developers, applications and services. It helps to evaluate and utilize your data and to gain breakthrough insights. Drive the performance and optimization of assets for maximized uptime. MindSphere would be a great option for application developers to integrate Smart Meters in their IoT platforms.

Siemens scored 9,304 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Oracle Internet of Things Applications delivers a set of IoT applications for enterprise assets, production lines, transportation fleets, and mobile workers. It provides smart with predictive, machine learning algorithms and extend core SCM, CX, HCM and ERP processes — with real-time IoT data and insights. Any smart meter could be connected to Oracle's Cloud and benefit from the IoT applications to gain an insight to the available data.

Oracle scored 9,204 in the average of all selection criteria based on the evaluation carried out in this Thesis.

IBM provides the Watson IoT platform and application development with a huge set of templates for developers to integrate all types of devices. IBM is perhaps the most complete set of solutions with the powerful Bluemix Cloud.

IBM scored 9,606 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

IBM Bluemix™

IBM

4.5 Potential Partner for Smart Building

IoT Stack	Potential Partner 1	Potential Partner 2	Potential Partner 3
Hardware and Embedded Systems	Intel USA	PointGrab Israel	Rambus USA
IoT Platforms	PTC's ThingWorx USA	GE's Predix USA	Zoho Corporation WebNMS India
IoT Applications	Legrand France	Mendix USA	Honeywell USA

4.5.1 Partner Selection Result – IoT Hardware and Embedded Systems

Intel provides end to end solutions for its partners by offering a set of hardware and software products, as well application-ready platforms that can be used in Smart Building solutions. Intel's long experience in embedded hardware and software brings a stable choice for the Smart Building solution in any Smart City. Intel can provide smart sensors to be used in Smart Buildings, for example, HVAC, lighting, or fire safety. Software solutions provide personalization and mobility, occupant comfort and productivity, sustainability and efficiency and location-based services. Intel has a large alliance of partners and invest in open innovation and collaboration with the community to bring the best Internet of Things solutions to the field. Its reputation and trustable hardware may be seem as the main asset to be considered in the selection.

Intel scored 9,680 in the average of all selection criteria based on the evaluation carried out in this Thesis.

PointGrab

Israeli's **PointGrab** is a much smaller company as compared with Intel, but it provides a strong portfolio for Smart Buildings. CogniPoint™ is an embedded-analytics sensing solution for building automation, extracting information about how and where occupants are using the building. It's comprised of intelligent sensors and building energy management systems, and provides embedded-analytics for tracking human activity across the space of the building. PointGrab provide lighting, HVAC, safety, security and facility management and can be considered a much more specialized company focused on Smart Buildings and could also be a potential partner.

PointGrab scored 8,690 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Rambus

Rambus in an American technology company founded in 1990 and most famous for the development of RDRAM. Nowadays the company is more focused on memory technology for smartphones and tables, and also on the licensing business with its proprietary inventions in the memory technology. Rambus does also own a portfolio of products for smart buildings. In its portfolio, the Lensless Smart Sensor technology provides smart sensing by combining ultra-small diffractive gratings with standard image sensors. Although the sensor technology is very specialized and could provide good results, Rambus reputation does not stay at the same level. Rambus has used its patents to start suing several other memory companies from 2000, such as Micron. Today, Micron has to pay royalties to Rambus. Likely Rambus would not be strategically the best hardware partner.

Rambus scored 6,886 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

Intel

4.5.2 Partner Selection Result – IoT Platforms

PTC's ThingWorx enables creation and deployment of new IoT applications that connect, manage, and optimize complex data sets for building operations, security and energy. Through ThingWorx an IoT application can link HVAC, lighting, environmental sensors, and security and safety equipment, along with external inputs such as the smart grid and weather. ThingWorx has a large ecosystem of partners, clearly focused on open innovation and open standards which make the IoT application development very fast. Adoption of ThingWorx can speed the ROI.

ThingWorx scored 9,618 in the average of all selection criteria based on the evaluation carried out in this Thesis.

GE is committed to the digital transformation which involves the Industrial Internet. The company has developed its own Industrial Internet operating system, Predix, which can be used as a Cloud based PaaS for analysing data and delivering real time information. The platform can be deployed with both GE and non-GE assets for Smart Buildings. GE predix platform makes used of open standards and the company has a large ecosystem of partners who contribute to its development. Having GE as a major stakeholder for traditional lightning solutions and adding a smart platform to analyse, for example, energy consumption, can be a good choice. Differently from other IoT platform partners, GE can provide an end-to-end smart building solution with its own sensors and software.

GE scored 9,086 in the average of all selection criteria based on the evaluation carried out in this Thesis.

WebNMS Smart Building Solution for businesses offers applications for building automation such as building security, energy management, comfort, and automated entertainment with cloud integration (management of sensor data). WebNMS uses wireless technology such as Wifi, Zigbee, and GSM for monitoring of smart devices in a building. The company provides the Symphony IoT Platform for building operations.

WebNMS scored 8,958 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

thingworx

PTC's ThingWorx

4.5.3 Partner Selection Result – IoT Applications

Legrand is a French industrial group with a long history that dates back in 1865. Although Legrand may not be a well known name in the embedded industry, in fact its switches and sockets had 20% of the global market, and it was also globally largest in cable management (15% of the global market). It has a strong market in India. Initially focused on switches and sockets, it has made its digital transformation to develop smart products for buildings and home automation. Legrand provides a comprehensive application solution for smart lockers, security, lightning, audio control, outlets, garage doors, etc. Legrand mainly offers the application that provides the smart building automation and it has a strong partnership with Samsung, by using its ARTIK Cloud to centralize all collected data from the devices. Legrand is a strong contender for the partner selection in a smart building. "Partnership and interoperability are central tenets of Legrand's ELIOT program to advance IoT in the built environment." (John Selldorff, CEO of Legrand North and Central America, 2016).

Legrand scored 8,958 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Mendix Platform provides the capability to build IoT applications. The platform consume IoT services from AWS, IBM Watson, Microsoft Azure and KPN LoRa. Through this platform agnostic strategy, Mendix enables organizations to build connected devices to transform their business models. Mendix abstracts the technical complexity of developing IoT applications to rapidly develop Smart Apps.

Mendix scored 8,542 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Honeywell has developed with a group of councils a Smart Building Evaluation Framework to assess how a building is performing in terms of green environment, safety and productivity. Based on the framework, a building can be assessed and improved. Honeywell has 5 main portfolios for Smart Building: Building automation systems, Software and controls, construction and maintenance, security and fire, commercial combustion controls. Honeywell has a strong presence in markets such as India and China, which makes it an important player in growing markets. In fact, Honeywell and Huawei (a major competitor of the target organization) are collaborating in large-scale smart city projects, such as smart building deployments. Huawei and Honeywell developed projects in the Longgang Smart City project of Shenzhen, China. Honeywell provided building automation for heating, ventilation and air conditioning (HVAC), security and fire infrastructure, as well as the connected building solutions to integrate all sub-systems for a building management dashboard, alarm management, work order management for efficient facility management, quick response and preventive maintenance. Huawei provided ICT infrastructures including data centers, security protection and monitoring, IoT gateways and cloud services. (Huawei, 2017)

Honeywell scored 9,560 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

Honeywell

Honeywell

4.6 Potential Partner for Car Charging Stations

IoT Stack	Potential Partner 1	Potential Partner 2	Potential Partner 3
Hardware and Embedded Systems	ABB Switzerland	Eaton Ireland	AeroVironment USA
IoT Platforms	Ayla Networks USA	Cisco USA	HPE USA
IoT Applications	PlugShare USA	PlugSurfing Germany	ChargePoint USA

4.6.1 Partner Selection Result – IoT Hardware and Embedded Systems

ABB provides Internet based Electric vehicle (EV) charging infrastructure supporting all EV charging standards, with charging solutions for any location type The chargers easily connect to any service or payment application. ABB's experience and market penetration are the stronger assets.

ABB scored 9,192 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Eaton provides EV car stations in different types for several locations. Its business model is similar to ABB; "Eaton Corp., though not as diverse as ABB in its IoT offerings, does provide a number of products and solutions, many of which exist as a result of its acquisition of Cooper Industries” (Levine, Scott; 2013). Eaton has a strong financial performance and it outweighs ABB in terms financial stability.

Eaton scored 9,418 in the average of all selection criteria based on the evaluation carried out in this Thesis.

AeroVironment™

AeroVironment provides a broad array of EV charging solutions. Although the company is much smaller than ABB and Eaton, it holds a specialized know how for charging stations in the North American market. It uses a subscription plan to adopt new users which are looking for charging stations in the American territory. The company is still in expansion and it promises to increase the EV charging station coverage in USA.

AV scored 8,754 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

EATON
Powering Business Worldwide

Eaton

4.6.2 Partner Selection Result – IoT Platforms

Ayla Networks

Ayla Networks is a Platform-as-a-Service (PaaS) vendor providing primarily smart building solutions for HVAC, fire and safety, appliances and lighting. Ayla Networks is specifically built for enterprise-scale, thus being a quite expensive option if considering the car charging market. However, in terms of IoT platform maturity and feature capability, it delivers a truly end-to-end software foundation that enables device manufacturers to develop smart reliable solutions for Internet of Things devices. Ayla Networks is a major contender against big companies such as IBM, Cisco and PTC’s ThingWorx. Therefore, its reputation is increasing with its strong portfolio. Ayla Networks has a strong presence in China and a large set of chip manufacturers who have strike deals with its IoT platform (such as NXP, Marvell, Broadcom and Qualcomm).

Ayla Networks scored 9,764 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Cisco is a well know network vendors, focusing on switching and routing solutions which has been able to rapidly transform itself in a major player in the Internet of Things platform market. It offers a consistent and scalable platform that can be used to connect any type of sensor, including EV charging stations. Cisco, with its extended partner network, is not doubt a partner to ally with.

Cisco scored 9,764 in the average of all selection criteria based on the evaluation carried out in this Thesis.

HPE Universal IoT Platform provides a solution that is industry, vertical, and client-agnostic scalability, modularity, and versatility. Use cases both within a vertical industry sector and across multiple others enable new business models and revenue streams.

HPE scored 9,572 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result (*):

Ayla Networks

Cisco

(*) Both vendors got the same evaluation rate.

4.6.3 Partner Selection Result – IoT Applications

PlugShare

PlugShare provides a Smart App for EV charging stations, so that users can locate and pay for their charges. With PlugShare, the user can find the right location to drive his car, by planning the trip in advance, avoiding traffic jam, adding up well to the concept of a smart city. It lists for example Tesla superchargers that are available for users.

PlugShare scored 9,234 in the average of all selection criteria based on the evaluation carried out in this Thesis.

PlugSurfing

PlugSurfing is the European pair of the American PlugShare. It has an extensive network in the Netherlands, Switzerland, Austria, Germany, Belgium, France and England.

PlugShare scored 9,266 in the average of all selection criteria based on the evaluation carried out in this Thesis.

chargepoint

ChargePoint is similar to PlugShare, but with slightly less car charging stations. It provides same feature sets, covering USA and Canada. It competes for subscription prices and car charging stations amount / locations.

ChargePoint scored 9,208 in the average of all selection criteria based on the evaluation carried out in this Thesis.

Partner Selection Result:

PlugSurfing

PlugSurfing

4.7 Conclusions from the Partner Selection

The selected partners for **Smart Metering** were: Gemalto for Hardware and Embedded Systems, Capgemini for IoT platforms and IBM Bluemix for IoT applications. **Smart Buildings** best partners were: Intel for Hardware and Embedded Systems, PTC's Thing-Worx for IoT platforms and Honeywell for IoT applications. Finally, for the **Car Charging** business vertical, the choices were: Eaton for Hardware and Embedded Systems, Ayla Networks and Cisco for IoT platforms and PlugSurfing for IoT applications. Several other partners could be strong contenders for the value network analysis, but they were left out to limit the scope of this Master Thesis. The difficulty in selecting the appropriate partners comes from a complex IoT business ecosystem. The amount of new companies investing in this area is extremely overwhelming and any system integrator who wants to select the best partners has to carefully evaluate each aspect. In some cases, not the most competent partner is the best choice, but rather price can make a major influence. Investing big in IoT solutions can be a risk, as the business cases are still under definition. Therefore, the alliances must be made with companies who indeed have a long experience in embedded hardware and software, but also with smaller, more innovative partners who will disrupt the business.

5 Internet of Things Value Network Analysis

5.1 Introduction

This chapter aims at defining the value network objectives, generate a description of where the value lies in the network, the focal point being the target organization and its key partners selected in Chapter 4. With the value network map, it is possible to identify and define the network entities and the partners who have more influence in the value proposition that the target organization delivers. An attempt to identify and describe the value each entity in the value network perceives from being a network member will be made, so that the captured value of the network participants can be better understood.

5.2 Value Network

The following chapters describe the Value Network Map and the Value Network Analysis.

5.2.1 Value Network Map

Based on the selected partners in Chapter 4, the Figure 33 describes one possible Value Network for the target organization. This network includes a very limited amount of network entities (i.e. partners) in 3 different use cases: car charging, smart buildings and smart metering for a smart city such as the Smart Kalasatama. However, it is possible to observe that the network entities interact between each other without direct influence from the target organization. This makes clear that the Internet of Things market is extremely vast and the market share is no longer attached to big players in the communications field. The Internet of Things ecosystem diversity is its major strength, where startups may have the power to threat and disrupt the market which was previously dominant for decades old enterprises. The ecosystem does not require experience, but rather it requires a strong aim for open innovation practices which brings together developers from different types of disciples, such as embedded hardware, embedded software, application software, etc. to create new smart solutions that can aggregate practical value for the society. In such an environment, the target organization needs to perceive its own value in the ecosystem and understand its position against this smaller, but innovative entities. It is by partnering with these entities that value can be co-created together with customers. In some cases, a bigger company may take a decision to make major investments by acquisition of the smaller players. The target organization needs to constantly seek for new entities in the value network that matches strategically with its goals and either create a strong partnership, extending its alliance, or acquire when the business objective that aggregate its internal goals, such as expanding its product offering. Although the Figure 33 is still quite limited, it clearly shows that a value chain is irrelevant or the Internet of Things business ecosystem, but instead a value network of interdependent partners is the new business model that creates new opportunities.

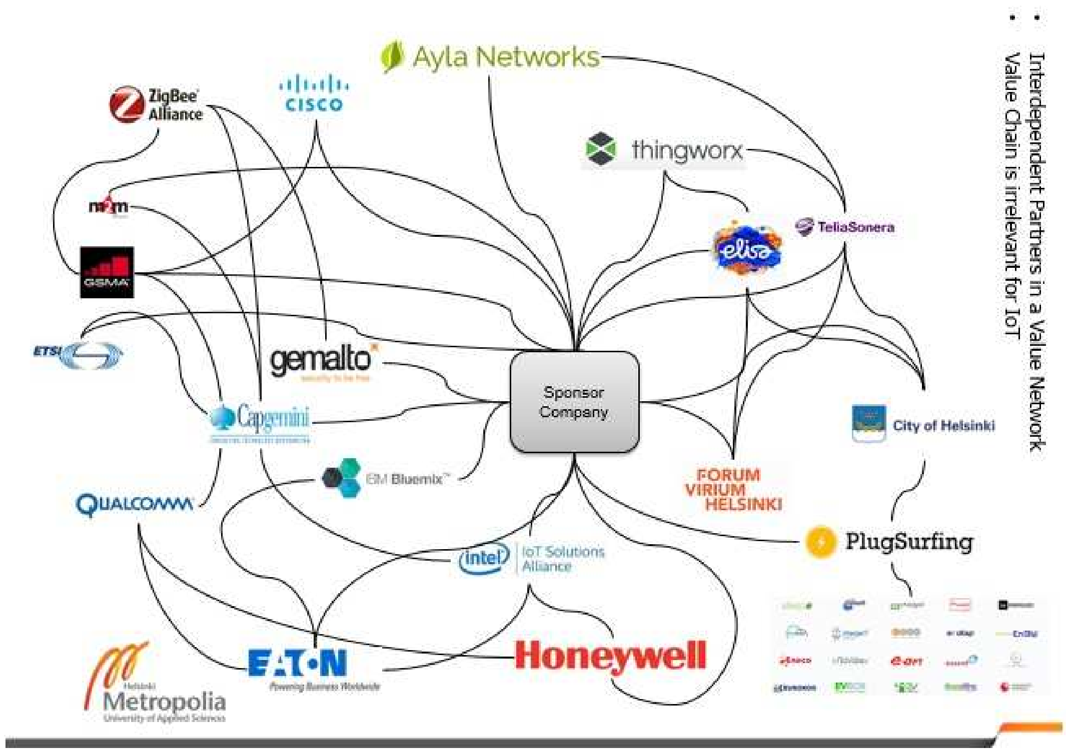


Figure 33. Value Network Map (Medyk, 2017)

5.2.2 Value Network Analysis

1) **Defining the network objectives**:
   a. As can be observed from the Figure 33, every network entity produces its value, being the development of IoT sensors, IoT platforms or applications. However, in order to truly create value for certain customers (such as mobile operators or governmental entities), the role of a system integrator is extremely important and necessary. The target organization lies in the focal point of the value network map, where it becomes clear that it can aggregate and co-create value with all the partner ecosystem through a strategic alliance for different Internet of Things business verticals.

2) **Identifying and defining network entities**:
    a. The partners who most influence on the value network map are the ones which directly provide solutions to the target organization. In the 3 different segments (car charging, smart metering and smart building), companies such as Gemalto, Intel, Honeywell, IBM, ThingWorx, Ayla Networks have the most influential roles, as they can control price, quality and delivery times for the target organization.

3) **Identify the value each entity perceives from being a network member**:
    a. In some specific scenarios, the partner may have a strong position than the of the target organization. This is because it can also create its own partnerships and start selling solutions directly to the organization's customers. This is a major threat in this kind of industry when the organization only acts as a system integrator. Therefore, it is also a key to the success that the organization develops its own Internet of Things solutions so that companies in the ecosystem would have to rely on the capability of the organization to deliver an end-to-end solution. By attaching part of the end-to-end solution to its own resources, it creates a very necessary dependency that contributes to the business. As the target organization has strong relationships and reputation with its customers, selling end-to-end solution using the brand makes it an advantage for smaller players to be willing to partner with the target organization.

5.3 Conclusions from the Value Network

The adoption of Internet of Things for the development of Smart Cities allows connecting an enormous number of physical objects (building infrastructure, car charging stations, air quality stations, parking spaces, etc) to the Internet in a seamless way. Therefore, Smart Cities can create business opportunities in different verticals and contribute to the revenue of different vendors in the field. In order to take advantage of the business opportunities with a fast time-to-market it is necessary to ally with different partners in order to deliver a complete solution. Taking into consideration the car charging stations, it would not make sense that the target organization develops smart car charging stations by itself, but rather partners with these types of vendors so that it can create a homogenous connectivity ecosystem, which is compatible with the target organization's own product offerings.

The value network map presented in Figure 33 shows the target organization positioned more as a system integrator, managing end-to-end solutions from different partners in the Internet of Things ecosystem. The value network consists mainly in using loyal customers of the target organization as a target for these end-to-end solutions for different business verticals. Operator customers such as Elisa and Telia Sonera traditionally purchase telecommunications equipment from the target organization, but the value network map shows that the influence of the partner ecosystem is stronger than the customer loyalty. The Internet of Things business model consists in dynamically creating new strategic alliances to reach more customers. For example, Elisa would probably not be willing to purchase the target organization's IoT platform if ThingWorx can provide a better price or an open environment for collaboration. That creates a huge challenge for the business model of the target organization. In fact, the target organization already reacted to that by launching its own specialized IoT platform to manage sensors and devices across the Industrial Internet use cases. The launching of an own IoT platform was necessary, but the fierce competition with several other small players in the market may limit the market share. On the other hand, operator customers are likely willing to have strong partners who help them in the transformation of the networks in order to allow a fully connected Smart City. In this case, the strategic alliances formed by the target organization are fundamentally important to Elisa to Telia Sonera.

Vendors who were traditionally focused on embedded hardware are perhaps the biggest threat, as they are pushing to incorporate software solutions (IoT platforms and applications) so that they can sell their products directly to their own customers. However, this ODM/OEM companies have less expertise on complete solutions, so the software quality may be an issue for them. In their case, it may be an advantage to partner with bigger companies in order to deliver their products to a wider range of customers. The most important for the target organization is to control the standardization of the hardware that is developed by hardware vendors, so that the connectivity solutions are compatible with the next generation network equipment. IoT platform vendors are not a threat, instead they are the driving force of the Internet of Things ecosystem. They drive innovation in the connectivity between the hardware and the application software. The main issue is in choosing the correct partner, as they are many IoT platform vendors surging in the ecosystem. Some vendors are new, but their products are very innovative and disrupting other bigger company's offering. For example, it could be quite clear that IBM and Cisco would be good choices for IoT platforms, but at the same time other companies such as Ayla Networks and PTC's ThingWorx cannot be ignored. In the IoT application area, most of the partners are driven by vertical use cases. Smaller companies, such as startups, are offer being create to address very specific Smart City scenarios. These startups cannot stand for bigger companies and therefore, the strategy with these smaller ones could be to assess their technical capabilities and consider in investing (acquiring) them. This Master Thesis concludes the value network as driving force for the target organization to understand and pull the best products of each partner to form a real end-to-end solution that helps customers to transform their business into real Smart City scenarios. The target organization must be aware that vendors may try to sell directly to their own customers to increase their revenues, it must know the correct IoT platform to choose so that it can deliver the most stable and with faster time to market (or develop its own) as well as always look in the value network the smaller entities with high influence which can be acquired through an economy of scale, by investing and increasing its portfolio. Smart Cities will constantly drive the needs for new services for end users and governments, so it is necessary that the target organization has a pool of partners from which it can always take the best solution.

6 Feedback from Stakeholders

6.1 Findings and Observations from the Received Feedback

As commented by Stakeholder 1 (target organization's business development manager in Hangzhou, China), it is extremely important that open standards, open APIs are used by 3rd party partners in order to allow the development of portable applications for the Smart City use cases. The selection criteria, in his opinion, could be improved so that to increase the weight of criteria "Open Standards, Open Data and Open APIs" which was rated with only 7% of weight. With an increased weight, the partner selection result could be slightly different, as well as the value network. In addition, according to the business development manager, the target organization should apply the DevOps concept where the customer of the target organization also evaluates the partners and the strategic alliances being formed by its vendor. Since the customer relies on a strong alliance, to ensure that long-term competitiveness of its products, there is a room for improvement so that to increase participation of the customer in the partner selection. Finally, regarding the value network, it is important to highlight that a fixed setup of the network is not the aim of any company and new partner reviews must be done in a continuous mode, so that new partners are selected as well as low performing partners are discarded.

As commented by Stakeholder 2 (target organization's portfolio manager in Espoo/Finland), the partner selection framework could be used in practice in the partner business unit organization. However, currently the target organization is already engaged in selecting partners through open innovation methods and the proposed framework somehow overlaps with what is already in practice. Additionally, the proposed framework in this thesis has a strong ground on literature reviews, rather than real use cases in practice. A workshop between the writer of the Thesis and the partner business organization experts could be held as to learn from each process framework and extract the best ideas to form an updated selection framework, if applicable.

6.2 Summary of the Partner Selection and Value Network Map based on Feedback

No changes to the proposed partner selection framework or value network map / analysis were required by the target organization. The concept of the Thesis would have to go through a deeper review with related experts in order to apply its framework in practice. However, the organization supports the proposed framework as a possible method for partner selection.

7 Conclusions

7.1 Summary of the Research Project and Output

New business opportunities are being driven by a new technological concept known as the Internet of Things, where objects are connected to the Internet through mobile connectivity and data is collected and analyzed in a Cloud environment to produce and create value for businesses and end users. The forecasted revenues are incredibly big and companies around the world are investing in this technology. The Internet of Things creates unlimited vertical use cases, which can be implemented in different sectors, such as manufacturing, connected cars, shipment tracking, improved location-based services, smart homes, smart parking space management, etc. A combination of several use cases can be implemented within a so called Smart City, an urban environment that is digitalized, connected and autonomous. Smart Cities consists also in a growing technological ecosystem, where ICT vendors all around the world strategically join forces to develop end-to-end solutions to satisfy the needs of citizens and government agencies. This research project aimed at identifying a method to select appropriate vendors to partner with, so that the target organization of this Master Thesis could implement a procedure to strategically choose the partners which best fit to its Smart City solutions. In order to scope the Smart City use cases, this Master Thesis selected the City of Helsinki, specifically the Smart Kalasatama area, to understand practical scenarios in which partners should be selected. Three use cases were chosen, as aligned with the Smart Kalasatama development objectives, (1) electric vehicle smart car charging stations, (2) smart metering and (3) smart buildings. The Master Thesis was able to define a partner selection framework as described in Chapter 3.5.1, which is supported by the Analytical Network Process (ANP) method as described in the literature review. The evaluation criteria of the selection framework consisted of definitions available from different scientific articles in the area of partner management as well as empirical definitions available in business reviews. These criteria were carefully selected according to the papers studied in the literature review. With the support from the target organization head of collaborated hardware design, a weight was defined for each criterion so that to establish a more precise relevance to the chosen evaluation criteria in the partner selection framework. Finally, each partner that was randomly chosen for each Smart City use case and evaluated accordingly. The evaluation was done mainly based on business reviews and stakeholder comments. Furthermore, the Thesis chose a Value Network Analysis method so that the chosen partners could be further evaluated in terms of their perceived value and influence in the strategic partner ecosystem of the organization's target business. The value network shows the importance of open innovation among Internet of Things vendors.

7.2 Recommendations for the Target Organization

The Internet of Things represents a major opportunity to increase revenues with a vast amount of possible solutions and services that can be created for end users and governments. One of the possible implementations of the Internet of Things is to create a fully connected, digitalized and smart city with services that improve the lives of its citizens. The target organization must be a specialist in the Internet of Things and must be engaged with governments and agencies involved in the Smart Cities investments to attract new business opportunities. The target organization could, for example, be more active with the City of Helsinki being a member of the Forum Virium partner ecosystem, so that it can trial its own Smart City solutions in Smart Kalasatama's Living Lab. Currently, the target organization is not part of the Forum Virium partner list. This means that at some extend, it proves that other partners are able to disrupt the company's business by being able to sell directly to mobile operators such as Elisa and Telia Sonera. As a matter of fact, Telia Sonera has its own Cloud R&D for the development of Smart City solutions, from which it can be considered a major threat. This Thesis strongly recommends that the target organization increases its participation in strategic alliances in the Nordics, by setting up an open innovation ecosystem, so that it can have stronger influence in the definition of the Smart City use cases and use its own partner ecosystem to sell solutions to mobile operators. Partner selection shall be a constant a dynamic action as part of the target organization's strategy and the alliance definition must consider all aspects in the Internet of Things business ecosystem. It must consider that other alliances are also being formed independently and disrupting solutions are constantly being brought into the market. Stronger participation in Smart City trials is necessary to ensure that its position in the industry remains strong, because brand value may not be enough to guarantee market share.

7.3 Assessment of the Thesis Project

7.3.1 Outcome vs. Objective

The initial objective in assessing the Internet of Things needs for a Smart City was intended to collect real feedback from the City of Helsinki (Forum Virium). The plan was to collect data through an interview with the head of the Smart City innovation unit in Kalasatama, but the data collection was prevented due to no response from the main stakeholders in Forum Virium. The possibility to collect information was through two steps, first a “meetup” session held in the target organization headquarters with the Helsinki Infoshare Region (HRI) and Open Data responsible persons, who gave a general presentation on the concepts used in Smart Kalasatama and second a visit to the Mobile World Congress Shanghai in China funded by the target organization. Most of the practical data used in this Master Thesis for Smart Cities was collected either through the Forum Virium’s online resources or via insights in the conference in Shanghai. Although this did not prevent the execution of this Thesis, it limited the possibility to brainstorm about areas in which the target organization could contribute in the Smart Kalasatama. As recommended in Chapter 7.2, the target organization could later engage in a more active participation in Forum Virium. The partner selection framework defined based on the ANP method could be possibly improved, with more real data as well. The criterion of the partner selection framework was defined based on the literature, while only the weighting of the criteria was established through a data collection with the head of collaborated R&D. Possibly, there are more criteria that would add value in selecting partners and this criterion should be checked with, for example, partner business managers in more details. Also the partner selection frameworks identified as part of the literature review were mainly focused on supply chain management (i.e. manufacturing, retail), while no standard definition for selecting partners in an open innovative ecosystem was available. The use of ANP may be seen inadequate for the Internet of Things ecosystem, but it still gives a good guide in categorizing best capabilities of specific vendors. Finally, the value network analysis was done within a limited scope of selected partners, but it clearly shows that such an evaluation is important to understand the strategic alliances that can be setup in this technological context. Generally, the business problem was covered within this Master Thesis and the outcome was produced according to the required goals. Improvements to the partner selection framework and the value network analysis are possible and could be further developed by the target organization, but it is very clear that the direction of selecting best partners will be always needed in order to fulfil a value network needs, by co-creating value with partners and customers.

7.3.2 Credibility Considerations

The credibility of this Thesis can be verified by the sources which have been selected for this research, which have been mainly focused on scientific papers, mainly on the areas of partner selection criteria and value network analysis. It is also presumable that, due to the nature of the recent development of the Internet of Things concept, not so many papers have been written concerning partner selection for Internet of Things vendors. As a matter of fact, most of the partner selection literature is focused in different sectors. In order to create the conceptual framework, it was necessary to take into consideration sources from business reviews which was not formally a scholar article. Anyhow, the sources, such as Harvard Business Review, do give a comprehensive and even more practice aspect of the Internet of Things ecosystem and business value. Similarly, it was not possible to find any article which executed a value network analysis with Internet of Things partners, which makes this Master Thesis grounded not only on previous studies, but also on new ideas around this topic. Whether the new idea can be implemented or not by the target organization, is part of the findings and observations given by the stake-holders. Finally, and in order to avoid any bias, the vendors enlisted in this Master Thesis were picked randomly and their evaluation does not necessarily match with results given with other sources. The evaluation of the potential partners was done in a simplified and neutral way. Naturally, different points of view may exist and there could be other results. In conclusion, there would be no concerns that the information given in this Master Thesis is not credible or grounded in consistent sources.

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