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Management Summary

Sensing machines connected home appliances, and wearable sensor technology that networks over the Internet and allows for process automation, predictive analysis, and artificially intelligent environments able to interact and communicate over a smart phone without constraints of time and distance are nearly ready for possible mass adoption.

In fact, the capabilities of the Internet of Things and big data are promising disruptive change. However, although for the smart home sector expects big growth, the transparency regarding the developing market, as well as the awareness regarding the disruptive technologies, still raise concerns, such as feelings of a lack of individual control of how data is used and shared by different data holders. Determining questions to be answered for the adoption and sustainability of the Internet of Things and big data in general, and the smart home in particular, will be what the benefits for its users will be and how risks will be optimized.

Literature was studied to identify the different potentially smart home related Internet of Things and big data players' strategies and a SWOT analysis was performed as a basis for the informed development of a sustainable smart home data governance setup. Survey research was used to analyze possible relationships between smart home adoption likelihood, opportunity, and risk perception regarding the increased collection and use of smart home data and perceived need for regulation. The survey respondents were also presented a set of smart home provisions strategic pillars, one of which was "citizen participating organizational form". The relative importance of the strategic pillars was analyzed and reasons for the rating of citizen participation as a strategic element were explored.

Overall, this project has to be understood as a situational analysis of the smart home value system and the development of a strategic planning framework that addresses the needs for smart home data governance. The body of knowledge elaborated in this work is incorporated into the smart home sustainability framework in terms of (1) smart home drivers, such as commercialization and human integration; (2) benefit realization and risk optimization; (3) stakeholders, namely corporations, government, citizens, and communities; and (4) strategic options such as top-down and bottom-up governance.

The main practical contribution of this master thesis lies in logically deriving, structuring, and formulating actionable tactics to reach the governance goal of creating economically and socially sustainable value for citizens, i.e., smart home users, in an evolving data value system. The tactics involve business, technology, and innovation perspectives. For example, a peer-to-peer smart home data-trading platform is planned. Societal and cultural points of view are considered as well. The proposed tactics conclude each with an analysis how they could be attained in order to put the smart home vision and the tactics feasibility into context.

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Abbreviations

3D	Three Dimensional
API	Application Programming Interface
BSC	Balanced Score Card
COBIT	Control Objectives for Information and Related Technology
CPOF	Citizen Participating Organizational Form
CSR	Corporate Social Responsibility
E-Governance	Electronic Governance
GPS	Global Positioning System
HVAC	Heating, Ventilation, Air, Conditioning
ID Card	Identification Card
iOS	Operating System
IoT	Internet of Things
ISACA	Information Systems Audit and Control Association
ISP	Internet Service Provider
M2M	Machine-to-Machine
MIT	Massachusetts Institute of Technology
MSC	Multi-Stakeholder Cooperative
NGO	Non Governmental Organization
NSA	National Security Agency (United States)
PCA	Personal Contextual Assistant
SMART	Specific, Measurable, Attainable, Relevance, Time
SWOT	Strenghts, Weaknesses, Opportunities, Threats

1 Introduction

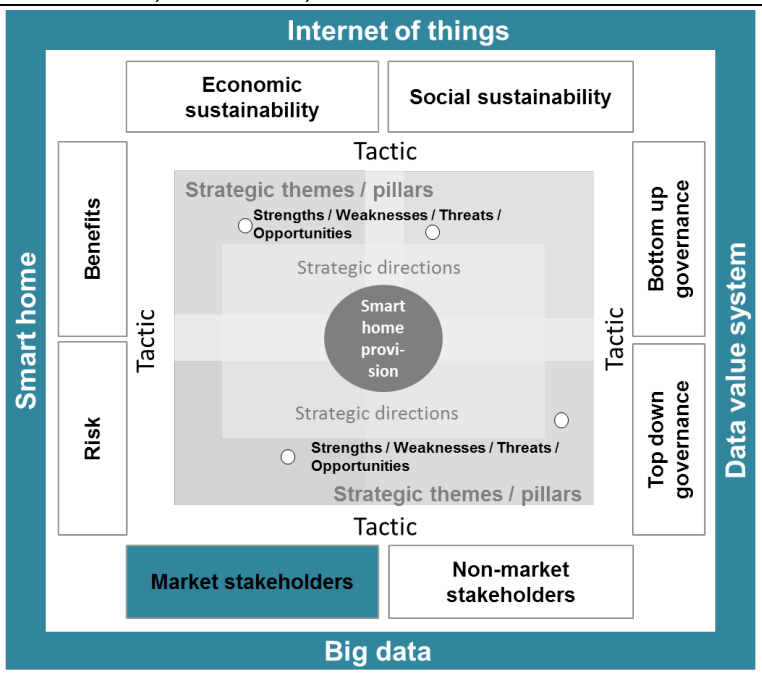
The Internet of Things and big data are not new terms. But their adoption and the formation of a smart home market, especially for data, are in progress with unclear outcomes and consequences. Mobile, social media, big data, sensor, and locations-based technologies are being integrated more and more, allowing for new possibilities. Smart solutions, such as intelligent home energy, security, and entertainment, controlled remotely with a mobile device of choice and integrating information from work, private, and public environments for a safer, healthier, more convenient and more efficient life are likely to be adopted by more institutions and individuals in the future. The infrastructure and services that enable this exciting new smart living are provided by device manufacturers, big network infrastructure and telecommunication companies, and Internet service providers, as well as by a growing number of new, innovative firms in this area.

Big data analysis attempts to “make sense” of any unstructured data. Nonetheless, scale is an important factor in mining valuable correlations for knowledge about the environment, businesses, customers, and citizens that can be used to develop services based on prediction capabilities. Companies like Google use their immense amount of information to produce knowledge that can be monetized. Competitors vie for a stack of the data from the increasingly connected world.

A closer look at this evolving technology ecosystem and big data value system has been motivated by the observation that an increased commercialization has occurred, while common users continue to enjoy freemium offers that lack the transparency to explain the business model behind the scenes. This thesis sought examples to provide insight for how and why the current practices—such as re-use, combination, and sale of data to third parties—must be considered a threat to a sustainable data value system where citizens should have their economic and social stake secured for the future as well.

1.1 Structure

Table 1: Overview

A: Knowledge generation	
1 Introduction Introduction, motivation, and structure of the master thesis	
 **Figure 1: Value system analysis**	**2 Value system analysis** Elaboration of definitions and acquisition of an understanding of the Internet of Things, big data, and smart homes from a technical ecosystem perspective as well as from a market point of view. Analysis of positions and strategies of data value system market stakeholders.

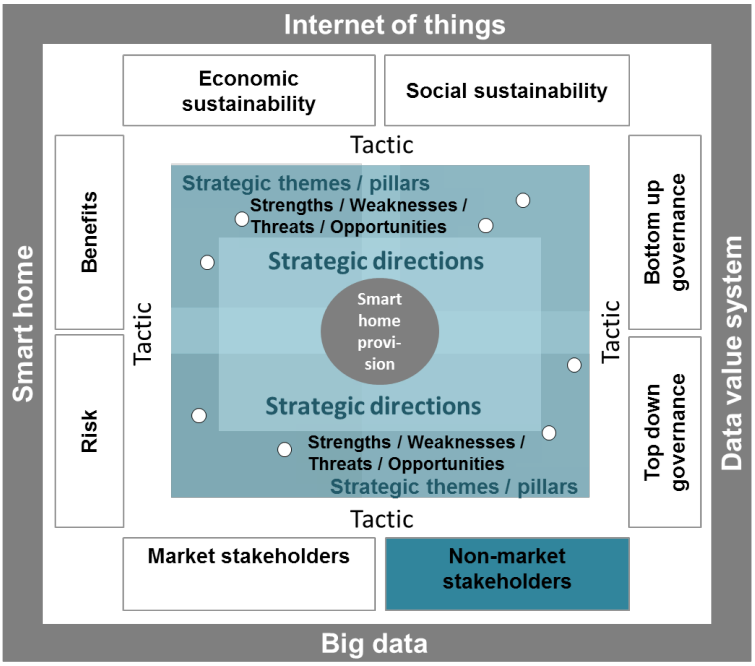


Figure 2: Identification of governance needs

3 Identification of Governance Needs

Based on the knowledge gathered so far, establishment of the thesis and performance of a SWOT analysis for the data value system regarding a preliminary definition of a smart home data governance goal and initial identification of strategic themes for providing the different perspectives of the data governance goal aspects.

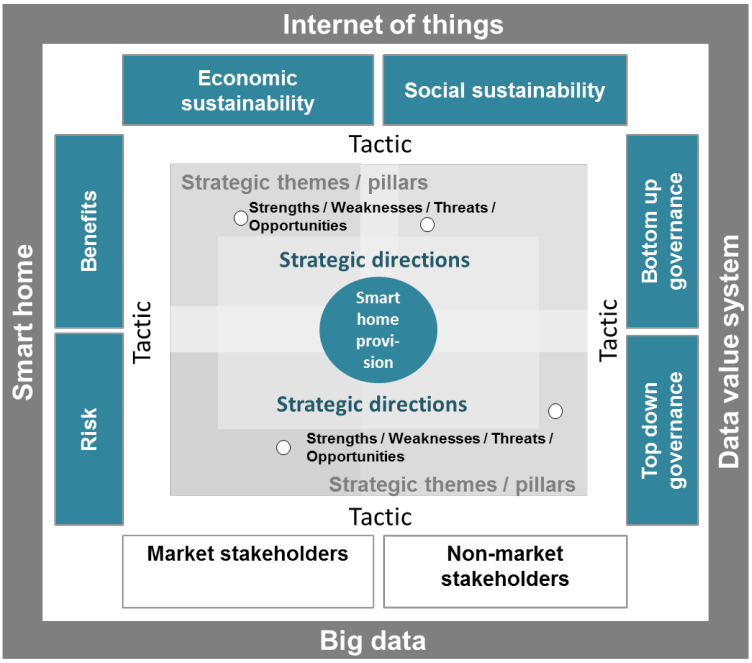


Figure 3: Sustainable smart home provision

4 Sustainable smart home provision

Derived from the previous SWOT analysis, outline of relevant sustainability elements for smart home provision inclusive of envisionable directions to be taken for the achievement of the smart home data governance goal that is updated in this chapter.

B: Survey Research

5 Survey Research

Description and exploration of survey respondents' answers. Use of interpreted survey results for the evaluation of the importance of the proposed strategic smart home provision elements.

C: Synthesis of Results

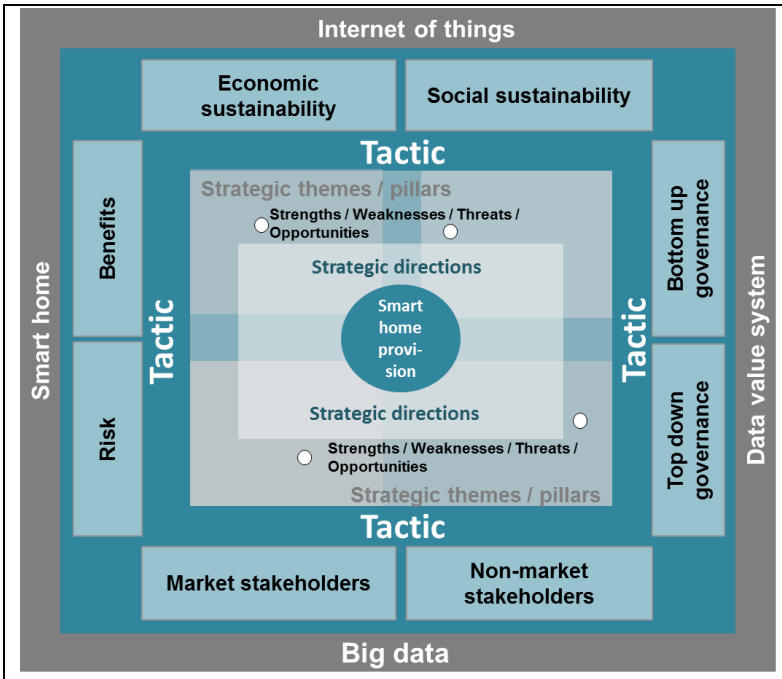


Figure 4: Tactics for sustainable smart home provision

6a Tactics for Sustainable Smart Home Provision

The different elements of the body of knowledge generated in Part A are brought together with the results from survey research. Formulation of sustainable smart home tactics for smart home provisions using selected SWOTs as starting points for the combined application of the strategic framework's elements.

6b Conclusion and Outlook

Summary and abstraction of the findings for a critical validation of the thesis.

2 Internet of things, smart homes, and big data

2.1 Internet of things

2.1.1 Definition and demarcation

Kevin Ashton (2009), cofounder and excutive director of the Auto-ID Center at MIT[1], assumes in the article '*That Internet of Things' Thing*, that the term "Internet of Things" started life after a presentation held by him in 1999.

Machine-to-machine (M2M) communications can be considered as synonymous with the Internet of Things. Gartner IT Glossary defines M2M as "automated data transmission and measurement between mechanical or electronic devices" ("Occupational safety and health administration," n.d.).

The Internet of Things is a difficult and evolving term. Whereas M2M is a pre-existing and synonymously used concept, other expressions, such as "The Internet of Objects," "The Internet of Everything," and "The Internet of the Future," are commonly used as well.

Wikipedia (n.d.) provides the following definition: The Internet of Things (IoT) refers to the interconnection of uniquely identifiable embedded computing-like devices within the existing Internet infrastructure. ("Internet of Things", n.d.)

Data capture in a digitized format such as from the Internet of People and the IoT, as well as contextual information, such as location data, are creating the possibilities of virtual representations (datafications) of the physical world. The knowledge that can be gained from all this digital data is what makes the IoT a promising vision for problem solving in the future.

Because of its broad view regarding both technology and capability involvement as well as consequences on a micro- and macro-level, the definition provided by the European Commission (2013) indicates the full meaning of the Internet of Things: "IoT is a long term technology and market development based on the connection of everyday objects to the Internet. Connected objects exchange, aggregate and process information on their physical environment to provide value added services to end-users, from individuals to companies to society as a whole" (page 2)

As in this project there is often talk of interoperability of technology and integration of services, the definition from Karnouskos, Marron, & Fortino (2014) of the IoT's "Cooperating Object domains (…) such as the Smart Grid, smart cities, industrial automation, aviation, robitics etc." (Section 5.1) is helpful to understand the IoT as a system of systems. Karnouskos et al. (2014) define in more detail:

> ""Cooperating Objects are modular systems of autonomous, heterogeneous devices pursuing a common goal by cooperating in computations an ind sensing and/or actuating with the environment." The domain of Cooperating Objects is a cross-section between (networked) embedded systems, ubiquitous (footnote) computing and (wireless) sensor networks." (Section 1.1)

2.1.2 Home automation and smartness

Wikipedia, (n.d.) does not provide an English definition for *smart home*. Instead, it provides a definition for home automation, stating that:

[1] Research group in the field of networked radio-frequency identification (RFID) and emerging sensing technologies at the Massachusetts Institute of Technology

> Home automation is the residential extension of building automation. It is automation of the home, housework, or household activity. Home automation may include centralized control of lighting, HVAC (heating, ventilation, and air conditioning), appliances, security locks of gates and doors and other systems, to provide improved convenience, comfort, energy efficiency, and security. (“Home Automation”, para. 1)

Throughout the literature, terms like “smart house,” “intelligent housing,” “eHome,” and “smart living” are used as synonyms for the automation of everyday home processes.
To be able to judge whether an automated home is smart or not requires the definition of “smart.”

”Any device that is connected is smart,” is a simple definition from Kellmereit & Obodovsky (2013, p. 10) of what smart means. Connecting devices to the IoT “creates an ecosystem of things that talk to each other, and people are in the middle of it,” they further conclude (Kellmereit & Obodovsky, 2013, p. 10).
Connectivity as a determinant for smartness supports the definition of the smart home being a subset of the IoT.

Because the focus of this master project is on the private domestic IoT user, the definition from Atzori, Iera, & Morabito. (2010) provides an overview of possible related IoT use cases and, at the same time, for a definition of what can be meant by the term “smart home” in a broader sense:

> Unquestionably, the main strength of the IoT idea is the high impact it will have on several aspects of everyday life and behavior for potential users. From the point of view of a private user, the most obvious effects of the IoT’s introduction will be visible in both working and domestic fields. In this context, domotics, assisted living, e-health, and enhanced learning are only a few examples of possible application scenarios in which the new paradigm will play a leading role in the near future (p. 1, para. 2).

Domotics is the field of robotics involving the field of artificial intelligence. Artificial intelligence is, as found in Wikipedia (2014):

> the study and design of intelligent agents,” where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. John McCarthy, who coined the term in 1955, defines it as "the science and engineering of making intelligent machines.” (“Artificial Intelligence”, n.d., para. 1)

Martin, Haya, & Carro (2013) use the term “Ambient Assisted Living (AAL)” and explain that this is a combination of Ambient Intelligence and assistive technologies. The terms are explained by the definition of smart home as provided by Martin et al. (2013), what at the same provides for a good summary for the purposes of this project:

> Smart homes are technology-enhanced environments that constitute the basic hardware and software infrastructure for assisting people in their home. Building smart environmets that exhibit specific forms of social interactions is the goal of Ambient Intelligence” (Section 1.2.1, para. 2)

2.2 Smart home ecosystem

2.2.1 Technology components

“Overall, the M2M technology ecosystem can be split into three major groups: data acquisition, data transport, and data analysis” (Kellmereit & Obodovski, 2013, p. 30). They complement the concept by adding a Connected Device Platform and an Application

Enablement Platform groups. Inspired by these categories, the following overview can be drawn.

Table 2: M2M technology ecosystem

Data Acquisition	**Connected Device Platform**	**Data Transport and Storage**	**Application Enablement Platform**	**Data Analysis**
Hardware	Middleware	Network	Middleware	Software
Hardware	M2M communication	Storage	Software (Application programming interface)	Application
Devices	Communication hub	Connectivity	Software application platform	Intelligence Software
Sensors	**Installation** (e.g., Zig-Bee (open standard), Z-Wave (not open))	(Wireless) network, cloud	**Installation** (e.g., software platform on iOS, Android or PC)	Process support

Connected device platform
The connected device platform can be considered the critical technology group in terms of interoperability of smart home devices. At this stage, the different connected devices' collaboration must be installed in the smart home. Smart home providers are offering, under different names, hubs compatible with one or more communication standards, such as Zig-Bee or Z-Wave, which provide for home automation standards. These standards have different technology specifications (e.g., radio frequency, type of chipsets used, software available, memory capacity, and protocol for communication).

A typical smart home package today comprises of a set of devices, a communication hub or controller that represents the aforementioned connected device platform, and a user application. Some providers enable the cooperation of a user's own set of devices (such as Insteon) or allow a user to connect devices from different manufacturers that are compatible with the platform (e.g., SmartThings). In all cases, the compatibility among the devices a user wants to connect requires an exact evaluation of the technology specifications.

Data transport and storage
Some collected data may be stored directly on the hub installed in the user's home environment. However, most services require the transmission of data over the Internet to the provider's servers because this allows the provider to analyze the data and build applications and services for the user. In other words, the data is stored in the cloud. "Cloud storage is a service model in which data is maintained, managed and backed up remotely and made available to users over a network (typically the Internet)" as summarized by (Techtarget, n.d., "cloud storage").

The cloud represents another point in the ecosystem where integration can take place. For example, Scobel & Shel (2014) state, that carmakers build alliances with cloud storage companies. If data is not yet brought together in the cloud, the so-called Application Enablement Platform (see table 1) is another means to combine data. In this scenario, data in the cloud can be accessed and consumed for further analysis using one or more different independent applications. Some of the smart home providers make such an interface available to other parties such as software developers, but only under restricted conditions.

Application enablement platform
Smart home applications are often provided for free, but they are only available in combination with the use of the providers' own hardware, middleware, and storage solutions, and they require a subscription to the services over the Internet. The applications often run on any kind of smartphone, tablet, or PC. For example, the Swisscom Quing Home starter kit has a separate dedicated touchscreen and remote control device included.

Data analysis, smart home application fields
There is a big difference between how smart home offers are packaged and how extendable they are. One reason is the decision taken by the smart home provider regarding the realized interoperability, as explained in the section above. On the other hand, smart home applications are designed according to the provider's strategy to cover different fields of the smart home area.

The identified definitions of the smart home application fields also do not follow a common categorization system. For example, an application field called "lighting" might fall under the field of "safety" in other instances if used as a motion detection alarm response method; it could be listed under a category focusing on "remote control," addressing the comfort of controllable lighting; or when used to build lighting scenes, it can be associated with the topic of "ambience." To use parts of the home, e.g. kitchen, living room, and outdoors, is another way to classify different smart home aspects and their related products and services.

Looking at some examples (for details see Appendix A), smart home offers often include one or more fields, such as lighting, safety (e.g., door locks and cameras), entertainment (e.g., audio and video), and energy management (e.g., thermostats and power switches). Smart home providers often complement their offer through the prospect of connecting additional devices, as long as they are compatible, and consequently allowing the implementation of additional smart home application fields according to customers' preferences and needs, as limited by compatibility constraints.

Based on the examples studied, a more detailed description of conventional smart home application fields is provided in section 2.3.3.

2.2.2 Smart home market

On one hand, it could seem surprising that for how long remote controllable amenities have been available, still many households do not have many automated or remotely controllable features. However, smart home does not just mean static automation but connectivity of related devices and appliances in order to make their automation more intelligent by using data analysis for predictive knowledge of future events about which can be informed or which can be used for self-directed automation. Therefore, the smart home market is tightly connected to the IoT and big data markets, which recently started to evolve and can be considered in an early stage.

From the existence of different proprietary smart home hubs and controllers, there remains a high fragmentation of different connected device platforms and smart home application software. Complexity and constraints regarding compatibility and interoperation may present an obstacle for mass adoption. However, there are also signs that smart home product vendors and service providers seek to increase compatibility by integrating more protocols and allowing installation on different platforms.

The increasing range of available products, the developing big data capabilities, and the movements in the industry for easier and broader integration of smart home components may be leading to optimistic outlooks regarding the market development.

According Berg Insight (2013), “North America is the most advanced region in the world for smart home solutions with an installed base of 3.5 million systems at the end of 2012. An estimated 0.7 million of these were multifunction or whole-home systems, whereas 2.8 million were point solutions designed for one specific function such as climate control or security. As some homes have more than one smart system in use, the installed base represents a total of around 2.9 million smart homes” (page 2) Berg Insight (2013) estimates that the “North American market was worth $1.6 billion (EUR 1.2 billion) in 2012, including revenues from hardware, services and installation. The market is expected to grow at a compound annual growth rate (CAGR) of 42% between 2012 and 2017” (page 2) Berg Insight (2013) also states that “The European market for smart home systems is still in an early stage and approximately three years behind North America in terms of penetration and market maturity” (page 2).

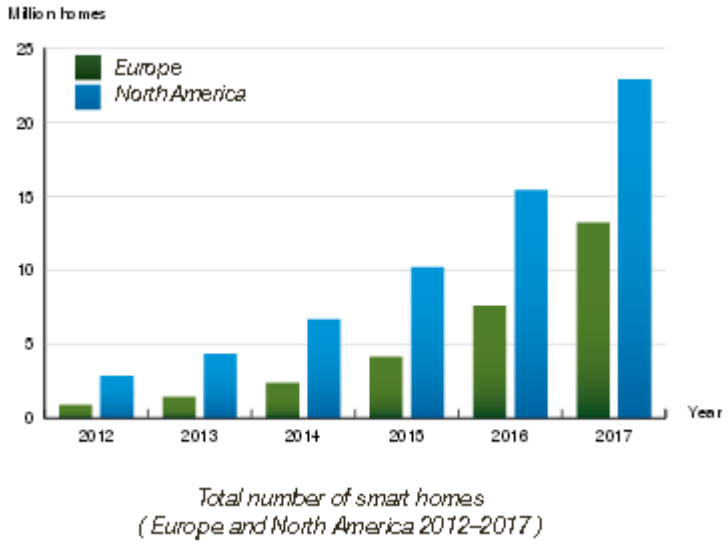


Figure 5: Total number of smart homes (Europe and North America)

These figures in terms of growth are impressive. But IoT application markets such as Vehicles, Manufacturing and Process industries represent the major portion of the market, as Karnouskos, Marron, & Fortino (2014) report. And Karnouskos et al. (2014) state that “at the moment, the Home is still considered a small niche market” (Section 5.1) One thing that seems to be clear is, as they reinforce as well, that “Cooperation among Cooperating Objects at local and system-wide level may create new business opportunities in the future” (Section 5.1)

2.2.3 “Conventional” smart home application fields

According to the examples studied, the following conventional smart home application fields have been defined.

2.2.3.1 Health, fitness and wellness

This field of smart Home technology and services relates to a group of usages that supports the goal of health, fitness, and wellness for the private user. Not included herein are products and services requiring prescriptions by a doctor.

Representative of the health, fitness, and wellness aids are any sensors in the environment or attached to or implanted in the body that enable the measurement of weight, metabolism, perspiration, blood pressure, eating behavior, and cholesterol levels as well as signals from brainwaves and accelerometers and more. Based on the data collected, personalized software is available allowing for the monitoring of health conditions and the share of information with the user as well as with his/her doctors about possible reasons and recommendations, such as medication or change in behaviors. This is where a further group of devices and usages comes into play, e.g., high-tech massage beds and light and sound therapy systems. Popular applications are watches and wristbands measuring travel distance, number of steps, and calories used to motivate and support the user in reaching his/her personal fitness goals.

Summary used for survey questionnaire: Health, fitness and wellness (e.g., activity, body functions and sleep tracking armband, light wellness therapy, dental cleaning app, etc.)

2.2.3.2 Security

All technology that is aiming to create and maintain a safe home environment can be brought together into the security area. For example, keyless front doors recognizing and authorizing approaching homeowners automatically allow them to remotely control, delegate, and monitor access. Noise, pollution, light, heat, frost, and humidity sensing devices connected to the Internet and analyzing and reporting human made and natural hazards to the user connected to the communication platform are additional possibilities.

Because transportation and mobility starts at the home base, I consider information about and connection to such systems to be an integral part of the smart home as well. Furthermore, the car as an extended living space with a smart home integrated interface is an important concept. Whether it is sensor data about the well-being of the driver; notifications of nearby emergency services and hospitals; or information about the car's speed, acceleration, or the car's self-driving option driver assistance information (self-driving cars are in development and testing), there are many possible current and future usages of smart technologies to increase user's everyday life security.

Summary used for survey questionnaire: Security (e.g., electronic monitoring, alarm system, etc.)

Security aspects outside the home, such as the connected car, have not been included in the questionnaire.

2.2.3.3 Comfort

An easy-to-use one-stop user platform that is conveniently integrated into all connected household devices allows for remote control and information access at any time. While thought-control is not yet a commonly available use mode, voice and gesture control are often built-in options in modern devices supporting a more intuitive user experience. The comfort the smart technology brings can also be described as implicit, meaning that the devices are learning programmed or learned actions automatically and without the need for user's explicit direction.

Summary used for survey questionnaire: Comfort (e.g., convenience)

2.2.3.4 Entertainment

It is estimated that the personalization of media consumption preferences and an increasing self-determination of the delivery of media content is developing further. Easy to search, manage, and share photos, videos and location information, publicly or private, over the device and social network of choice, is how the user can expect to entertain himself/herself and others. Advanced gesture technology, as included in video game consoles, whose platform can sense the user's pulse as a measure of thrill, is another method of smart home entertainment usage.

Summary used for survey questionnaire: Entertainment (e.g., multimedia integration with smart home)

2.2.3.5 Cost savings

Cost savings is a further possible effect of intelligent home automation, whether it is reduced time for completion of tasks or more economical use of resources by the means of supportive information and efficient processes.

Summary used for survey questionnaire: Cost savings (e.g., better consumer offers, reduced consumption needs, etc.)

2.2.3.6 Education, learning and home office

The home is an area where education, learning, and work for one's own business or using home office time for one's employment, takes place. Smart technology going beyond the use of computers and communication and collaboration tools can enhance the education and work experience at home. Some examples include distant and self-paced learning including predictions about learning outcomes through big data analysis (see Section 2.5), monitoring of learning and working speed, work place and learning institution connected resource selection, sharing platform use, and 3D printing for prototyping serve.

The goal of defining the application field of education, learning, and home office as outlined above is to add a component of human creativity fostering the use of technology to reach its own development goals, and in cases where education is otherwise difficult to access. Education into the direction of technical literacy and more specifically the use of smart technology shall be included as well.

Summary used for survey questionnaire: Education, learning, and home office (e.g., distance learning, self-paced learning, working from home etc.)

2.2.3.7 Environmental protection

Contextual thermostats that turn themselves down when people are leaving the room, phantom power elimination devices, and analysis reports of home systems' usage can help save energy, as can water purification and re-use for showers and toilets as well. Adding a social layer to the production, distribution, and consumption of electricity for sharing, gaming, and rewarding can motivate users in their efforts to protect the environment.

More efficiency can be achieved if the smart homes use linkages to real-time information from and to the public (e.g., city) infrastructure and services, such as dangers of sewage overflow, information about local transportation, pollution, energy, and waste management status information.

Summary used for survey questionnaire:
Environmental protection (e.g., energy consumption and waste management)

The link to the city, respectively smart city, was not made in order to stay consequently in the smart home area.

2.3 Value of data

2.3.1 Option value of data

Structured data collections that can be aggregated create a good that is traded for a certain market price, such as news and research data. However, now, unstructured data, whose concrete possibilities for use were never known, is attracting interest. Big data analyses promise to derive knowledge from any kind of data in a big enough volume, by reusing and re-combining without the effect of depletion.

As Mayer-Schönberger & Cukier (2013) wrote, “The extra cost of collecting multiple streams or many more data points in each stream is often low. So it makes sense to gather as much data as possible, as well as to make it extensible by considering potential secondary uses at the outset. That increases the data’s option value” (p. 109).
Internet companies and big data firms are looking for new ways to collect more data, any kind of data, and to re-use and re-combine the data to harvest its option value. In view of unforeseen future business cases, it is difficult to determine how data’s value is developing over time and by which rate. Therefore, keeping as much data as long as possible is especially important in light of declining prices of data storage, which is an understandable strategy for businesses relying on data.

2.3.2 Data valuation

Digital data is like a raw material for production; it is indispensable for the production of information and knowledge. Although this might sound logical, there are different opinions for determining the value of data. Brynjolfsson & McAfee (2014) cited Google’s chief economist Hal Varian, saying that data is “something that’s getting cheap and plentiful” (p. 199). Awareness about the value of data is increasing and data holders will, as described by Mayer-Schönberger and Cukier (2013), “probably hold it more tightly than ever, and charge outsiders a high price for access” (p. 134).

According to McChesney (2013), “Internet-related corporations now comprise nearly one-half of the thirty largest firms in the United States in terms of market value.” (p. 222). The sheer size of many Internet firms is important and might result in a considerable overall market share.

In February 2014, there was news of an acquisition of the mobile messaging service WhatsApp by Facebook. Facebook paid $19 billion for a company with 50 employees. It is not that the price would have been determined by any special tangible assets in the books of WhatsApp, nor that the software would represent an unlimited product in terms of technology or functionality. The value of the company was in the 450 million users and, more exactly, in the data available on the provider’s platform. Most importantly, the willingness of Facebook to pay this high price might be based on Facebook’s expectation on option value of this immense amount of amassed data as well as the prospect of the continuing source of data gathering that WhatsApp platform promises.

2.3.3 Types of data

Contextual data
Lazakidou (2012) defines context as “knowledge about the user’s and IT device’s state, including surroundings, situation, and to a less extent, location” (Section 12.5). Although device configuration asks users for consent to track location, much of this contextual data is gathered by services without the user being explicitly aware. Data sent from devices and appliances in a smart home context could represent such examples.

Section 2.3.1 and Section 2.3.2 intended to identify the economic value of data. The next paragraph addresses the privacy aspect, which is relevant considering the current progressing digitization.

Personal data
Personal data is not only name, birthdate, address and telephone number, as many discussions about data protection and data policies indicate. In the age of big data, any kind of data can become valuable. Therefore, it is important to bear in mind that when consuming digital services, even passively, the user’s invisible data is also collected. Examples for this type of data include browser data, such as the tracking of activities on websites, and IP addresses from users’ computers.

The World Economic Forum (2011) defines personal data to be “data (and metadata) created by and about people” (p. 5, para. 2). This, therefore, suits well for a broader definition of personal data, including data actively and passively generated by and about individuals.
Also, the definition of personal data from the European Parliament (1995) in the data protection directive is sufficiently broad to include different data types:
“Personal data” shall mean any information relating to an identified or identifiable natural person (“Data Subject”); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity. (article 2, para. (a))

Especially important is the indirect identification possibilities that big data analysis is making possible. By combining more and more data sets from, often at the time of the creation of the data unforeseen, different data sources respectively holders, data that has been regarded as anonymized may become personal again.

Big data
Big data is defined by Oxford dictionaries as “Extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions” (“Big data”, n.d., para. 1)

2.4 (Big-) Data value chain

The activities involved in big data can be structured into a big data value chain, as presented by Figure 6.

Figure 6: Big data value system

The overview builds upon the smart home ecosystem's three basic groups of data acquisition—data transport, data storage, and data analysis—and is complemented with the value chain activities "sharing" and "retention and destruction." By doing so, the value chain represents a comprehensive general data life cycle model. Nonetheless, this is focused on the specifics of a big data market, as opposed to more non-big data or purely security focused data life cycle models, of which many different adaptations exist.

2.4.1 Data acquisition

Data acquisition is enabled by sensing devices and appliances. However, data collection for the big data value chain contains both machine data and data created by people directly. Within this value chain activity falls the acquisition of any kind of data. Data acquisition represents the necessary first step for the realization of the vision of the IoT, and from a technology perspective, heavily involves the industry of device manufacturers. However, data acquisition, as often determining the possibilities or the price for becoming a holder of data, is letting other players be present at this stage of the value chain.

In a smart home, connected devices communicate with each other and send data to the cloud, where information about the smart home can be derived and made available to the connected devices and their users in return. The capability to produce information and knowledge out of machine-generated data in combination with many data sources and content from the people and the Internet lies in the analysis of the data, in particular where it is about unstructured and messy data. Big data analysis presents the type of data analysis that becomes more and more important because the types of data and the amount and messiness of data generated by an increasing number of devices and sensors asks and allows for new analytics.

2.4.2 Data storage

As discussed in Section 2.4.1, data transport can be considered together with data storage. The main goal of pointing out data storage as an important stage in the big data value chain is to highlight the position of the actors who possess the data for further use. Although these data holders are not necessarily the ones who neither created the data nor applied data analytics to the data, they store it at their premises. Thus, they still can use data for sharing with other parties.

2.4.3 Big data analysis

Prediction
As Mayer-Schönberger & Cukier (2013) identify, "At its core, big data is about predictions" and "it's about applying math to huge quantities of data in order to infer probabilities" (p. 12) Whereas single devices and sensors can send data in a high frequency over a long time, they are a representative sample of what they measure, and reliable statistical analysis methods can be applied.

Big data analysis goes beyond statistical possibilities because it does not have to rely on sampling; optimally, it can use an entire data set (provided a full population of sensing objects is connected). Because of this quality of big data, it is not only possible to search the data for what one is looking for, but to process the data in such a way that the result gives hints for what it would be worth to look for.

Data matters most
Of course, storage capacity, computing power, and sophisticated algorithms are required as well. However, the main driver and limitation for many businesses for the application of big data capabilities is the availability of data. Mayer-Schönberger & Cukier (2013) state,

“Google processes more than 24 petabytes of data per day, a volume that is thousands of times the quantity of all printed material in the U.S. Library of Congress” (p. 8). This amount of data allows a company like Google to learn from consumers precisely and timely because it captures all details, including outliers and slight changes over time. Google translation, for example, gains its intelligence from data analysis of many different and continuously updated sources of textual data rather than from language interpreters.

Big data for smart home services

If a smart home is put in context of a number of smart homes and, for big data purposes, in an as big as possible number in order to reach as much scale as possible, much more data would be available, allowing for correlations on a specific topic to be found. In general, this would produce more accurate analysis results, a kind of benchmark over all smart homes, for the purpose of better information and services for every single smart home, although it could be a challenge to agree on what constitutes the most valuable predictions. Human ideas and the appropriate use of the results remains a most important aspect.

2.4.4 Sharing

The circular nature of the data flow indicated in Figure 6 above by the backwards directed arrow reflects the understanding that data can be reused, meaning it can be acquired by other parties and analyzed and shared for different purposes. Sharing can be achieved in different forms, such as free share, usage on demand for the exchange of commissions, or leaving the data under predefined conditions for a licensing fee.

2.4.5 Retention and destruction

If data risks becoming obsolete or the period for its use is constrained by data policies (e.g., after a user unsubscribed from services), data holders might strive to use the data before its value diminishes. On the other hand, because the future value of data (option value) in times of big data cannot be foreseen, keeping data as long as possible is a valuable strategy.

2.5 Big data value system

After having described the big data value chain in the last section, this section’s goal is to present the overall data value system by looking at the different value system players’ value chains and related interdependencies between those activities in a broader context.

As described by Wikipedia (n.d.),

> [The] industry wide synchronized interactions of those local value chains create an extended value chain, sometimes global in extent. Porter terms this larger interconnected system of value chains the "value system." A value system includes the value chains of a firm's supplier (and their suppliers, all the way back), the firm itself, the firm distribution channels, and the firm's buyers (and presumably extended to the buyers of their products, and so on). (“Value chain”, n.d., para. “Significance”)

The data value system brings together IoT-related technology ecosystems, such as the smart home and big data value chains. As the identification of the value system’s players makes obvious, it is not about single industries. The data flow in the big data value chain is crossing and affecting multiple industries and markets. Picturing the end-to-end data flow, however, is crucial to understand the system in terms of the different stakeholders’ positions. The strategies of controlling the ecosystem and vertical integration in the value chain illustrate this.

In the next sections the value system players' strategies have been analyzed with a focus on their potential impact for the users. For the discussion of government's role in the data value system see Section 3.8.

2.5.1 Device manufacturers

While smart thing homemakers may buy sensors, chipsets, and wireless modules separately to implant them into objects, for the mass adoption, device manufacturers provide complete devices. As shown in Section 2.3.3, there are almost no limits to what devices can sense and connect to the Internet. The design and production of smart devices can involve appliance manufacturers, architects, interior designers, artists, and even "do-it-your-selfers."

An opportunity for appliance manufacturers is the possibility to obtain and analyze information about the usage of the appliances, which can be used to improve product design. The information may also support the maintenance of devices. From usage data, people's behavior can be better understood and according marketing strategies developed. It is also likely that besides design features the data aspect will be a determining factor for the success of manufacturers. They increasingly consider the importance of storing the device-generated usage and user data and providing APIs to foster a rich application ecosystem around the data they seek to have access to.

For smart appliances, high margins are paid by customers. The price consists not only of the conventional appliance itself and the additional technical components for sensing and connectivity, but also, to a lesser degree, of the smart service itself for which the appliance takes over the data acquisition activity as the basis for the application at the other end of the value chain.

It is possible that, as with PCs and smartphones, smart appliances will become more commoditized as the market grows. It can be expected that high profit margins will move toward software built on top of connected device platforms and the investment intensive device manufacturing business will rely on economies of scale. It is likely that besides design features, the data aspect will be a determining factor for the success of manufacturers, and they increasingly take into consideration the importance of storing the device-generated usage and user data and providing APIs to foster a rich application ecosystem around the data.

2.5.2 Network infrastructure and telecommunication companies

Network infrastructure providers and telecommunication operators are providing the means for connectivity and data transport. The smart home area is predestined to represent good new business opportunities for them, as the critically important position of providing access of homes they already own.

Controlling the flow of data

The network and telecommunication infrastructure sector tends to possess regional or national dominant positions. Owning the data transportation means immense infrastructure investments—such as coaxial cable, optical fiber, and wireless—from which returns are generated through subscriptions. Although network and telecommunication companies, as a schematic principle, own and manage the communication infrastructure rather than the content that is going through it, theoretical logic dictates that whoever is controlling the network is able to control the content. In order to ensure that communication means are made available for businesses and the public in a fair way, the sector is highly regulated. To find a balance between regulation and the possibility to operate on a profitable basis is a challenging task, especially in light of rapidly emerging technologies, such as the IoT and the commercialization of the Internet in general.

The Example of AT&T and Netflix
Netflix—the world's leading TV and movie subscription service—recently agreed to pay Comcast—the biggest Internet provider in the United States—guaranteed network capacity. Reactions are discussing the so-called "Internet neutrality" that is a basic feature of the World Wide Web. Another business model, as proposed in January 2014 by AT&T—one of the biggest global telecommunication companies—is to let firms sponsor the data used by the users of mobile applications and services. The impact of such initiatives on the openness of the Internet and competitive equality in using it has been hotly debated.

The usage data that telecommunication operators collect from their subscribers in a big data area becomes of great value. Mayer-Schönberger & Cukier (2013) mention the possibility that mobile operators "regard their data as a potential source of income" and "In 2012 the large Spanish and international operator Telefonica went so far as to create a separate company, called Telefonica Digital Insights, to sell anonymous and aggregated subscriber-location data to retailers and others" (p. 107).

Integration into the data value system
Mayer-Schönberger and Cukier (2013) further explain that Apple contractually secured the right for the most important usage data from operators around the world and that now "Apple gets a far richer picture of cellphone use than any mobile carrier alone can see" (p. 146).
Because it is possible to track location, even when the location services on a device are disabled, through wireless beacons used in communication with antennas, it would be wrong to conclude that location data would not be stored on the servers of telecommunication companies any longer.

Smart city infrastructure projects
Cisco is the biggest specialist for components of the Internet infrastructure, such as routers and switches, which are important for functioning networks. With the acquisition of Linksys in 2003, Cisco was also operating an in-home network business. However, focusing its strategy on corporate business, Cisco sold Linksys to Belkin International in 2013. Smart cities are projects where companies like Cisco are active in providing the technology enablers for connected facilities, systems, and services of the city, such as energy, traffic, and sanitation management. The goal of such projects is to address cost effectiveness and efficiency. While the government is believed to control the connected system and the related data, smart city big data specialists, such as IBM, may find themselves in a certain dependency on the infrastructure providers because there is no industry-wide standard guaranteeing interoperability and interchangeability of technology components for different providers. Cloud solutions for data storage further pose the problematic benefit of global organizations while keeping data in local legislation. The future will decide whether and in what way smart city and smart home data will be integrated and combined by whom and what role the Internet will play.

2.5.3 Internet service providers

Big player or niche player
According to Wikipedia (n.d.), an "Internet service provider (ISP) is an organization that provides services for accessing, using, or participating in the Internet" ("Internet service provider", para. 1). Especially with regard to accessibility to the Internet, there is some overlap among telecommunication operators. Companies that provide Internet-related services may be positioned in the middle of the value chain. However, their diversity and especially the big companies' pursuit to integrate more in the big data value chain, make it impossible to define this group of stakeholders clearly.

First, two tendencies can be identified. Either an Internet service provider tends to be big, using a vast amount of data for its services, or the company positions itself as an agile niche player. Often the latter struggles with establishing a sufficiently monetizable business or is tempted by a marriage with the power of a big player. Therefore, in many cases smaller companies are acquired at some point. However, according to the big data business cases available for the big companies, a reason for the inability to monetize on the idea is the lack of data. Therefore, the possibility or cost of data acquisition can be seen as an entry barrier for companies that have an business idea but not the data.

Integration into the data value system
Recognizing the value of data, an Internet service provider is likely to search for additional possibilities for data acquisition, storage, big data analysis, and data sharing. With the continuous commercialization in the view of potentially increased competition between data holders, it is probable that data in the future will be shared less freely. This pushes firms requiring data for their business toward the beginning of the value chain, which is the acquisition of the data. The case of Google is a good example for illustrating this progressing vertical integration of Internet service providers in the big data value chain. In order to become more integrated in the value chain, ownership of the technical components at each point in the value chain guarantees control over data.

The example of Google
Google's recent purchase of Nest, a smart home technology company selling smart thermostats and smoke alarm systems, can be interpreted as the expansion of its means for data acquisition to smart home hardware. In addition, there is a lot of news about the market introduction of Google Glass, a voice controllable smart computer in the form of eyewear, signifying a next step to combining things with mobile connectivity and gathering and providing information about people's lives. Google Glass incorporates a complete set of IoT technology components and big data value chain activities into one smart device. The same is true for Nest smart home products and services. Although the data used for Nest services has not been announced as being used by other Google services, it could be integrated into the ecosystem of Google services. Also, the Google Corporation is creating open automotive alliances, which aligns with the plan to realize the Google self-driving car to cover a further area of life where people spend a lot of time.

The ability of Internet service providers to acquire digitized data to have the rights to hold, use, and share data for datafication in more and more areas of life, makes them grow to full-fledged end-to-end providers. There are even examples where they strive to own network infrastructures by themselves to compete against the network infrastructure and telecommunication operators (e.g., Google Fiber). Interoperability of technologies and services should be a logical goal of providers because these qualities are drivers for the easy add of further components to the ecosystem, widening the range of big data value creation from data acquisition to the analysis of data and the sharing of the data within the system as defined and controlled by the provider.

2.5.4 Application developers

With the IoT, smart home applications are the piece of software that allows the smart-home owner to control the devices and obtain information from the data gathering points installed. Serving as a user interface to the world of things, information is presented to the user so he/she can gain knowledge about his/her home and aspects of life according to a range of application fields applied.

Easy to install and free software
Smart home application developers often provide the devices for data acquisition, the storage solution, and data analysis capabilities in an integrated way. Often users can download smart home applications for free to their PC and smartphone. Whereas the user mostly has a choice regarding operating system (e.g., iOS or Android), a vendor specific communication hub has to be installed. Applications from many smart home solution providers are free. The hardware components, however, come with costs.

Integration into the data value system
When looking at the application development aspect of the IoT and smart homes broadly, the software part also comprises data analysis and data acquisition. In this instance, data acquisition means that the software itself enables the gathering of data and information without devices other than the computer or smartphone. Peoples' application usage and location data are examples of data acquisitions as determined by the installed software without the need for additional devices. It is important not to forget people themselves in the IoT, especially in areas like the smart home where it is not only about the control of machines, but the activities in everyday life of people in their environment altogether.

Depending on scale
Mobile application developers, in general, and smart home application developers, in particular, to the degree they did not yet scale up regarding their deployed smart home solutions and depending on their services they provide, may not be able to truly apply big data analysis. The volume of data available is just not diverse and voluminous enough. Applications need data to generate information and knowledge; application developers often face the problem of not having the data yet, as is required for big data analysis, especially when the application has only recently been launched. First, they have to convince enough users to use their applications so they can obtain the data. Bigger data analysis results in the development of more benchmarked and predictive services. This is an important driver for the creation of attractive user applications. Because big data results can be considered as a quality of applications determining the success of their adoption, application developers struggle to get into business at all.

Fast and low cost data acquisition is, therefore, important for the survival of many application developers. Engaging with users directly in a way having them create the network effect for viral adoption and the content by them is, therefore, a principle often attempted for realization. Another business model may be that an application developer is providing the software for another organization that does not have the data analysis and software programming skills but does have the data from which value can be derived.

If not financed by additional relatively expensive hardware, being contracted to complement the offer from a bigger data holder, or otherwise having data available, it can be difficult to run economically successful applications. Therefore, many of these businesses are acquired by bigger data holders, even before they become profitable.

Closed systems
Like the mentioned interoperability challenges regarding the connection of different devices with different technical specifications as provided by different manufacturers, there remains a lack of standard solutions enabling the integration of different software components in order to realize a vision of easily and modularly combinable applications from different vendors into an overall smart home platform.

3 Governance of smart home data

3.1 Definition of governance in the smart home context

3.1.1 General definition

According to Wikipedia (n.d.):

> Governance refers to “all processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organization or territory and whether through laws, norms, power or language.” It relates to processes and decisions that seek to define actions, grant power, and verify performance.” (“Governance”, para. 1)

This general definition provides for a broad, rather than enterprise specific, definition of governance fitting the concept such as the IoT, smart home ecosystem, and the big data value chain. Accordingly, the eco-/value system’s players are deciding and influencing the control of the system, including the users of the outputs of the system, through their activities as described in Section 2.4 and Section 2.5.

“The World Bank defines governance as ‘the manner in which power is exercised in the management of a country's economic and social resources for development” (Wikipedia, n.d., “Governance”). Putting data in the center of governance activities and having data defined as an asset and production factor, the World Bank definition suits the use of governance related to the IoT and big data value system.

3.1.2 Smart home data governance goal

Data governance
There are specific concepts about data governance, especially in enterprise environments, that target the effective use of data and information assets. However, building on the general definition of governance, it is basically nothing more than governance applied to a specific topic. Taking on the view of this work—that the IoT, smart home and big data topics are basically always about data—any activities to be governed are related to data as well. When speaking about smart home data governance, any steering/directing influences, whether directly affecting the management of data very specifically or the smart home ecosystem in general, are subsumed under the term.

Value creation by benefit realization and risk optimization
In Section 2.5, strategies of the IoT and big data system actors were described. The ISACA (2014) places governance within the context of strategic management and defines ‘value creation’ as the objective of governance, driven by stakeholder needs. Benefits realization, risk optimization, and resource optimization are the means by which this objective is reached. Benefits realization and risk optimization are discussed in Section 4.1.

Smart home data governance goal
According to the understanding gained so far, a smart home is dependent on how the value chain, i.e., the data value system, is governed. According to the definition of value,

Smart home data governance shall focus on how value is derived from smart home data for its users (citizens) through the realization of possible benefits and the optimization of possible risks.

This governance goal will be re-evaluated and updated if necessary later in this work (see Section 4.3).

3.1.3 Citizenship

Definition
The use of “citizenship,” according to Preuss (2003), originates back to ancient Greece in the early first millennium BC when independent city-states were emerging as a reaction against governing landowners or other powerful masters. And Preuss (2003) continues to describe: “The well-being of the community might be better served if its matters were conducted by a class of individuals who due to their personal qualities and resources were valuable for the community as a whole” (Preuss, 2003, page 1) Citizenship therefore is closely connected to the concept of democracy and community in general.

Leydet (2014) describes three dimensions of citizenship to include legal status, active participation in a society’s political institutions, and membership in political communities.

Citizen as stakeholder
When using “citizenship” or “citizen” in the course of this work, the definitions from above are meeting the need for setting the context for the meaning of the term. “Citizen” is used in this work to avoid using even more general terms, such as “individual” or “people” and to reflect the fact that it is referencing an active or activatable stakeholder. Therefore, the use of “citizenship” in this work can be summarized as being a local member of a larger society who also belongs to a societal system and communities, such as the city and the neighborhood.

3.2 Thesis

The Internet of Things and big data are emerging. Citizen participation is important for sustainable smart home provision.

3.3 Data value system SWOT analysis overview

Performing a Strength, Weakness, Opportunity, and Threat (SWOT) analysis aims to analyze these areas of the data value system. The analysis takes on the perspective of the governance goal of sustainably creating value for the smart-home users.

Because critics of SWOT say there is no prioritization applied to an often too extensive list of points, this prioritization here is done by choosing no more than four aspects for each part. Therefore, it is not a comprehensive list with the aspiration of a complete analysis. The selection of SWOT points is made based on reasoning for selection incorporated into the descriptions in the following sections. Table 2 provides an overview of the SWOT analysis as described in the following sections.

Table 3: Overview of SWOT analysis

Strengths	Weaknesses	Threats	Opportunities
S1 Availability and spread of Internet access	W1 Complexity and lack of interoperability	T1 Inappropriate use of big data generated knowledge	O1 Developing data value system (data market)
S2 Existing smart home technology	W2 Weak linkage of smart home and smart city	T2 Unsufficient individual control of privacy	O2 Reputation and trust
S3 Big data capabilities for the smart home	W3 Superficial and inconsistent data policies	T3 Lack of transparency and dominant data holders	O3 Software integration and data trading services
	W4 Lack of data pricing and trading services	T4 Missing or over-regulation and cyber war	O4 Learning, innovation and human values

The opportunities identified aim to meet the smart home data governance goal as set in Section 3.1.2 and shall serve as guiding principles for the development of a sustainable smart home setup proposition as will be outlined in Chapter 4.

To remember, the smart home data governance objective was stated as following:

> Smart home data governance shall focus on how value is derived from smart home data for its users (citizens) through the realization of possible benefits and the optimization of possible risks.

3.4 Strength: Technology capabilities

3.4.1 S1: Availability and spread of Internet access

Assuming that a smart home solution involves Internet connectivity for the transmission of smart home data to data pools and processing capabilities rather than home based stand-alone solution, Internet access plays an important role as a technology component of a smart home system.

In developed countries, open Internet access and smartphones are a commodity and, therefore, well positioned as an existing platform for deploying further personal assistance software such, as smart home applications.

Although there is news about potentially discriminating practices exercised by telecommunication companies that are not hindered by a responsible authority (see Section 2.6.2), access to the Internet and the affordability of wireless technology, such as used for connected devices and smartphones, can be considered a good precondition for the further development of the smart home sector.

3.4.2 S2: Existing smart home technology

Many products are available for a wide range of smart home application fields. New innovative functions and trendy designs complete a collection that is already established.
Some smart home providers not only integrate their own products into their solutions, but work toward making it more compatible with devices from other manufacturers and vendors. Even though interoperability remains a concern and complexity driver for installation, improvements have been made and further consolidation of existing protocol standards for the M2M communication can be expected in the future.

Smart home software's compatibility with common devices as well as its often free availability, easy installation, and ease of use are qualities of note. However, it might not always be clear whether these features are intending to provide good services (customer centric view) or to easily bind new customers (data acquiring corporate view).

3.4.3 S3: Big data capabilities for the smart home

Personalization often is used in combination with marketing strategies to confront potential customers with advertisements that fit their preferences. Google maps, for example, uses locations already visited as the basis for automated recommendations. In the smart home area, there are many opportunities to use personalization techniques to make the home environment more proactively responsive to the user's habits and to create value through more personally suitable assistance.

The smart home has the potential to become even more intelligent than to just have connected devices or provide personalized services. By adding big data capabilities, the development is going toward real artificial intelligence, meaning learning from signals, be it from human users or any animal, plant, or object. Any digitized data can be analyzed to recognize patterns and to predict future events and behaviors to improve the performance of the smart home system and its users in many ways.

The computing power and algorithms available to process huge amounts of data allow for the identification of correlations between data close to real-time and that otherwise would not have been possible. Because big data is not using a sample only, but also intends to analyze the whole population of data, it is more exact than statistical methods and can find every specific constellation.

Rather than being based on hypotheses or statistical probabilities, big data analysis allows for more accurate information and predictions. In the smart home area, these can be used to trigger communications, such as alerts or automated self-responses, by the machines freeing users from completing the tasks themselves.

From this perspective, big data capabilities seem to have the potential to complement human productivity and creativity in the smart home area.

3.5 Weakness: Integration and cooperation

3.5.1 W1: Complexity and lack of interoperability

Devices from different vendors are often not able to interoperate. A specific connected device platform has to be in place to connect a compatible set of home devices and appliances. This technology complexity represents a weakness that probably hinders a faster spread of connected things in the home and other areas.

That the smart home hubs are still required and have not yet disappeared (they could have been integrated into the cloud) signifies that the deliberating technology step has not yet been accomplished. The hub system also contradicts ubiquitous (omnipresent) computing. Let's imagine a citizen wants to take his/her smart home devices with him/her when on vacation; without the hub in reach, their digital presence is extinct.

At the Consumer Electronics Show in 2013, Samsung announced interoperability of devices forming a "system that links up washing machines, air conditioners, and kitchen appliances with its TVs, phones, tablets, and smart watch" (Simonite, 2014, para. 10). How effortlessly this will be realized was not yet clarified.

For accessing different sources of data for the data's possible integration in different software systems, the Internet cloud plays an important role providing APIs. However, looking at existing smart-home providers, the availability of such APIs represents a mixed picture. Three providers make available a developer interface, in only one case with subscription. Only one provider claims to make available a fully open API. Three examples do not offer APIs, and another one is undocumented.

For smart-home users, it would be important to have the possibility to interconnect their possible different data sources (e.g., from different smart home application fields) into their existing software platform. Making data easily integrated into any application would eliminate the current integration weakness.

Although strategies of data value system owners will expand into more verticals (in the case of smart home, these are the application fields) and go into the direction to add more smart home products and applications, it might be impossible for single players to provide an always updated comprehensive range of application fields alone.

3.5.2 W2: Weak linkage of smart homes and smart city

It may seem not obvious why the linkage of smart homes to the smart city represents an expected requirement. I have chosen this linkage as an important condition for the evolvement of a smart domestic ecosystem. The single homes and households are the cell of the city as a whole organism. Arguing that homes are already connected to the electricity, sanitation, and communication network, the analysis of the data for further insight and functionalities represents a logical next step. Smart cities are recognizing this fact for the mentioned technical areas. However, it is not only about these fields predestined for efficiency optimization. The homes, neighborhoods, and cities constitute a network of citizens and are involving in many more aspects of everyday life.

The lack of available platforms and initiatives facilitating a creative design of social applications connecting homes for new and enhanced possibilities for communication beyond current e-government advances with other homes and the city itself is, therefore, considered weakly developed compared to the potential such a bottom-up approach of connectivity (smartness) could comprise. Smart home solutions are not yet providing possibilities to voluntarily weave in local culture and communities as would be beneficial for solutions closer to citizens.

3.5.3 W3: Superficial and inconsistent data policies

Looking at current data policies from smart-home providers[2], different shape and detail levels of information can be found as following.

Upfront consent for shared personal data with third parties
Although it may be limited to aggregated data, as well as the requirement for anonymization, the share of personal data with third parties is mostly described in privacy policies not to be excluded, especially in the case that other vendors' devices are connected to the system or the providers are working with trusted third parties or other strategic partners. The reasoning used to legitimate the sharing of data is the improvement of customer services and integration of customer research. By accepting this data policy, a smart-home user agrees to all future events when data is shared with third parties. The smart-home providers, therefore, are neither obliged to explicitly obtain additional consent nor to inform the user about further details for these single specific cases.

[2] The privacy policies of the following smart home providers have been examined directly on their homepage: Staples connect, Phillips hue, Smartthings, Revolv, Insteon, Vera, HomeSeer, Crestron and Nest

Another reason to move data to other companies may be acquisitions, mergers, or re-organizations. Only in some instances is consent for new data users explicitly requested from users; the question whether and how data would be deleted in case of termination of the use of the products or services is treated superficially or is left open by the data policies examined.

Smart home providers seem to make use of the possibility to void the duty to disclose information on how data is shared with third parties for direct marketing purposes by letting users decide upfront whether their data will be shared or not. That data other than personal information and the sharing of data for purposes other than marketing are included in privacy protection measure was not seen in the examples examined.

Browsing and usage data
Less often than for personal data, the use of data from browsing or the smart-home devices themselves are specifically addressed. In some cases, the data from smart home products and services is used to publish trends, to help third parties provide demand-response services, and to improve the system generally.

Location of data storage
For example, Nest also informs users that data may be stored in any country where the servers reside, which raises questions about the jurisdiction under which data is stored and processed.

According to the observations made, smart home providers' data policies do not follow an integral and consistent approach ensuring that data is not shared with third parties that are unknown to the user. Also, the scope of the policies does not include all data and leaves questions regarding the retention and destruction when a termination of the service is envisaged.

3.5.4 W4: Lack of data pricing and trading services

Goal
The high value of data contradicts the low level of maturity of the mechanisms available for systematically sharing or even trading data. The argument is that tools should exist that allow any player in the big data value system to easily and transparently participate in the share of data. Because sharing inevitably will consider data's value, a pricing system for data, i.e., a market for data could develop as it has for other tradable assets too.

Data intermediaries
In some examples, associations are formed to share and combine data in order to create a more valuable result for more stakeholders. Mayer-Schönberger & Cukier (2013) state, "Inrix is the quintessential independent data intermediary. It collects its information from numerous rival car companies and thereby generates a product more valuable than any of them could have achieved on its own" (p. 135). It is unclear whether such alliances exist in the smart home sector that benefit the smart-home users in the sense that an organization is offering such data combining services for citizens.

Platforms for businesses and specialists
A platform for sharing data today, for example, is represented by data brokers, who act as intermediaries between data creators, holders, and users. Of course, at this intersection between demand and supply of data, contracts and payments are involved. However, there is not yet an open and transparent data exchange existing that is systematically organized and technically supported in a way that citizens could participate on at the same arm's length.

IBM (n.d.) is providing an integration governance function specifically designed for enterprise data management and data quality. The big data related solution helps “to manage diverse data across its lifecycle, protect sensitive information, and secure all enterprise data” (“What is Information Governance?”, para. 1).

Businesses also started to implement data-sharing models, such as taking commissions for data usage. A major divide seems to exist between the corporate and the public world. Citizens, in the future, to a more significant extent, contribute to the smartness and big data availability,but are seemingly still not taken into account as another equally important stakeholder in the value system, in terms of the data governance respectively data trading solutions available to them.

Mayer-Schönberger and Cukier (2013) document existing data pricing and trading, i.e., licensing solutions, such as the following:

> A number of marketplaces have sprung up to experiment with ways to price data. DataMarket, founded in Iceland in 2008, provides access to free datasets from other sources, such as the United Nations, the World Bank, and Eurostat, and earns revenue by reselling data from commercial providers like market research firms. (…) Import.io encourages firms to license their data that might otherwise get “scraped” from the Net and used for free. (p. 121)

Existing open APIs for the consumption of data from data holders are certainly a good start to make data sharing technically possible; however, they are by definition designed for a software developer community rather than for less technically skilled citizens. Smart-home users are not actively supported in deploying easily useable interfaces to their smart home data, although the functionality could be provided as a service like any other Internet service.

The idea that comes closest to meet the goal with a specific solution

As Mayer-Schönberger and Cukier (2013) state, “other startups have tried to be information middleman, platforms for third parties to share their data either for free or for a fee. The idea is to let anyone sell the data they happen to have in their databases, just as eBay provided a platform for people to sell the stuff in their attic” (p. 121). The last example comes closest to what could enable citizens in the future to participate in the market developing around data.

Because the recognition of data value and the enablement of the rightful beneficiaries is a crucial point, I also expect smart home provisions to consider it seriously from the beginning of the development.

Although startups are moving in the right direction and the market around data is in the early phase, low transparency, limited openness, and lack of proven solutions for empowering citizens to participate in the data market will be a weakness.

Problem of point-in-time-pricing of option value of data

In a blog article, Gutjahr (2014) discusses how LaterPay proposes to allow online readers to pay voluntarily after they have read the online content according to their value perception. The idea of a platform philosophy as LaterPay is envisioning would take into account the option value of data. However, whether the idea is perceived well and works as intended, appealing to consumer’s willingness to pay for value, has to be proven first.

In any case, the fact that freemium offers lack the impression that real value is delivered tends to justify the charge of online content consumption. As McEwen & Cassimally (2014) concisely state, “Not paying means not complaining. (…) Companies you pay treat you better” (p. 237).

3.6 Threat: Lack of individual control

3.6.1 T1: Inappropriate use of big data generated knowledge

Judgement based on big data
Besides the availability of the big amounts of data, the analytics part also plays an important role for the capability to predict future events based on analysis of big data volumes. Townsend (2013) writes that, if not made transparent for citizens, they "can never hope to understand the software that secretly controls their lives" (p. 297). The controlling aspect can be understood as Mayer-Schönberger and Cukier (2013) describe problems with big data related to its predictive capability: "the use of predictions to judge us. (…) by using big data to hold him responsible for his (future) acts" (p. 159).

In a bigger context, if citizens' future behavior is predicted by big data analysis and, assuming this can be done with a high probability, Mayer-Schönberger & Cukier (2013) are right when they state that, "if we hold people responsible for predicted future acts, ones they may never commit, we also deny that humans have a capacity for moral choice" (p. 161).

Understanding big data results
Translated to the smart home area, it is in fact a matter of concern, regardless of whether its users will understand why the smart home system acts and responds in a certain way. Just as a principal condition, it should be possible for the user of a smart system to investigate the reasons for the system's behavior in case he/she feels any need to do so. This principle would also provide for the competency required based on being able to take on accountability for how smart devices are used.

Using data for predictions requires more control of every individual over the data collected, i.e., more transparency about the software analyzing it and how the results are being used. Despite the power of big data to gain new insights and knowledge, the human non-data based investigations and reasoning should not be left out or even become more formally incorporated into the interpretation of big data results. Citizens' involvement, however, in these kinds of company or government internal processes has not progressed much yet.

3.6.2 T2: Unsufficient individual control of privacy

In the case of further smart home adoption, the trend of people generating more digitized data about themselves will significantly increase. For the organizations processing the data, this represents a big opportunity to improve their smart home services. On the other hand, the responsibility for protecting its customers' privacy becomes more important as well. The pressure for new revenue streams, however, can lead to business strategies that result in data policies as explained in Section 3.5.3. The fact that citizen-generated data is not guaranteed to not be shared with third parties without explicit consent is threatening the protection of citizens' privacy.

The data citizens' produce about their behavior, lifestyle, and environment can benefit them in many ways in many smart home application fields. But if data is shared with unknown parties, it is unclear for what purposes it will be used.

Lazakidou (2012) discusses a "fair trade" label that is similar to those used on food and can be created for data holders' practices regarding sharing data.

Surveillance and abuse of data
As revealed by Edward Snowden in mid-2013, the U.S. National Security Agency (NSA) is surveilling and monitoring citizens' digital communications, and the possible abuse of data

became even more clear. In a time where news about surveillance activities of the government and by subjectively questionable social and commercial power and practices of companies (such as collecting and using data created by or about citizens for other purposes than citizens have explicitly given consent) may weaken citizens' trust in the data-processing industry. This is why companies' alternative approaches, especially in terms of controlling personal data, are attractive for concerned users.

Citizen's loss of control over their data

Moreover, it seems not to be primarily a technical problem; it is about the intentions of data value system players and how data is governed in the value system. Available techniques, such as not to collect unnecessary data, anonymization and encryption would help to enforce data privacy. Today's approach for the provision of smart-home services requires citizens to transfer the rights for further use of the data to the provider. From this point on, legal control over the data is lost to the extent that data policy from the smart home provider is defining it.

Smart home data, as created from devices and appliances in the household, does not represent intellectual property and, therefore, does not automatically fall under the copyright law. Reasoning that the creator of the data can be seen as the legitimate data owner and that the data has the potential to generate more value in the course of its repeated use, this is is not equally reflected by the value returned in form of services, which are only compensating for the primary use of data that is transparent to the user. This does not constitute an equilibrated situation in terms of value exchanged between the current and rightful owners of the smart home data property.

Smart home data does basically not comprise of medical data, although data from (body) sensors for fitness and wellness purposes may come close to it. Nevertheless, considering the highly personal aspect of everyday lifestyles, data from one's own four walls is sensitive (even though it is not defined as such legally); looking at the health sector may be informative. In fact, the European Parliament (1995) states that "in order for personal data to be lawfully processed the entire data process needs to be analog to the dedicated purpose" (Article 4). Such a legal provision, however, does not exist for smart home data unless it would clearly fall under the category of medical data, which would lay the basis for regulating the current practice of sharing data with third parties without the explicit consent of citizens.

Difficult anonymization

In the big data area, it is not enough to only protect, as classically defined, personally identifiable data. Reducing the smart home-generated data only by this subset of data does not guarantee anonymization. Because data can be combined with any other data sets and types, it will theoretically always be possible to find links and patterns that will reconstruct the whole and, therefore, un-anonymized picture.

Schmidt & Cohen (2013) use the expression "re-creation of a model of the home in the virtual space" to describe how far the future of connected objects in a home could go. Analogous to the world of objects, individuals would not only be leaving single traces of online activities in the web but they would have a virtual identity. Delivering on the promise of the IoT, it will be possible to identify, interlink, and treat as a whole all single parts of information and interactions summing up an entire virtual identity. Similar to the real world, it becomes obvious how the possibility for guaranteeing privacy must be ensured as a basic need of every citizen. As I often hear, some people approach non-participation in the virtual world as a valid approach available to everyone without having to compromise on many benefits. In the extreme, however, as Schmidt & Cohen (2013) depict, "a government might suspect that people who opt out completely have something to hide" (p. 173). In addition, if privacy concerns lead citizens to the decision to opt out, this would

also exclude them from the many benefits of the IoT and smart homes. A much better option seems to be providing citizens with more control over their data to create trust for participation in areas where benefits are selected according to a citizen's needs and preferences.

Possible counter measures

Brinn (2014) was propagating at Princeton University an initiative "Reclaim Your Name," which aims to:

> empower the consumer to find out how data brokers are collecting and using her data; give her access to information that data brokers have amassed about her; allow her to opt out if she learns a data broker is selling her information for marketing purposes; and provide her the opportunity to correct errors in information used for substantive decisions. (Reclaim Your Name section, para. 1)

In an interview, the U.S. search engine company DuckDuckGo explains its success thanks to their strategy not to collect user data, such as IP addresses or unique browser identification data. Interestingly, their search engine optimization and provision of relevant advertisement works without collecting personal tracking data (Klotz, 2014). A similar alternative exists with Qwant, which does not collect personal data about the user; it also does not provide personalized advertisements.

As Scoble and Israel (2014) report, "EasilyDo, one of the personal contextual assistants we like, uses a 'Do-It' button that gives you an opportunity to override your software assistant before it performs tasks on your behalf. Google Now, the most popular PCA, does not have the equivalent of a Do-It button" (Chapter 12, Human Override section, para. 1)

3.6.3 T3: Lack of transparency and dominance of data holders

Scale matters

It is unquestionable that the services from data value systems' data holders are voluntarily chosen by its customers. However, what makes the services is not the software itself, but rather, the data that is used. If there were a much more convincing Facebook, from a functionality perspective, it would have a very hard time attracting people before achieving a certain number of people networked in the system in order to become attractive for the masses. Today's Internet services are often—and this might be true also for smart home solutions in the future—heavily dependent on the amount of data allowing for the application of big data analysis. The fact that scale matters is threatening the co-existence of a healthy number of competitors.

Lack of transparency and data value understatements

How much value is perceived by the user? The many cases that Internet services are offered for free may suggest that it is, from a provider perspective, nothing more than a plaything without more serious consequences—unless one believes that all provider revenue comes from advertisement in services where this business model is applicable, or the free provision represents a charitable activity. Therefore, such free services do not impose the real value of data. Whether low awareness about the real value of data is caused by lack of transparency by the service providers or negligence of self-information by citizens, the current willing acceptance of free services for leaving data ownership could have severe effects on future freedom regarding the further liberation of the option value of data for every individual and society overall.

Dominant positions

On its company home page, Google (n.d.) states that its "mission is to organize the world's information and make it universally accessible and useful" ("Company"). In order to make the world's information accessible and useful for the users, information has to be categorized and weighted; thus, most relevant information for a specific search can be found and presented. It will be very important for companies to remain transparent in how they organize the information, e.g., what data is not selected or treated with low priority for what reason.

Government can be considered a monopolistic data holder. E-government is a positive example for how, in democratic societies, an increasing amount of data is available to citizens for more intensive and better informed interaction with the government and the services it has a mandate for. Nonetheless, it remains at the government's discretion how much data is shared with a wider public.

As for democratic systems, hope remains that citizens will always have a voice in decision making. The possibility for decisive participation among individuals outside the management of corporations, however, seems to be limited; although the company itself may consider citizens an important stakeholder deserving consideration in how services are designed.

3.6.4 T4: Over-regulation and cyber war

Free Internet and data protection

Government can be an important driver for the spread of the IoT. For example, it could require sensors as standard equipment for certain devices and appliances, justified by security reasons. Governments may affirm that an open and free Internet must be an overarching goal. Regulation often is required in order to avoid chaotic situations that would be harmful for such openness and freedom.

For example, government wants to restrict access to content for legal reasons. Goldsmith & Wu (2006) report that "Clambake's materials were an infringement of copyright that Google was legally obliged to block. Google complied, and for a while, a search for "the secret library of Scientology" failed to deliver anything related to Operation Clambake. (…) an under-recognized fact: search engines like Google routinely block links because of possible governmental action." (p. 74)

However, if data protection went too far, it could hinder the freedom of how data today is shared over the Internet and, therefore, could hinder the data value system's potential for development.

Controlling the virtual world

Signs indicate that the open and borderless Internet is perceived as a threat to the control of the nation state. While governments control the physical boundaries of their countries in order to possess the power to protect and support the citizens, the international Internet society poses difficulties for governments to impose the same influential vigor. In particular, less democratic states want to directly or indirectly control the Internet by acting as gatekeeper to the virtual world, e.g., by controlling, monitoring, and sometimes limiting people's Internet access. According to Goldsmith & Wu (2006), "Today, regulations in cities like Shanghai, where Clinton went, require users to register with their national ID card before logging on" (p. 97).

National nets

The telecommunication sector is one of the most regulated areas because it delivers a strategically important good for the public: Internet access. Combined with its own interests, as a data value chain player, to get knowledge from the data flows through its

infrastructure, the telecommunication sector develops propositions to enable intra-national networks. Whether such national nets would hinder smart home development is difficult to say. Principally the reach for data acquisition could be limited to national boundaries, and therefore, the possibility to realize the biggest data possible would be limited as well.

Cyber war
Recent news about issues such as the espionage by the United States National Security Agency (NSA), which even tapped the telephone line of German Federal Chancellor Angela Merkel, give an idea of how technology can be used by governments against other governments. For governments, the importance of secrecy might be very important in many cases; surveillance and espionage can be considered attacks with the severity exceeding a just disturbing or unfriendly nature, but potentially leading to so-called cyber wars. For citizens, this threat can mean increased fear of being surveilled themselves, which in the light of connecting more data points from the privacy of the smart home to the Internet must be considered a threat for smart home specific use of the Internet too.

3.7 Opportunity: Bottom-up market development

3.7.1 O1: Developing data value system

As CB Insights (2014) reports, venture capital investments are increasing. Venture capitalists (VCs) “deployed $3.7B across an array of mobile industries from payments to app development in 2013. (…) In Q3 2013, venture capital investors poured $1.12 billion across 150 deals into U.S. mobile & telecom companies, marking the largest financing quarter to the mobile sector ever” (para. 1).

Kellmereit & Obodovski (2013) observed that “companies that offer home automation services, such as Control4 and Vivint (acquired in 2012 by Blackstone for $2 billion) are surging, and the decreasing cost of sensors, coupled with the growing ubiquity of smartphones, tablets, and high-speed wireless Internet, is enabling a raft of new applications” (p. 139).

Despite the competitive advantage of some data holders that they owe their massive amount of data available for big data analysis, there may be opportunities also for other existing players and new market entrants—namely, in terms of better reputation—to provide software systems that are improving interoperability between data silos and services that allow for trading data.

According to Kellmereit & Obodovski (2013), KDDI, a Japanese wireless carrier company, takes an interesting approach to drive their share in participation in the IoT by actively looking for uninteresting qualified low-revenue-generating connections. Kellmereit & Obodovski (2013) continue reporting about U.S. carriers who “for the first time had specific quotas for M2M connections for their salespeople; those goals gave M2M adoption a significant boost” (p. 20).

A press release about a new report from Juniper Research reveals forecasts that revenues generated from smart home services are set to reach a global market value of $71 billion by 2018, rising from $33 billion last year (Juniper Research, 2014, para. 1).

As the flow of data is crossing the boundaries of different technologies and businesses, the lines between industries and markets are blurring and forming into a data value system as described in Section 2.6. This can represent opportunities for new businesses by connecting, combining, and mashing the different technology components, as well as different stakeholders and smart home application fields.

3.7.2 O2: Reputation and trust

On one hand, big players enjoy a good position regarding the scale of network and the big data analysis capabilities they are able to leverage. On the other hand, their powers and revenue streams are difficult to explain transparently, and in some cases their involvement in using data for other purposes than expressly intended by the users, damages their reputation. Alternative solutions addressing these issues have a chance for developing a more trustworthy reputation.

3.7.3 O3: Software integration and data trading services

Software integration
With a view to a larger clientele, it will be a goal of Internet service providers to improve the integration of as many application fields and data sources as possible into their software platforms. For example, Google provides a forecast for how integrated personal assistant software could evolve further, having already included prediction based and proactive information services for many areas of daily life. As removing the struggle of data flow breaches, missing interoperability of applications, and the use of more data for more intelligent systems, news such as Google's acquisition of Nest Labs lets us imagine that it is only a matter of time until more integrated and intelligent smart home systems will be available.

For now, however, there remains the opportunity to enter the market. However, as discussed in a blog post:
The startups will have to step up with making their products smarter and less manual while the big companies need to move from their secretive product development phase into real implementation. (…) Not the manual implementations that we see today where the consumer has to manually add devices, manually set rules and otherwise tweak their networks with every new app update or device they bring into the home. Instead we'll see the launch of the anticipatory home—a home where devices aren't just connected, but also intelligent. (Higginbotham, 2014, para 1)

Data trading services
Examples in Section 3.5.4 have shown that solutions for data trade are rare and underdeveloped from emerging business models. As for any tradable asset, opportunities for businesses exist to find new ways on how data can be traded by a broader mass.

3.7.4 O4: Learning, innovation and human values

Learning and innovation
Education is a crucial means to harness the benefits resulting from the collaboration between machines and human beings. As the IoT becomes about everyday life, it will not be about technology for technology purposes itself anymore, but about how to use technology to improve life. The following is a good example for how this fascinating world can be made accessible for educational purposes: "TechShop … provides people with access to advanced tools, software and space. They invite makers to 'come and build dreams' for $125 a month or less. Individuals or small teams can frolic in a creative playground that includes over $1 million worth of equipment and software" (Scoble & Isreal, 2014, Chapter 6, Future-Makers section, para. 10).

The example of TechShop not only provides a good idea on how to facilitate learning, but also can represent a source of innovation, which is a most important factor for prosperity of the local and broader economy. It is unsure whether the innovation capacity of the industry has done an optimal job or not. In every case, many innovative and relevant applications of the IoT also should be expected from the bottom up, outside the research and development and IT departments of big profit-oriented corporations. The argument

herein is that nobody can know better about the specific needs citizens havethan the local people themselves.

Human values
An apt formulation for different stakeholders' values and visions Townsend (2013) is providing: "There are many different visions of what the opportunity is. Ask an IBM engineer and he will tell you about the potential for efficiency and optimization. Ask an app developer and she will paint a vision of novel social interaction and experiences in public places. Ask a mayor and it's all about participation and democracy." (p. 15) It is an opportunity from a smart home user perspective to have preferably all of these values addressed. In order to deliver on this view, a position closer to citizen's point of view should be taken on instead of or in addition to corporate managerial standpoints that risk, especially if oprating on a global basis, to miss considering important local specifics.

Crowd-sourced content creation is an opportunity that also many Internet service providers are exploiting. As for example the radiation level measurement network that was created after the Fukushima catastrophe, user generated networks and data are very effective means for relevant specific and local information. Since there are tendencies for more global and more local approaches, neither should discrimate the other be it coming from local interests or global ignorance.

It is also important that citizens have a voice in how they want to use technology. A compelling vision for how more human future technology use could become, comes from Kelsey Breseman, engineer at Technical Machine, who describes an "age of calm technology, when technology recedes into the background of our lives…(…) We could stop interacting with our devices, stop staring at screens, and start looking at each other, start talking to each other again." (Martin, 2014, para. 8)

3.8 Government's role

Despite the trust damaging news about which Section 3.6.4 reported, in face of government's real mission, government needs to be taken into account as a special (non-market, but market influential) stakeholder for the development of the data value system's sustainable value creation.

The government often earns its voters approval when spending taxes locally. E-government shows how beneficially the government's treasure of data can be made available for its constituencies for a more and better informed interaction. In addition to developing applications by the government or its contractor themselves, bottom-up approaches such as engaging small business or civic application developers and communities are important too in order to recognize specific needs other than efficiency goals typically addressed by corporations focusing the most attractive customer segments. For example, the government will hold app contests where it releases its data to developers for the development of applications. Optimally, these applications would be made available to citizens as open-source software free for use and open for further development.

One formulated vision of Brynjolfsson & McAfee (2014) is that government could "use taxes, regulation, contests, grand challenges, or other incentives to try to direct technical change toward machines that augment human ability rather than substitute for it, toward new goods and services and away from labor savings" (p. 245).
For the smart home this would mean that it could be seen as an opportunity not only for rationalizing processes, but to improve how people are assisted by smart technology to increase the quality of all areas of life. It would not be about gaining efficiencies only, but about creating new ways of living that would not be possible by machines or humans

alone, but only through supplementing each other. The government, and especially city mayors, is well positioned to govern in such a way that the data value system is realizing benefits and optimizing risks for the sake of such overarching goals.

Although smart cities also need to act on themselves to fulfill their responsibility, and although they often rely on companies that bring in their values in the planning of the city as well, particularly for infrastructure, the city government has the opportunity to take on a more balanced view regarding societal and commercial interests. It could even be imagined that governments would prefer to own the city infrastructure, such as broadband access, by themselves irrespective of its communities, rather than being bound by exclusive contracts with infrastructure companies. Such empowerment of the citizens would, at the same time, increase trust in government.

Government actions often tend to correct, rather than proactively steer, directions that a value system is taking. The timing is important, so that required development is not hindered but chaotic situations are adjusted.

3.9 Strategic themes

The SWOT analysis's results will be used as input for the smart home provision tactics, as described in the conclusion chapter in Section 6.2. The knowledge generated in Chapter 4, as well as the survey results from Chapter 5, will complement the body of knowledge.
As a preliminary more general indication of the strategic direction for defining smart home tactics, strategic themes as showed in Figure xxx have been identified. The strategic themes "good technology," "profitable business," "innovation and education," and "society and culture" were identified by logically categorizing the different strengths, weaknesses, threats, and opportunities. Because some SWOT points could be addressed and belong to different strategic themes, it was decided under which strategic theme the different SWOT points best fit.

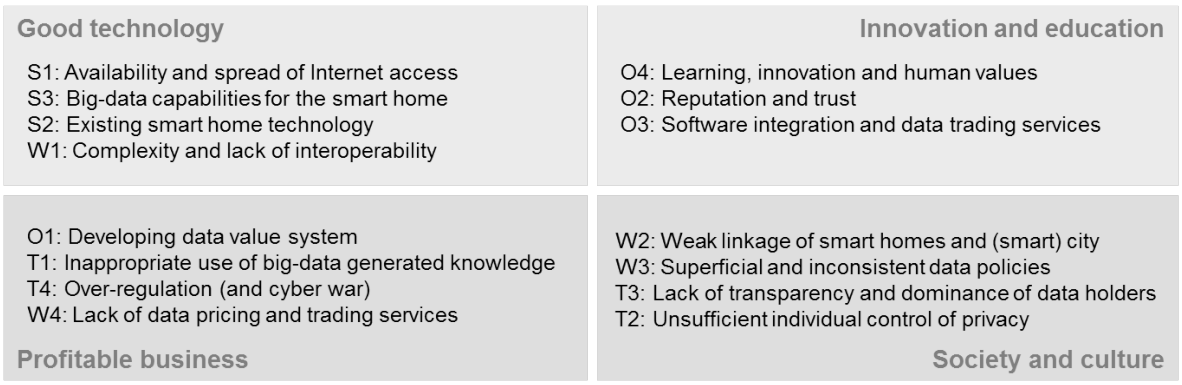


Figure 7: Strategic themes

The strategic themes provide guidance for the definition of the strategic pillars, which are defined later in Section 4.4 in the course of the development of a smart home provision setup proposition.

4 Sustainable smart home provision setup proposition

The development of a smart home setup is required to gain an understanding of the options available and to select how to present smart home applications and smart home service provider information in the survey research part of the work. Therefore, in the following, for each smart home application field (Section 4.5) and each smart home provider strategic pillar (Section 4.4), it is explained how the elements are taken into the questionnaire that was used for survey research (Section 5.1).

The goal of the setup is to provide a realistic scenario that includes selected sustainability elements. Results from the analysis of the data value system, as well as from the SWOT analysis, influenced the setup design as follows:

- presentation of the strategic pillar “innovation and learning”
- inclusion of two unconventional smart home application fields (for conventional application fields see Section 2.2.3) that implement an additional social component into the smart home offer—namely, “friendship and family relationships” (see Section 4.5.1) and “social engagement” (see Section 4.5.2)
- definition of a strategic pillar “citizen participating organizational form” that especially addresses equitable sustainability as further explained in Section 4.2 and the cooperative governance model as outlined in Section 4.3

Although ecology is a sustainable dimension, it is not specifically treated in this work. Instead, it is added as a strategic pillar to provide for a complete and realistically composite smart home setup.

The addition of sustainability elements to the smart home offer as described in this chapter is also informed by considerations such as the relationship between value and risk as described in the next section.

4.1 Relationship between value and risk

The namings of the smart home application fields already imply possible areas of value that can be created for its users, such as:

- health, fitness, and wellness;
- security;
- comfort;
- entertainment;
- cost savings;
- education, learning, and home office; and
- environmental protection

Current smart home offers do potentially not fully implement the potential of smart home data toward its revelation of shared data value, i.e., value created from big data. The still weak integration of different smart home application fields may negatively affect the persuasiveness of the smart home area on the one hand. On the other hand, the interoperability and combination of more technology and application fields might increase the likelihood for higher risk perception. The surprisingly slow marketing of technology that is already available might be a consequence of such a phenomenon. An assertion could be made that Google, for example, with its enormous amount of data and data analysis capabilities could present much more sophisticated services to a wider public than they do.

Diffusion theory lists relative advantage (perceived advantage, such as economic advantage or social prestige), compatibility with existing values and practices, simplicity and ease of use, trial-ability and observable results, as important qualities positively influencing the adoption of innovations (Robinson, 2009). For many people, the smart home is still a new concept.

Relative advantage and compatibility with existing value and practices
People's values can differ among groups of individuals, regions, and cultures. People rely on their personal preferences when taking decisions to adopt or not to adopt innovations. The data value system's weaknesses and threats (as identified in Sections 3.5 and 3.6) represent potential obstacles for adoption because they negatively affect the compatibility between the transported values of the data value system and the personal values and preferences of citizens.

Simplicity and ease of use
Especially complexity and lack of interoperability (see Section 3.5.1) is potentially hindering the adoption of smart home systems and the development of a mass market.
Interestingly, Zhang, Tan, & Xu (2012) found "five independent dimensions, perceived health risk, perceived quality risk, perceived time risk, perceived delivery risk and perceived after-sale risk which affect significantly online consumers' purchasing behavior. The results also show that the other three dimensions, perceived privacy risk, perceived social risk and perceived economic risk are the less relevant factors" (p. 1). However, this result must be considered within the context of consumer purchase behavior, influenced by the desire to immediately satisfy feelings of delight by buying new things, as Zhang, Tan, & Xu (2012) explain. Many new smart home offers today seem to address this behavior by offering easy to purchase, but limited, smart home kits combined with easy and freely downloadable software.

Without denying the benefit of a convincing purchase process, the installation and use of a smart home system is more long-term and constitutes an adoption of a lifestyle, which requires personal engagement for setting it up to enhance existing and new home applications, rather than the satisfaction of an ordinary purchase and consumption desire alone. For that, the prices of smart home systems for most people would still be too high. As the commercial aspect (the purchase phase) seems to be addressed by the smart home industry, the real use cases of smart home systems may still lack clarity, create uncertainties, and slow down adoption.

Trialability and observable results
Real smart home implementations are still not very widespread. Few opportunities exist to try to observe such a system, although the IoT technologies are already more present, as one might be aware of at first glance (e.g., GPS devices and smart TVs). The lack of transparency in the data value system (Section 3.6.3) and uncertainties regarding the appropriate use of big data generated knowledge (Section 3.6.1) are further aspects of concern because people lack the possibility to experiment with without any bigger investments or possible farther-reaching and severe consequences.

Risk: Uncertainty and seriousness of outcome
Risk perception might play an important role for how attractive smart home services appear to potential users. Featherman and Pavlou's (2003) paper, which might be taken as analogy for smart home (e-) services as well, underlines this by stating that "Consumers have shown reluctance to complete simple on-line purchase transactions (Hoffman et al., 1999), primarily due to risk concerns (Jarvenpaa & Tractinsky, 1999; Pavlou, 2001), and therefore, perceived risk is similarly posited as a prominent barrier to consumer acceptance of e-services" (p. 452).

Regarding the kinds of risk, Featherman (2003) writes, "Perceived risk (PR) is commonly thought of as felt uncertainty regarding possible negative consequences of using a product or service. It has formally been defined as 'a combination of uncertainty plus seriousness of outcome involved' (Bauer, 1967)" (p. 453). The smart home usage is still not yet widespread, and the important mechanism of gaining trust through the spread of

positive word of mouth is not effectuated. The seriousness of outcomes in the smart home field is severe because any everyday personal life aspect can be affected.

Following this reasoning, risk perception regarding the use of smart home data may influence the adoption of smart home products and services. For this reason, risk optimization is an opportunity for sustaining the perception of the benefits that can be realized from a smart home system according to its user's needs.

According to the ISACA (2013), which asked in a survey IT professional about benefits and risks of the IoT for consumers, showed the following results:

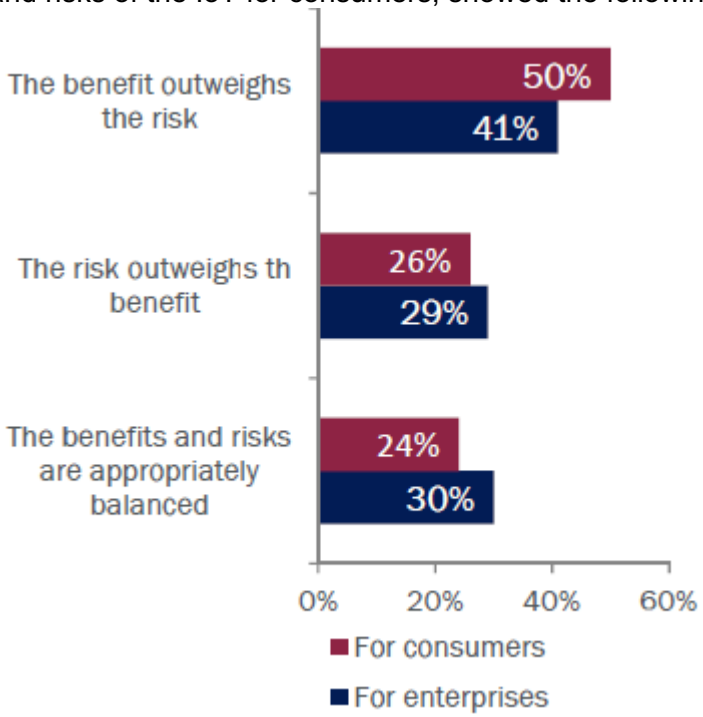


Figure 8: Benefits and risks for consumers and enterprises

Simply summarized, the report informs about an outweight of perceived benefits for consumers (with 50% of respondents thinking that the benefits outweigh the risks), while for enterprises the perceived risks were predominant.

4.2 Equitable sustainability

Income disparity

The World Economic Forum's (2014) Global Risks publication reports, "income disparity the most likely risk to cause an impact on a global scale in the next decade. Other risks of significant concern include extreme weather events, unemployment, and fiscal crises" (para. 1). Despite the extreme weather events mentioned, the most significant risks relate to economic wealth. The risk of income disparity might be interpreted as a negatively perceived inequality (disproportionality) of income among individuals.

Sustainability

According to Wikipedia (n.d.), "the word sustainability is derived from the Latin *sustinere* (*tenere*, to hold; *sub*, up). Sustain can mean "maintain," "support," or "endure." ("Definition", para. 1). Risk is "the potential of losing something of value, weighed against the potential to gain something of value" (Wikipedia, n.d., "Risk", para. 1). The World Economic Forum (2014) report rates income disparity as a risk because of the negative effects it can have on the middle class in developed countries, as well as the poverty in developing countries.

Equitable sustainability – economy and society

Sustainability as a guidnace for the governance of any system seems to be a good idea because it supports maintaining value for its stakeholders. For the data value system, the fact that data contains personal information about individuals and, therefore, is not only containing monetary value, but also information that potentially contains knowledge value for society, leads to the further idea that a twofold value presents an opportunity to discuss the synthesis of social and economic concerns in making sustainability considerations. Schmidt & Cohen (2013) summarize the bigger context for appreciation of the relevance of this two-fold sustainability perspective: “An estimated 52 percent of the world’s population is under the age of thirty, and the vast majority are what we call ‘socioeconomically at risk,’ living in urban slums or poorly integrated immigrant communities, in places with unreliable rule of law and limited economic opportunity” (p. 177).

The best term found to express a concept of sustainability that is considering economic equity as a precondition for social sustainability, is used by Güler & Crowther (2008) who argue that “sustainability cannot exist without equity in the distributional process.” (Introducing Equitable Sustainability section)

The term equitable sustainability is supportive in describing the identified opportunity regarding the contribution to a more sustainable data value system in general and smart home ecosystem in particular by this work by connecting the economic and societal aspect of sustainability.

Unequal power

The unequal power regarding data governance (e.g., Section 3.5.3, Section 3.6.2) and the existing monopolistic market situation (Section 3.6.3) of big data holders shall be considered under the equitable sustainability point of view.

For Sustainable Measure (n.d.), equitable sustainability is about economic fairness and “whether all people have similar rights, opportunities and access to all forms of community capital” (para. 1). Data collected from smart homes might be considered an intangible asset created by the data collecting community.

It is not the intention of this work to propose a socialistic economic approach. Within the capitalistic system, there is a potential for increased participation for citizens resulting in more favorable social and economic results. Capitalism does not pretend not to aim at common wealth and to produce social surplus.

In order to counteract against a possible imperfect data market, without having to wait for governmental, urban planning, or other community intervention and development activities, equitable sustainability is considered a good guide for the governance of smart home data. It could be beneficial for the smart home sector to consider to organize its governance from the perspective of a smart home community at the intersection of economy and society that is able to provide for control of smart home generated big data and to reap its benefits. Equitable sustainability applied to a smart home setup would not mean a wealth re-distributing approach. However, one category of beneficiaries of a smart home setup according to equitable sustainability would be the ones who generate smart home data, namely the smart home owning citizen themselves. The stake of a community member shall be defined by a fair measure of quality and the extent to which smart home data is provided. Therefore, data in this case can be compared to savings and investiments of other goods or assets.

4.3 Cooperative governance model

Data ownership (control)
First, there is an opportunity to balance between the ones who create digitized data, whether using a free service or not to do so, and the ones who benefit from its use, including potential future uses. Second, the question itself suggests who can be accountable for the control and protection of data—the one by whom and about whom the data was created. Clear data ownership would be a precondition for defining and executing on rights and responsibilities.

McChesney (2013) writes about the subject as it was written about by "economists like Richard Wolff, Juliet Schor, and Gar Aperovits: The wealth of a community has to be controlled by the people of that community" (p. 230). In addition, McChesney (2013) continues to list that, "There must be a strong commitment to a variety of cooperatives and non-profit organizations" (page/paragraph #). This proposition reflects the need for a cooperative governance model as a huge opportunity for governing the citizen created data in the data value system.

Collaboration
The IoT business cases in general, and smart home provision in particular, are requiring the creation of new products and services. These are best developed and operated in joint efforts in order to ensure interoperability and realization of the full innovation potential. For citizen managed smart home services, as opposed to smart home provider managed services, citizens will have to rely on the engagement of trusted specialists for taking over mandates for the different data value systems' activities.

Freeman, Harrison, & Wicks (2010) state, "Instead of trying to find and create arguments for one group's right to trump the rest, engaging stakeholders in creating as many win-win situations as possible lies at the heart of creating sustainable value" (p. 282). A possible general common interest in creating more data for broader and deeper business cases could be a good starting point for collaboration. Regarding the use of the data, however, it may be difficult to assemble the data value chain on ad hoc basis because involved parties' interests could be incompatible.

In contrast to the terms "participatory governance" and "collaborative governance," the cooperative governance model does not directly relate to state and policymaking. "Participatory governance focuses on deepening democratic engagement through the participation of citizens in the processes of governance with the state," as Wikipedia (n.d.) defines. Collaborative governance, on the other hand, has been defined by Ansell and Gash (2007) as, "A governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets" (p. 2). A cooperative governance model in comparison can involve any stakeholders by the means of the membership categories it has defined.

4.4 Smart home provider strategic pillars

For the description of the organizational setup of the smart home service provider, strategic pillars have been formulated. In order to provide a methodological framework to situate the strategic pillars in a strategic planning and management context, a combination of the COBIT5 IT governance and 3rd Generation Balanced Scorecard have been used for guidance. The following graph provides an overview.

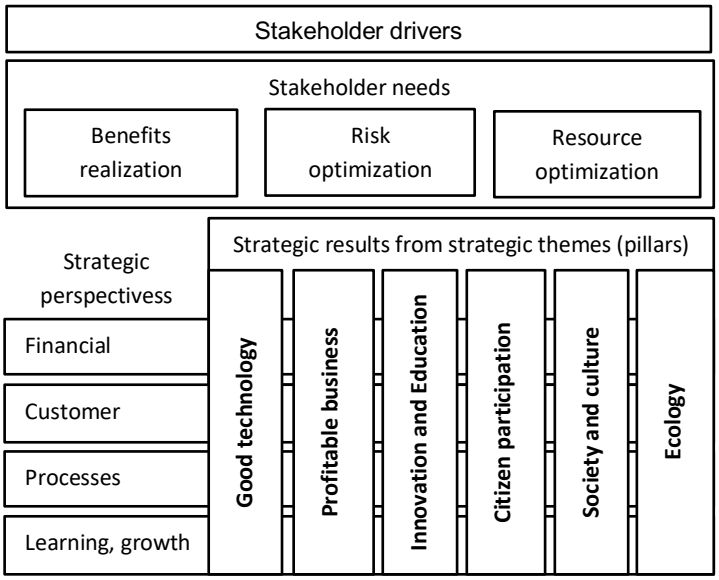


Figure 9: Strategic Management and Governance

The formulation of the six strategic pillars aligns to the aforementioned overall context of linking to stakeholder needs, which have been identified and described in Chapter 2 and Chapter 3, especially the categories of benefit realization and risk optimization. In order to create an overview of this link here, when establishing the strategic pillars, for each strategic pillar a set of strategic results is described in the following sections.
The descriptions of strategic pillars and related results are used for the survey questionnaire used in the survey (see Chapter 5).

In contrast to the strategic pillars, the Balanced Scorecard (BSC) strategic perspectives focus more on a corporate view strategic formulation and serve as a basis for the evaluation of strategic objectives and indicators, because “BSC is a tool to identify the 15–25 strategically most relevant aspects and to link them causally and hierarchically towards the long-term success measured by the financial perspective” (Figge, Hahn & Schaltegger, 2002, p. 279). This causal analysis is not part of this work and would be an area for future research.

The balanced scorecard perspectives can be complemented or renamed according to specific needs, e.g., Kaplan (1999) is doing so for the example of public sector organizations where the financial and customer perspective are combined into strategic themes. However, because this work is not aiming to justify an adapted set of balanced scorecard perspectives, from a more comprehensive and detailed strategic planning and management point of view, the possibility to add the additionally and specifically formulated themes of “Citizen participating organizational form”, “Ecology” and “Society and culture” as strategic pillars to the framework seemed to be a reasonable approach.

To sum up, for the high level, user centric and equitable sustainability focused further discussion, the creation of some thematic duplication between the strategic pillars and the strategic perspectives was created intentionally, and the strategic pillars seem to be appropriate to be used for further discussion and evaluation.

The description of the strategic pillars provides the background for why and how they have been formulated as they are, although some aspects between the pillars may be partially overlapping.
Not all aspects of the strategic considerations formulated in the next sections could be included and explained in the survey research questionnaire. According sub-sections for each strategic pillar provide information on how it was summarized for survey questionnaire purposes.

As an answer to the value system SWOT analysis in Sections 3.3–3.7, strategies for the development of a smart home setup have been identified and are specified in more detail in Section 4.5 for the application fields and Section 4.4 for the strategic pillars.

Generally, the strategic direction taken can be summarized as adding elements of equitable sustainability to the smart home application fields and strategic pillars. Regarding the addition of smart home application fields, to add “social” applications seemed to be important because these reflect the envisaged integration of human and machines, combining the Internet of people with the IoT.

4.4.1 Citizen participating organizational form

The citizen participating organizational form strategic pillar is the main response to several threats, weaknesses, and opportunities as identified by the SWOT analysis (see Section 3.3 – 3.7) and incorporates the legal constitution of a cooperative. Because it is considered the key transformational strategic element for a possible smart home ecosystem influencing all other strategic pillars as well, it is in the following elaborated in more detail. The other five strategic pillars are described in the subsequent sections. For simplicity reasons and to expose the cooperative principles that might influence all other pillars as well, the citizen participating organizational form was listed in the survey as one of the strategic pillars.

The cooperative organization could be seen as a smart home ecosystem novelty providing for institutionalized equitable sustainability. The following points do depict possible advantages and recapitulates reasons that led to the decision to choose a coopertive form:

- As already spurred, especially with opportunity of equitable sustainability and bottom-up approaches, the cooperative seems to provide the organizational form (as the most basic determinant for organizing the smart home provision for citizens) suitable to identify the possible benefits of these opportunities. The optimization of risks related to citizens’ use of smart home services can be addressed well by such an organizational form.
    - Because the data value system does not yet represent a well-developed and governed market, a multi-stakeholder cooperative could bring together a smart home ecosystem that is able to realize benefits from sharing data and, at the same time, to govern citizen’s data under their control and for meeting their values and interests.
    - The organization of collaboration within a smart home ecosystem by a cooperative could provide for an end-to-end solution provider and solving today’s challenges of having a single point of contact for system integration. A multidisciplinary integration of smart home technology components and

application fields by architects, interior designers, and electricians, together with smart home appliance vendors, and network and Internet providers, could provide for a more holistic smart home concept.

- Similar to the example of Privacy Rights Clearinghouse (PRC), a nonprofit consumer organization in the United States that informs about information holders' privacy policies, a cooperative could make transparent to its members what smart home data is used and with whom it is shared
- As citizens on their own would own the cooperative, there would be less divided accountability between the organization and the users of the products as is typical for business relationships. The users, therefore, could have the chance to balance better between accountability and competency by having the possibility to influence democratically how the data should be managed instead of having only options, such as to opt out, in case of disagreement.
- A multi-stakeholder cooperative could be capable to union and activate local smart home related businesses and stimulate employment.

4.4.1.1 Multi-stakeholder cooperative

Corporate social responsibility and stakeholder-friendly legislations, in general, may provide for social sustainability factors guiding an organization to some extent. However, Freeman et al (2010) point out that, "The problem of value creation and trade does not fall within the scope of CSR, unless the way in which the company creates value affects society negatively. CSR has nothing to say about how value is created, because ethics is an afterthought in the value-creation process" (p. 241).

For this project, with selecting a cooperative form, a more radical research setup with an inherent citizen participation element was created. Corporate social responsibility has a lot to do with stakeholder management. A cooperative, in contrast, goes much further by implementing governance by multiple stakeholders.

The cooperative organizational legal form incorporates a special type of corporate governance models. Co-operatives are, as defined by the International Co-operative Alliance (n.d.), "businesses owned and run by and for their members. Whether the members are the customers, employees or residents they have an equal say in what the business does and a share in the profits" ("What's a co-op", para. 1).

Cooperatives can be both not-for-profit or for-profit. In addition to conventional cooperative forms, whose members represent a single category, multi-stakeholder cooperatives are built on multiple membership classes.

> "Multi-stakeholder cooperatives (MSCs) are co-ops that formally allow for governance by representatives of two or more "stakeholder" groups within the same organization, including consumers, producers, workers, volunteers or general community supporters." (Lund, 2011, p. 1, para. 1)

Thus, there is the possibility for establishing multi-stakeholder cooperatives as a variation of member category cooperatives (e.g., as often seen in the form of consumer cooperatives in the food sector). A multi-stakeholder cooperative would be open for consumer, producer, community, and investor members. The still highly fragmented and weakly interlinked players of the smart home ecosystem could be brought together this way.

4.4.1.2 For profit organization

The envisioned approach in taking a multi-stakeholder cooperative as study object does make use of the possibility of a cooperative organizational form that does operate for profit and does not stand in contrast to capitalism. The decision to select a cooperative

organizational form for study purposes was informed by observations leading to concerns regarding the data value system, that need to be addressed from governance perspective.

4.4.1.3 Cooperative principles

A cooperative is “an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise,” as defined by the International Co-operative Alliance (n.d., para. 2). A cooperative is guided by seven cooperative principles: (1) voluntary and open membership, (2) democratic member control, (3) member economic participation, (4) autonomy and independence, (5) education, training and information, (6) cooperation amongst co-operatives and (7) concern for community.

The first three out of the seven cooperative principles—namely, open membership, democratic control, and economic member participation, as they directly affect citizens—are further elaborated in the following as fundamentally determining factors for the governance of a smart home providing organization.

4.4.1.4 Open membership

The availability of the Internet is the all-deciding element for smartness as defined through connectivity and building a basis for big data as well. The availability of the Internet is not discussed and taken as a given precondition, although there are signs that Internet governance is heavily competed with by governments and corporations, such as telecommunication firms. Cooperative owned broadband services would be a countermeasure for the case of lacking access to connectivity. However, as a working hypothesis for the setup, the connectivity aspect is not a primary concern under consideration.

4.4.1.4.1 Multi-stakeholder theory

Open membership in the case of multi-stakeholder cooperatives literally means participation of multiple stakeholders, such as consumers, producers, communities, and investors, as possible member categories. Following the reasoning from Chapter 2 and Chapter 3, smart home solutions and the use of collected data from the very personal and intimate domestic environment of a smart home represents sensitive data. The processing of this data in an unknown or untrusted environment out of reach or control can be suspect for many people. Corporations, however, strive to earn trust from their customers by formulating and publishing favorable messages. Nonetheless, Freeman et al (2010) believe that “a large body of work in CSR supports a view of business that is fundamentally “detached” from society.” (p. 260) In addition, they cite Wood (1991, p. 697) who stated that, “Freeman’s definition of stakeholders …brought the abstract idea called society close to home.” This is similar to the following concept, which is supporting a need for more closeness of a smart home solution providing organization to citizens: “Firms provide an important form of community between the individual and society. Stakeholder theory provides a lens for thinking about that relationship that should inform our view of the corporation, its purposes, and the legal structures that shape its function” (Freeman et al., 2010, p. 167).

4.4.1.4.2 Alternative to opt-out option

Open membership can also be understood as meaning access to a smart home service solution that is open to be shaped for user acceptance, rather than only having an opt-out option that would result in sacrificing the use of smart home and benefits as promised by big data.

4.4.1.5 Democratic control

Democratic control of the organization by its members allows them to proactively take a course of action without waiting for more lengthy political engagement and government regulation. Without waiting for release from the government for infrastructure or laws, democratically decided actions from citizens in a cooperative represents a strategic option for direct control over an organization's practices. Democratic control not only involves power, but also responsibility. The shift to democracy implementation directly into the organizational governance, e.g., the cooperative governance model, is forming its board of directors through election by its membership, and is leading to a more personal value system and possibly to a lower degree of delegation of accountability and dependency to less directly controllable institutions—both corporate and government.

4.4.1.5.1 Government's role

"Capitalism without government intervention would lead a society astray from ideal values," (Freeman et al., 2010, p. 279). A cooperative organization, although not denying capitalist principles, but through its membership's democratic control, integrates a more social capitalism. Given that, in a democratic society— where the citizen participating organizational setting is assumed to be installed—government is considered to act and intervene on the behalf of citizens.

A smart home services cooperative organization would provide for the possibility to take action as timely and specifically (smart home specific) as determined by its members. Governmental decisions may be delayed or not specific enough. The same is true when comparing to corporations, which are driven often by shareholder needs that might conflict with consumers' needs or the needs of other outside stakeholders, such as smart home ecosystem contributing producers.

"Hill and Jones argue that non-shareholder stakeholders also deserve representation by managers" (Freeman et al., 2010, p. 111). "In addition, shareholders have a difficult time maintaining the idea that their property rights are like other forms of property rights (e.g., owning a car or a baseball hat)—in that they lack possession and use of the property in question—and therefore cannot sustain demands for managements' unwavering commitment to their interests (e.g., Boatright, 1994; Donaldson & Preston, 1995)" (Freeman et al., 2010, p.205). This seems to be especially true when it comes to holding and using data from citizens; in this case, data from smart home application fields' sensing devices and appliances. Of course, corporations provide products and services in the interest of their customers. Further uses of data, which are possibly not intentional, by the smart home data creators are, however, a topic of concern because resulting profits are not transparent to the data owners. With the possibility for direct democratic control, smart home users could better impose their data ownership rights, not having to rely on corporate management's commitment alone.

4.4.1.5.2 Data based decisions

Another area of concern for which I think ideally more democratic control is required is the key ability of big data analysis to make predictions toward future behavior. This new capability does not necessarily reveal the cause side of the cause and effect equation. Therefore, it is important to consider who is using predictions, how, and for what purposes. If a potential customer is receiving unappealing commercials, this is one thing. A much bigger issue would it be if government officials use predictions to pre-judge citizens for actions they have not committed, nor plan to commit. Closer involvement in the process of interpreting prediction results should always stay a basic right for every citizen, whether for more accurate judgments or for better learning by discovering reasons that led to the predictions. The chances to ensure this right are probably higher if citizens have a say in the organization where their data is analyzed.

4.4.1.6 Economic member participation

Freeman et al (2010) report that authors such as Christensen, Andrews, & Guth (1965) include obligations to "stakeholders other than stockholders" as important elements of strategy. (p. 85) The obligation to segments of society other than shareholders in a cooperative setting is not only achieved by acknowledging it, but is incorporated by organizational definition and structure—the basis for including appropriate economic participation of citizens as an organizational obligation as well.

With appropriate economic participation, on the one hand, there is more equal distribution of ownership and monetary profits to other stakeholders than shareholders and management. On the other hand, it shall also be about the best possible realization of the potential that can result from innovation.

4.4.1.6.1 Virtual world's ownership

Taking the physical world's land as an analogy for the virtual world's data, it becomes obvious that ownership might be a serious consideration. While the available land remains constant, more data can always be created, one could argue. However, speaking in terms of the virtual world, the number of subjects and objects potentially generating digitized data is constrained by the phyiscal world.

4.4.1.6.2 Monetary profits

There are tendencies for shifting the focus of social responsibility to increased organizational accountability. In addition to such an approach, data asset valuation and inclusion in the financial statement would further benefit transparency regarding the true value of data (see Section 2.3). Data created from smart home users actually should stay the possession of its creators, rather than being contracted otherwise, e.g., by applying terms of use and data policies that try to withdraw ownership rights from users. Hesitations for the realization of such ideas may be not only a question of a firm's intent but it is also manifested in the legal organizational forms in the capitalist society and may have its justification as well. However, data asset valuation and related financial reporting, which is logic as a standard for firms basing their business heavily on value creation and trade with data created by and about individuals, would be a good means to enable appropriate economic participation of citizens in a smart home solution provider organization.

4.4.1.6.3 Value creation

As indicated in Section 2.2.2, the necessary "killer applications" that boost the smart home adoption seem to be missing. The technological possibilities are amazing, but because the ecosystem itself is not yet working as a harmonizing system, the standards for sufficient interoperability and integration are not yet in place. The critical limitation though is less the technology than the ecology players themselves. In other words, these players so far were not able and willing to create more value for customers.

Starting with ideas based on real smart home users' needs rather than unilaterally planning for profitable business is a suitable approach for real value creation. However, locally and niche grown solutions also have to reach scale in order to reap the benefits of big data. Once scale is reached, however, the temptation to be taken over is high. In such cases continued and unimpaired creative and entrepreneurial drive for value creation can be at risk.

For the creation of a collaborative, interoperable, local and stable smart home ecosystem, the idea of a smart home full-service provider cooperative could represent a feasible organizational approach.

4.4.1.7 Summary of rationale for citizen participation

Uncertainty exists regarding the progressing digitization of the world and the possibilities and dangers that the use of big data can bring. The Internet of everything (people and things) will not only change specific areas of life, but also necessitate a paradigm shift regarding how to use and protect data.
Who other than citizens themselves can bear this responsibility? To bind citizens formally in an organizational setting allowing them to decide on how value from data is created and to allow them to take over responsibility in the use and trade of their own property according to their intent could become a valid alternative to today's tendency of evolving private and public data holder dominance, which can hinder benefit realization and risk optimization and ultimately hamper a more sustainable data value system.

It seemed to be most straight forward for survey research purposes to express the element of citizen participation as distinct as possible by proposing a citizen participating organizational form.

4.4.2 Good technology

Technology addresses smart home related weaknesses and threats as listed in the SWOT analysis in Chapter 3.

Smart home technology should be designed for use by all. Therefore, reduced complexity, especially when it comes to interoperability between technology components and the integration of different application fields, e.g., supported by a smart home platform, is very important. In addition, products (e.g., devices and appliances) should be designed and configured for easy accessible integration with other systems and devices, and should ensure and protect important areas of domestic life, including security and health.

Special focus should be paid to data protection. Any kind of smart home data can become sensitive. Therefore, along the whole data flow and data life cycle data protection has to be ensured according to defined rules. Risk-based preventive and detective controls have to be implemented into the ecosystem's different components and be monitored and independently tested.

For any technology decision regarding data protection and data privacy, especially where existing laws and regulations are considered insufficient, decisions can be taken by the means of the democratic control of the members of the proposed smart home cooperative.

Summary used for survey questionnaire: Good technology (trouble-free, safe, easy to integrate, and persistently available services and information)

4.4.3 Profitable business

For a business to be profitable constitutes a requirement that ensures the independent continuation of the operations of the smart home cooperative. Resources should be used efficiently, and profits used for investments and to be shared by the cooperative members are important. Rather than profit maximization as a primary goal, the ability to provide affordable products and services for the cooperatives members should be prioritized.

The cooperative form of the smart home provider democratically ensures that profits are spent according to the will of the cooperative members, and that smart home key products and services are incentivized and priced in a fair way for its members.

Summary used for survey questionnaire:
Profitable business (moneymaking business, efficient organization, competitive offerings)

4.4.4 Innovation and education

Innovation and education is another crucial strategic pillar. Compared to big corporations' capacities to mobilize for research and development, the advantage of a multi-stakeholder cooperative organization as envisaged is the close and effective cooperation of multiple stakeholders regarding the smart home ecosystem. Specific local needs and preferences can be identified easily through the cooperative access of the organization to the smart home users. Ideas evolving from the bottom up—e.g., by promoting ideas and application contests, engaging with schools and other educational institutions—provide a distributed and enriched innovation approach likely to benefit the specific everyday life and local needs.

One means to foster innovation and education could be a smart home lab, inviting members to practically learn and to experiment and exchange with other smart home cooperative members. Because having a smart home is not only about technology, but also about how to use the technology, according workshops could provide for an additional educational means.

The evaluation of new smart home solutions shall be made transparent to the cooperative members so that awareness regarding smart home developments can be created and the solutions evaluated according to users' needs.

As part of the strategic pillar of innovation and education, the value of the collected smart home data should be made transparent to cooperative members. Reporting on the data asset would allow for making informed decisions on where to invest and how to trade the data asset, e.g., for licensing to application development companies.

Summary used for survey questionnaire:
Innovation and education (useful products for reaching smart home goals by new and meaningful ways)

4.4.5 Ecology

Ecology already can be seen as a "conventional" smart home application field because a growing number of ecologically sensitive citizens are using these technologies. To see ecology as an integrated application field, as well as a strategic pillar, possible synergies could be realized. If ecology is combined with smart home goals, such as cost saving and security, a larger group of potential adopters can be identified.

Incentives for ecological behavior could be defined for the smart home cooperative. Whether competitions on an individual or individual household level or just achievements measured for the overall smart home community and, if possible, within the context of information from the city as well, ecology related helpful and motivating goals and information should be part of the strategy.

Summary used for survey questionnaire:
Ecology (protection of the environment, thoughtful handling of natural resources)

4.4.6 Society and culture

Societal and cultural considerations build an important cornerstone for the setup of a smart home claiming to fulfill equitable sustainability aspects. Much of the results of this

strategic pillar aim to build trust among the citizenship for a flourishing smart home ecosystem. A socially sustainable smart home ecosystem should provide its users with a self-chosen and transparent infrastructure wherein the primary goal is to enable cooperation for a better quality of life, rather than invasive technology collecting data for others interests.

Furthermore, the smart home solutions should serve a diverse range of people, especially children or elderly people with special needs for development and care. The smart home cooperative should provide the organization and the tools for everyone to reach his or her smart home goals.

The smart home cooperative, thanks to its multi-stakeholder characteristic, can shape the smart home ecosystem as a common effort, e.g., by deciding to provide job opportunities for students and foreigners or to foster smart home start-ups. Cooperation with other cooperatives as well as with local government is another way to intensify support and exchange for the benefit of a sustainable smart home ecosystem.

Appreciating local culture, art, and language would foster a local identity that could have positive effects on the quality and frequency of real-life interactions, which are building the trust necessary to also contribute with digital means to a smart life.

Summary used for survey questionnaire:
Society and culture (solutions for social needs, such as care, support, and exchange of services, as well as concern for the neighborhood and for regional art and culture)

4.5 Additional smart home application fields

Instead of using an existing organization—whether this was an enterprise or a business unit of an enterprise—the organizational setup has to be defined. For this setup, an imaginary citizen participating smart home full-service provider was defined in the last section and is used as a study object in the furthe course of this work.

I am not aware of an existing smart home cooperative. The future will show how the current trend toward digitization of the physical world will bring in terms of new governance models. As more disruptive as the IoT will be, the more radical businesses and society could be affected. The setting of this sustainable smart home provision proposition intends to anticipate a progressed state of IoT development, having become ubiquitous in the area of smart homes.

In the questionnaire used for the survey research, a smart home full-service provider was described as providing products and services around devices, sensors, Internet data storage, apps, etc.. It was the intention to draw the picture of a “one-stop-shop” solution within which products and services regarding all smart home application fields, as well as the topic of personal data storage, were possibly included.

This section represents the horizontal view on the smart home ecosystem, which is giving an indication of what kind of personal data can be involved. Personal data, as defined by the WEF, is digital data created by and about somebody.

Furthermore, this section provides the foundation for the questionnaire evaluating potential users’ preferences regarding fields of usage.

Last, but not least, the examples, however realistic or futuristic they are, let one imagine the value of smart home usage will bring for their users.

Remember, an overall use case for smart homes was not yet found. The trend toward smart cities and the emergence of local communities led me to judge the goals and needs identified as important enough to introduce new elements into different smart home application fields as well as to add two additional, seemingly "unconventional" smart home areas, representing the social aspect of a possibly more socially integrated smart home overall solution.

Smart home application field summary descriptions have been presented in the survey questionnaire. The following introduction to the smart home was given in order to make sure that too futuristic and technically specific aspects were not included in the application field summaries in order to avoid confusing or intimidating respondents:

Introduction used for survey questionnaire:
"Smart home" is used as a generic term for technical processes and systems in homes and houses, which focus on increasing quality of life, safety, and efficient use of energy by the means of networked devices and installations, as well as automated processes.One speaks particularly of a smart home if all devices used in the home are remote controlled and networked with each other and the devices can store data and develop their own logic. A smart home includes a programming interface that can be addressed (also) via the Internet and can be controlled via expandable applications (e.g., control of the household through the Internet [cloud] and an iPhone app).

4.5.1 Friendship and family relationships

Family member home presence detection and notification, user specific device and appliance usage preference recognition, baby, disabled and elderly watch by the means of motion or sound monitoring, and remote pet feeding are smart technology supported processes that help family members take care of each other. Special family devices—such for playing games together or socializing by sharing and coordinating information and activities—integrated with social networks with other relatives and friends are further examples for what is meant by this usage field.

In addition to the facilitation of the purchase of a smart home system and the tendency for a prevalence of smart home offers addressing efficiency, safety, and entertainment, social applications could be offered to include in smart home systems; they are already widely accepted. Emphasizing the facilitating of social interaction within the family and neighborhood, providing a platform for sharing and organizing could shift the value from technology-based to human-based.

Summary used for survey questionnaire:
Friendships and family relationships (e.g., smart home integration with social networks, communication, and coordination)

4.5.2 Social engagement

In addition to the usage field of friendship and family relationships, social interaction with the neighborhood and the local area can be integrated into the smart home information and management system. Peer-to-peer marketplaces and platforms for the organization of support, care, and charity activities are imaginable areas for the use of smart technologies and services.

The goal of the introduction of this "unconventional" smart home application of social engagement is to build in a social component serving to connect to a possible smart home community. Such connectivity would allow for the creation of a local identity and, while privacy must be maintained, still would allow for better arrangements for living together. This smart home application, in contrary to promote a purely virtual community, aims to

encourage face-to-face interactions and the facilitation of real local social activities and projects, especially those related to the promotion and use of smart homes.

Summary used for survey questionnaire:
Social engagement (e.g., babysitting, sharing, etc.)

4.6 Strategic directions

The overall setup is defined by the smart home as described by the smart home application fields (Section 4.5) and the smart home service provision as explained by the means of the strategic pillars (Section 4.4), it is summarized in the following table.

Table 4: Sustainable smart home setup

Application field	Applications	Strategic pillar	Strategic results
Health, fitness and wellness	E.g., activity, body functions and sleep tracking armband, light wellness therapy, dental cleaning app	Good Technology	Trouble-free, safe, easy to integrate and persistently available services and information
Security	E.g., electronic monitoring, alarm system	Profitable Business	Money-making business, efficient organization, competitive offerings
Comfort	E.g., convenience	Innovation and Education	Useful products for reaching Smart Home goals by new and meaningful ways
Cost savings	E.g., better consumer offers, reduced consumption needs	Ecology	Protection of the environment, thoughtful handling of natural resources
Entertainment	E.g., multi-media integration with Smart Home	Society and Culture	Solutions for social needs such as care, support and exchange services as well as concern for the neighborhood and regional art and culture
Education, learning and home office	E.g., distance learning, self-paced learning, working from home	Citizen participating Organizational form	"Smart Home" multi-stakeholder cooperative with open membership, democratic control, as well as economic participation of members
Environmental protection	E.g., energy consumption and waste management		
Friendships and family relationships	E.g., Smart Home integration with social networks, communication and coordination		
Social engagement	E.g., babysitting, sharing		

Sustainability dimensions				
Economy		Society		Environmental
	Equity			
Strategic perspectives				
Finance	Customer	Internal processes	Learning & growth	Non-market perspective

For study purposes, ecology is taken into the questionnaire to build a complete picture; for analysis purposes, however, equitable sustainability, and namely the economic and societal dimensions of sustainability, are the focus.

Figure 10 builds on the strategic themes identified in the course of the SWOT analysis (Section 3.9). Knowledge has been generated about the citizen participating organizational form as well as factors for sustainability, such as understanding the relationship between value and risk (Section 4.1), equitable sustainability (Section 4.2), and cooperative governance (Section 4.3) in the context of the data value system. Based on that knowledge, integration, distribution, transparency, and awareness have been identified as strategic directions.

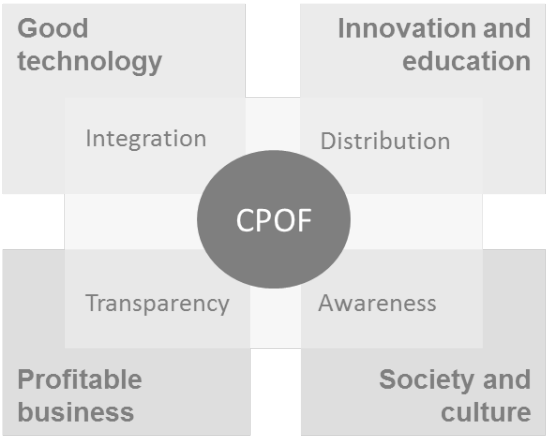


Figure 10: Stretegic directions
CPOF = Citizen Participating Organization Form

The multi-stakeholder cooperative is proposed as a strategic pillar to provide an organizational form that facilitates the integration of the smart home technology components, to provide systematic education, and to foster a distributed innovation approach by collaborating between the organization and its members. While aiming to generate profit, creating more transparency would be an important strategic direction to inform the nature of contracts and transactions. The strategic direction of increased transparency would serve as a cornerstone for enabling citizens to become aware of why and how their contribution and participation would be important for the socially and culturally beneficial development of the smart home and the data value system in general as well.

5 Evaluation of the proposed smart home provision setup

5.1 Survey research

5.1.1 Questionnaire, population, and sample

Questionnaire

The structure of the questionnaire aimed to allow for introducing a topic that could not be considered to be equally familiar to all respondents. A mix of different answer types (closed and open-ended) and formats (fill in, scales (e.g. Likert-scale), rankings and open-ended) have been used according to the goal of the questions. The questions and question types are explained in the according analysis section later on in this Chapter 5.

The questions intended to be neutrally formulated and to be answered from a personal perspective. However, where the questionnaire did present already pre-composed concepts, possible limitations of the level of detail at which consistently comparable data was collected has to be taken into account. There have been open-ended questions introduced in order to get information about whether respondents did have difficulties in interpreting the question or whether the question did not address important points, which has been proved to be very useful.

The questionnaire was implemented with Survey Monkey and took respondents between five and ten minutes to complete, what should not raise questions about attention span issues.

The survey invitation was sent to 571 people through social and professional networking online platforms. 124 people did respond, what represents a seemingly usual or good response rate of 21.7 %. Motivation to participate in the survey could be an interest in the topic or in doing a favor. This is another reason, why the survey results cannot be considered to be sampled in a probabilistic way allowing for statistical tests.

The response percentage within the questionnaire was 93%, since out of the 124 responses, 8 highly incomplete answers have been useless. There the number of valid responses was 115. And another 6 sets of answers did show missing answers or answers not possible to validate for only one specific mandatory question due to actual or perceived technical problems. Respondents did seldom use the given possibility to answer with “Don’t know” and where it did appear it was considered for the results.

Almost three fourth of the respondents were male. This might be a result of using the authors professional network rather than lack of interest in survey participation by women.

Age categories among the respondents was as follows:

- 18 – 24 years old: 5; 25 – 34 years old: 36; 35 – 44 years old: 57, 45 – 54 years old: 12, 55 – 64 years old: 5

Hundred respondents’ origin was Europe. 47 respondents indicated to live in a rural area and 68 of the respondents said to be urban residents.

5.1.2 Smart home adoption

5.1.2.1 Smart home application field adoption likelihood

With the question, “How likely would you use more smart home (smart living) technologies for the following capabilities/goals in the next two to five years?” the adoption likelihood of the nine presented smart home application fields among the 116 valid respondents was measured. The results were sorted by level of probability of adoption in descending order.

Because the distances between the different Likert-scale items (from 0 = “very unlikely to 4 = “very likely”) can be considered as uniform building a regular interval, the sum was built for each sub-question in order to get the overall strength according to the ratings of the respondents, resulting in a table ranking the adoption likelihood of the smart home applications fields.

Table 5: Ranking of adoption likelihood for smart home application fields

	0 very unlikely	1 unlikely	2 maybe	3 likely	4 very likely		
Application fields	N %	N %	N %	N %	N %	**Sum**	**Rank**
Entertainment	5.2%	5.2%	11.3%	40.0%	38.3%	346	1
Education, learning and home office	2.6%	7.8%	15.7%	40.9%	33.0%	338	2
Comfort	3.5%	6.1%	22.6%	36.5%	31.3%	329	3
Cost savings	7.0%	13.0%	26.1%	27.0%	27.0%	315	4
Security	3.5%	7.8%	23.5%	41.7%	23.5%	292	5
Environmental protection	15.7%	15.7%	24.3%	22.6%	21.7%	290	6
Health, fitness and wellness	3.5%	12.2%	32.2%	33.0%	19.1%	252	7
Friendships and family relationships	13.0%	19.1%	36.5%	20.9%	10.4%	226	8
Social engagement	11.3%	27.8%	33.9%	21.7%	5.2%	209	9

N = number of respondents: 116
For details regarding absolute likelihood counts per smart home application field please see Appendix 1-1a

For details regarding absolute likelihood counts per smart home application field, please see Appendix B.

The applications fields that are ranked from 1 to 5 received between 78% and 54% of all respondents’ agreement for “likely” or “very likely” adoption within the next two to five years. As the response “maybe” clearly separates from “unlikely,” it still can be considered as not hindering a further future (mass) adoption. That being said, for all application fields, there is no negative outlook regarding its future adoption.

Rank 1 to 7 is taken without exception by conventional application fields. The application fields “Friendship and family relationships” and “Social engagement” that intended to address a more social and human aspect, to cover the last ranks. The result confirms a common characteristic of the conventional smart home application fields compared to the additionally defined social fields. While social media is well adopted, there seems to be a disconnect of social applications for the respondents to the smart home. Whether the less likely adoption of the social application fields is due to the opinion that there is no further need to address these topics, or whether the home is considered a private space not requiring further social linkage, or whether there are other reasons, it is not identified by this work.

In absolute terms, it can be observed that there is a bit a bigger cut between Rank 6 and 7; overall, however, no application is totally cut off showing a clear tendency for non-adoption. Although the social application fields are the only ones that have slightly more votes for “unlikely” than “likely,” a third of the respondents for these fields rated their adoption likelihood as “maybe.” This supports the analysis of the big growth potential and opportunities that the smart home market represents (Section 2.2.2).

5.1.2.2 Special interest in smart home

Survey participants were also asked whether they have a special interest or reference regarding smart homes (e.g., as an urban planner, a civil hacker, or as an enthusiastic technology user/data collector, etc.); 45.2% responded positively. Although this result is assessing the smart home concept as an interesting one, it has to be considered that interest in the topic may have constituted a certain predisposition among individuals willing to participate in the survey.

5.1.3 Opportunity and risk perception

5.1.3.1 Likert scale anwers

Respondents were asked whether they saw more opportunities or more risks as more and more data and information (such as from the smart home area) created by them and about them is collected and used: 49.6% saw more opportunities and 43.5% saw more risks. A relatively small number of respondents saw neither more opportunities nor more risks.

Table 6: Opportunity and risk perception

		Count	Percent
Valid Values	More opportunities	57	49.6%
	Neither more opportunities nor more risks	8	7.0%
	More risks	50	43.5%

N = Number of respondents is 115

This result is consistent with the ISACA (2013) survey report cited in Section 4.1, which states that IT professionals think the IoT outweighs in terms of benefits for its consumers.

5.1.3.2 Open ended answers

The questionnaire was asking respondents to express their view freely regarding the statement:

- Question 1: It is a race going on, a race for data and information that are already known as the oil of the present time?

For the analysis, similarly focused comments in the open-ended/free text answers from the following questions had been included.

- Question 2: Regarding the previous question (ranking the smart home full-service provider strategic pillars): What has made the decision(s) for you most difficult?
- Question 3: Your additional thoughts, experiences, or questions?

The analysis of the questions presents the following results.

- 99 of 115 respondents stated agreement with open-ended question Nr. 1, 13 partial agreements, 1 disagreement and 2 “not applicable” were notified.
- 60 of 115 respondents in at least one open-ended answer addressed the need for governance of data (need for benefit realization and/or risk optimization). This was somewhat influenced by the questionnaire as the formulation of open-ended question 1 (see above) was tendentious.
- 49 of 115 mentioned data privacy protection or technology security aspects (although the questionnaire did not go in a technology direction, and was quite balanced as an overall perspective).

Answers have been studied and categorized according to key words identified in order to be useful to provide insight about respondents’ thoughts about the kinds of opportunities,

risks, and specific governance needs they are concerned about. The allocation to the governance topics is made by judgment, and some answers could possibly be listed under different or multiple categories. The original answers and categorization can be found in Appendix C.

The analysis does not consequently structure into opportunity and risk sub-sections, but summarizes the responses by topics that often could represent both.
From the set of answers from open-ended answers, no representativeness for any population can be made and the respondents cannot be considered as serving the same purpose as expert interviews would do; thus, the responses are put in relation with the analysis done during the detailed SWOT analysis in Sections 3.3 – 3.7. The analysis of the open-ended answers serves to identify whether relevant strengths, weaknesses, opportunities, and threats are a potential consideration for the respondents.

5.1.3.2.1 Compatibility with personal values

As explained in Section 4.1, meeting personal values is important for a product or service to become adopted. Main points that met respondents' value expectations from the data value system were:

- Better search results and information
- Personalized advertisements
- Reasonable price

One respondent explicitly stated that he did not have any interest in smart home products and services. The wide interest of the overall sample, however, was shown in Section 5.1.2. Others did not deny their possible interest, but did indicate that technology is not yet available or that the purposes (the benefits) of the technology, e.g., for a better life, is not yet obvious. One statement mentions difficulty in evaluating the smart home provision because of the gap between beliefs and values and actual behavioral reality.

A balanced view between opportunities and risks was stated several times, e.g., by contrasting the added value that smart technology provides on one side, and the influential abuse of provisions of useless information and loss of privacy (transparent consumer) on the other side.

5.1.3.2.2 Easy to use, safe and interoperable technology

Simplicity, safety, and compatibility
Simplicity, safety, and compatibility of technology were mentioned as important by a relatively high number of respondents (14 statements out of the 60 have been identified) although the questionnaire did not ask after this specifically. Examples were provided, such as the ease of use of a TV, an iPhone, or the trust creating security standards that are applied in cars. For interoperability, the easy transmission from legacy equipment in building (such as cabling) and the practical (and inexpensive) installation of smart home solutions within the existing environment, especially where it would be in a rented home, were highlighted. One respondent informed that today's software is not able to provide for control of data flow throughout the smart home ecosystem.

Four times, the inconvenience created by data overloads such as email floods, was depicted and a wish for reduction of intensity and complexity was expressed.

Useful and transparent results
Proper big data analysis capabilities are needed in order to make data useful over time, which was recognized by three respondents. Another one concluded that because of increased interrelation and abstraction of services, more transparent information about smart home services is required too.

5.1.3.2.3 Uncertainty

Uncertainty and severity of outcome (see next sub-section) are, according to the Section 4.1, seen as influencing factors for the adoption of innovations.

One respondent expressively stated he knows what is possible with today's technology. A series of other survey participant, however, stated different areas where they feel uncertainties, such as the following:

- Technology security (e.g., technological failures)
- Data protection (examples provided were protection of privacy because of the risk of surveillance, especially in more corrupt societies, and cyber-attacks also on individuals)

In a more general way, a number of responses indicated a lack of transparency regarding how the market around data is working and stated that it is hard to say what consequences the emerging data value system is bearing. Smart home offers, related contracts, and reporting are not yet transparent enough.

These examples can be attributed to be the data value system's players' duties. Several statements from survey participants estimated the need for information also to be a self-responsibility of citizens as they are, according to the respondents, not aware of what can be done with data; they give away their data too deliberately and users of digital services should be aware of the risks when leaving data uncontrolled in cyber space.

5.1.3.2.4 Severity of outcome

Dangerous development
Eight instances of expression of the perception of "danger" regarding the development of the *"*race for data" were found in the three open-ended answers.

Superficial and inconsistent data policies
Nine survey respondents explained agreement with the development of increased data collection and data value by providing examples of how personal data is shared, sold, stored, and used by third parties. The examples were commented with "more and worse," "for very high prices," "used against the original intention," and "questionable whether data is used ethically or profit oriented only." This result very much supports the weakness of "superficial and inconsistent data policies" as discussed in Section 3.5.3.

The respondent's answer that stated that more transparent information about smart home services should be available goes into the direction of emerging offers, such as an information platform about data brokers' data policies and practices.

Section 3.6.1 identified the threat of inappropriate use of big data generated knowledge. Survey respondent comments were given about big data becoming a primary source for decision making, higher risks because of possible correlations between different data sources, and the importance of a correct interpretation, especially of private and confident information. The examples were completed by a statement appreciating the opportunities of big data on the one hand, and the risk that data could be used against people on the other hand.

Unsufficient individual control of privacy
Also, the topic of "insufficient individual control of privacy," as identified as a possible threat in Section 3.6.2 too, was brought up explicitly by 11 respondents. The words and phrases can be summarized as following:

- Transparent consumer
- "Big brother is watching you"
- Problematic of privacy protection in less democratic environments
- Lacking security capabilities
- Risks also in terms of criminality
- "Safety must come first, then personal benefits"
- "State knows everything about people"
- Individuals are losing control over their data
- Need for possibilities to opt-in and opt-out at any time

Lack of transparency and dominant data holders
Several comments identified that the seriousness of outcomes is going farther than punctual individual effects, but is affecting whole markets and is being related to power from knowledge that can be used in general. It was also mentioned that the "race has pretty much been decided by now—major players are unlikely to surface in the foreseeable future," pointing at dominant positions, such as hold by big companies who also have been named—namely Google, Apple, Facebook, and Samsung. These kinds of answers show the sample sensitivity regarding the threat outlined in Section 3.6.3 "Lack of transparency and dominant data holders."

5.1.4 Missing or over-regulation

The relatively frequent topic of regulation in the free text questions is consistent with the result of the questionnaire's Likert scale question: "Do you believe there needs to be more and better laws/regulations for the handling of personal data?" 87% answered this question positively with "rather yes" or "yes". Although an unusual high representation of consultants and auditors have been in the sample, this still indicates concerns that need to be addressed.

In order to reach better stability and trust in the digital market, more legally sound and enforceable legal provisions, such as for data protection, should be present, as a couple of respondents stated. In one response, doubt was expressed whether it is even already too late to even take corrective actions.

Analogous to the Section 3.6.4 on "over-regulation and cyber war," two survey participants question the further developing potential of the data value system because increased privacy protection (e.g., as counter-reaction against the NSA scandal) could become too big of a constraint for related businesses.

5.1.5 Smart home provider strategic pillar ranking

5.1.5.1 Strategic pillar ranking table

Respondents were asked: "If you could shape the smart home full-service provider (for products and services around devices, sensors, Internet data storage, apps, etc.) organization of your confidence, how would you rank the following areas by importance (1 being most important and 6 being least important)?"

Five respondents expressed some difficulties regarding the perspective of the question. Despite the difficulty in prioritizing the importance of the different strategic pillars, the respondent's comments indicated that they assumed a user/customer view, as it was the intention of the question.

Table 7: Smart home provider strategic pillar ranking

		Rank selection (count)					
Smart home provider strategic pillars	***Mean (Diff.)***	***1.***	***2.***	***3.***	***4.***	***5.***	***6.***
Good technology	2.25	47	21	18	7	7	5
Innovation and education	3.11 (-0.86)	10	34	20	22	13	6
Ecology	3.36 (-0.25)	18	17	21	21	14	14
Society and culture	3.66 (-0.30)	11	15	19	23	28	9
Profitable business	4.16 (-0.50)	14	9	12	16	19	35
Citizen participating organizational form	4.46 (-0.30)	5	9	15	16	24	36

Table 6 shows the mean of the received rankings from all respondents for each strategic pillar (in total 105). This allows for sorting of the strategic pillars in decreasing order of importance as reflected by the increasing mean values.

The clear winner in terms of importance for the respondents is “good technology.” “innovation and education” follows in second. Smart home is, of course, first about technology, so the result may not surprise. If the question had to be answered from a perspective other than as a customer, the pillar of “profitable business” probably would have been ranked higher.

The strategic pillar of “citizen participating organizational form,” on which the analysis focuses most, is rated as least important by the overall sample.

5.1.5.2 Difficulties in ranking decisions

After the strategic pillar ranking question survey, participants were asked what had made the ranking decision most difficult for them. Out of 97 valid answers, 16 answered this question with no difficulties. The remaining 81 free text answers were analyzed for content and key words and categorized. Three categories of difficulty were found in the answers: balance, importance and interpretation.

Balance
When having had balancing difficulties, it was difficult, in general or between specific strategic pillars, to balance them; in other words, the order of ranking posed challenging decisions. When focusing on specific strategic pillars, “good technology,” “profitable business,” and “ecology” were mentioned most often.

Importance
Difficulties regarding importance were expressed in general or for specific strategic pillars for which it was hard to evaluate their position in the overall ranking or for more than one strategic pillar, where these were considered of same importance, causing difficulties to prioritize between them for ranking purposes. Those kinds of problems were stated for all strategic pillars in the same frequency.

Interpretation
Interpretation difficulties occurred in a general manner, such as uncertainty regarding what the smart home full-service provider really means and what the set of strategic pillar in detail in the smart home and big data context would be about and what consequences their definition would have. “Understanding” and “imagination” were words typically used to describe that the question required respondents to judge a setup for which according experiences were missing.

Four times, “citizen participating organizational form” was explicitly mentioned as being difficult to grasp. All other difficulties related to interpretation were not pointing to specific strategic pillars. This observation supports the finding that the “citizen participating organizational form” in fact represents a new approach. For many respondents, the cooperative organizational form itself might not be well known, while the combination with the smart home area might be an even more novel idea to most of the participants.

5.1.6 Risk perception as a negative driver for adoption

Respondents were asked, “Do you see more values or more risks as more and more data and information (such as from the smart home area) created by you and about you is collected and used?” Table 6 provides an overview of the result. For more details, see Appendix 1.

Table 8: Comparison of adoption likelihood means for value and risk perception

Application field Value/risk perception	***ENT***	***EDU***	***COM***	***COS***	***SEC***	***ENV***	***HEA***	***FRI***	***SOC***
More value (Mean)	3.26	3.14	3.25	2.95	2.91	2.81	2.75	2.37	2.00
Difference	-0.52	-0.40	-0.83	-0.45	-0.77	-0.57	-1.11	-0.83	-0.38
More risk (Mean)	2.74	2.74	2.42	2.50	2.14	2.24	1.64	1.54	1.62

N = number of respondents is 115
Legend for application fields: ENT = Entertainment, EDU = Education, learning and home office, COM = Comfort, COS = Cost savings, SEC = Security, ENV = Environmental protection, HEA = Health, fitness and wellness, FRI = Friendships and family relationships, SOC = Social engagement

The cross-tabulation of the smart home application fields’ mean adoption likelihood (from 1 = “very unlikely” to 5 = “very likely”), differentiated for the groups perceiving significantly or rather more value or significantly or rather more risk, showed for all application fields that for respondents with prevalent risk perception, adoption likelihood was significantly lower than for the more value perceiving group.

All application fields’ likelihood for adoption was reduced if respondents were risk sentient. However, the “health, fitness, and wellness” application field was stronger negatively affected by the perception of risk, compared to the other application fields. Together with “comfort,” the field of “friendship and family relationships” was also a particularly risk sensitive application field.

The assumption that risk is destroying value (Section 4.1) was confirmed by the survey analysis results. The question specified the values and risk in association with the collection and use of smart home data. This allows linking the result likewise to the specific governance of smart home data with the objective to create value. Smart home data governance, therefore, should steer in a way that not only benefits are realized, but also risk optimizing actions are taken in order to positively influence users’ perception of value created from smart home.

5.1.7 Risk Perception and Citizen Participating Organizational Form

It was analyzed whether a relationship of value and risk perception toward the ranking of the strategic pillar of “citizen participating organizational form” could be found. Indeed, the 50 respondents indicating more perceived value (respondents answering “rather more value” and “significantly more value”) in comparison to the 48 respondents who perceived more risk (answering “rather more risk” or “significantly more risk”) did evaluate the “citizen participating organizational form” to have lower importance (expressed with a

higher mean, indicating a ranking closer to the last ranking position of 6) as the overall sample did. The group perceiving more risk, in contrast, evaluated citizen participation as more important as the group that perceived more value and also more importance than the overall sample mean.

Table 9: Influence of value and risk perception on CIT ranking

Value / risk perception	***Mean CPOF ranking / (Difference to sample)***	***Count***
More opportunity	4.62 (0.16)	50
More risk	4.33 (-0.13)	48
Overall sample / total	4.46	105

CPOF = Citizen Participating Organizational Form

The "citizen participating organizational form" was proposed as a means to enable the creation of value in the data value system for the smart home users by better realizing benefits and optimizing risks. As the personal value and risk perception of the respondents is influencing the adoption likelihood of smart home application fields, the same might be true in terms of their evaluation of strategic themes. The result above being judged as significant, therefore, is expressing that for the sample analyzed, the "citizen participating organizational form" represents a valid possible means for creating value and optimizing risk.

5.1.8 Social application fields likely adopters' citizen participation ranking

Besides value and risk perception, a further relevant precondition of survey participants for how they would judge the importance of smart home provider strategic pillars could be their favoritism of certain smart home application fields. In order to prove or reject this assumption, it was analyzed how the likely adopters (including the answers "very likely" and "likely") of each smart home application field ranked the "citizen participating organizational form" strategic pillar.

Table 10: Likely adopters' CPOF ranking means (per smart home application field)

Smart home application fields	***Mean CPOF ranking***	***Difference to overall sample mean (4.46)***	
		Absolute	*Symbolic*
Entertainment	4.49	0.03	-
Education, learning and home office	4.36	-0.10	+
Comfort	4.60	0.14	- -
Cost savings	4.43	-0.03	+
Security	4.45	-0.01	+
Environmental protection	4.51	0.05	-
Health, fitness and wellness	4.39	-0.07	+
Friendships and family relationships	4.26	-0.20	++
Social engagement	4.27	-0.19	++

N = Number of respondents is 82
CPOF = citizen participating organizational form

The respondents who indicated a higher likelihood for the adoption of the conventional smart home application fields (number 1 – 7 in the table above) tended to rate the importance of the citizen participating organizational form slightly lower compared to the overall sample. One exception is the "education, learning and home office" application field. This could be interpreted as that respondents who were valuing this application field highly are generally seeking opportunities to become involved and to learn actively;

therefore, they rated also positively the importance of a the citizen participating organizational form.

The unconventional social smart home application fields “friendship and family relationships” and “social engagement” as they represent the social aspects added to the set of application fields were expected to be liked by respondents who also would appreciate a citizen participating organizational form. In fact, these two application fields’ likely adopters produced a mean ranking of the “citizen participatin organization form” strategic pillar that is lower than the one of the overall sample, meaning that they find higher importance for citizen participation respectively a cooperative organizational form compared to the overall sample and the other application fields’ likely adopters.

5.2 Summary

First, the survey analysis did help to support findings from the data value system analysis and the related SWOT analysis. The following paragraphs are summarizing these.

Secondly, because no radically new aspects were brought up by the survey respondents compared to the analysis performed in the course of this work so far, it provided confidence having considered a broad range of most relevant aspects. New ideas, i.e., indications for prioritization of smart home provisioning setup elements, have been provided.

Valuable and safe technology as precondition for value creation
First, it will be important that value is created. For example, one respondent commented, “…waiting without patience for technology …”; technology advances are expected to come from the smart home ecosystem in the future.

The overall positively likely adoption of the smart home application fields in the future and the outweighing perceived opportunities seen support the outlook to a growing smart home market.

Importantly, there was a clear prioritization of the “good technology” strategic pillar, followed by “innovation and education.”

Opportunity and risk perception
It is important to consider that perceived opportunities of the IoT, big data, and the smart home area might be based on past experiences (such as experienced benefits from the use of data for marketing purposes), and on the other side based on expectations that are still not yet clearly and widely realized. As the option value of data is not yet clear in many cases, the future value of smart home solutions contains uncertainties. Many respondents see more opportunities than risks for the collection and use of smart home data, but this does not necessarily indicate an optimal perception of great value. Many comments were received regarding the collection and the value of data that indicated concerns. Many of these concerns may be caused by uncertainties due to the yet emerging market and its data governance.

Risk perception is destroying value
Risk perception is destroying value—what was successfully measured by changes in the adoption likelihood of the smart home application fields for respondents that perceived more risks than opportunities.

Smart home data governance
The survey respondents’ answers indicate an important risk category being technology related, but inequality in power and lack of control of data with economic and social

consequences was mentioned by respondents as well. Although this is indicating possible needs for data governance, it would be of too much interpretation to derive a finding that the weakness of “lack of data pricing and trading services” (Section 3.5.4) and the opportunity of “data trading services” Section 3.7.3) would have been somehow more explicitly covered by the answers collected by the survey.

Sustainable smart home provision setup evaluation
Within the overall smart home provision setup, so considered sustainable elements—such as the smart home application fields “friendship and family relationships,” “social engagement,” and “citizen participating organizational form”—as a strategic pillar have not been recognized as more popular than what makes a conventional set of application fields and a non-cooperative organizational smart home provision setup. In contrary, the added sustainability elements were, in terms of likelihood for adoption for the application fields and in terms of the ranking of importance of the strategic pillars, the least well perceived elements of the overall setup.

Risk perception and social application adoption likelihood are positive factors for a higher ranking of the “citizen participating organizational form” strategic pillar.
The need for weighing a citizen participation component in a smart home provider context with increased importance was seen by respondents who are expecting more risk than opportunities from the data value system. The “citizen participating organizational form” therefore, can be evaluated as providing this group of concerned respondents a means for the effective mitigation of risks. This group of potential “citizen participating organizational form” proponents shares a further common tendency or characteristic. Compared to the overall sample, likely adopters of the social smart home application fields “friendship and family relations” and “social engagement” are ranking the “citizen participating organizational form” strategic pillar as more important.

Positive relationship between sustainable elements
The positive relationship between the sustainable elements tended to be risk driven rather than opportunity driven, as it was demonstrated that increased risk perception leads to an increased adoption of social smart home application fields. These were then the application fields whose more likely adopters ranked the sustainable element of “citizen participating organizational form” higher than the sample mean did.

6 Synthesis and conclusions

6.1 Towards S.M.A.R.T. tactics for sustainable smart home provision

When trying to synthesize the insights gained from the data value system analysis (Section 2.6), SWOT analysis (Sections 3.3 – 3.7), and the survey research (Chapter 5) into a strategic framework that specifically addresses different stakeholder views (value system players, government and citizens), governance elements (value creation by benefits realization and risk optimization), and sustainability dimensions (economic and societal), the following framework was developed.

The smart home sustainability framework (Figure 10) illustrates the different starting points of consideration in terms of adoption and sustainability. As the survey results found, technology was the most important for the sample analyzed. Therefore, user adoption can be seen as the ultimate basis, not for sustainability per se, but for the sustainability of the smart home ecosystems and data value system in the sense of being supported by its users.

Therefore, the smart home sustainability framework aims to be a useful tool facilitating strategic discussions around the data value system. Situation specific elaboration and positioning of SWOT points would allow for specifying and concretizing such discussion for a specific organization or environment.

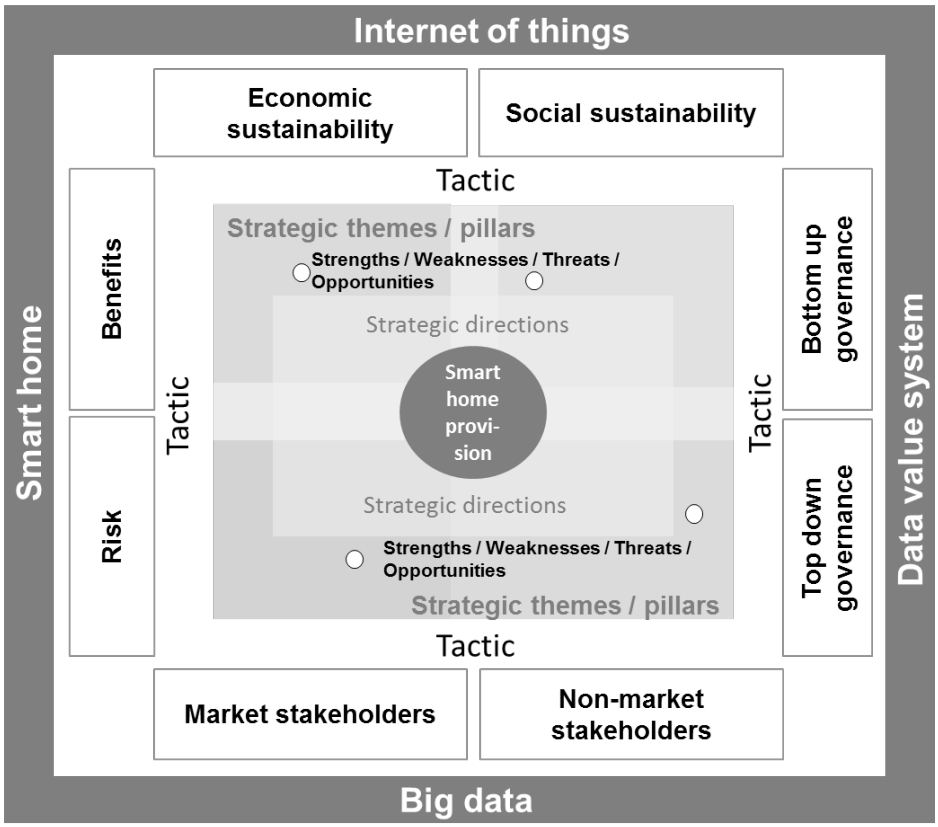


Figure 11: Smart home sustainability framework

The smart home sustainability framework can serve as a tool to prioritize and summarize a sustainability analysis for the generation of actionable recommendations. In the next sections, tactics for smart home provision—namely, combine, balance, do both and institutionalize—are explained that bring the most important points of each sustainability view of the radar into relationship with each other. This will prove the frameworks' usability

for systematically addressing sustainability needs across different sustainability views and using different strategic elements and governance aspects.

The thesis does not go so far as to consequently define specific objectives in detail (although SMART (**S**pecific, **M**easurable, **A**ttainable, **R**elevant, **T**ime-based) criteria are used as guidance) to achieve the smart home **data governance goal of creating economically and socially sustainable value for citizens**. However, the SMART criteria shall be considered for the discussion of possible future tactics that address the smart home data governance mid- or long-term goals (Section 3.1.2), the strategic directions (Section 4.6), and the strategic themes/pillars (Section 4.4). The tactics proposed in the following sections can be used as a basis for the definition of more detailed action plans for implementation and for more specific objectives for strategic planning and management.

In the following sections, selected SWOT points have been focused, i.e., for each tactic opponent points (strengths and opportunities versus weaknesses and threats) were selected. Although most of the SWOT points were somehow considered in one or more tactics, the possible width and depth of tactic definitions is not exhausted. Nonetheless, the examples provided aim to be sufficient for the purposes of providing a synthesized summary of knowledge and findings as elaborated in the chapters before.

6.1.1 Combine: Technology and education

Tactic

Combine commercial and human drivers. Reduce complexity and lack of interoperability and harvest the opportunity of integrating software and data trading services.

Selection

The survey research result indicated a high importance for the strategic pillar of good technology (Section 5.1.5) for which the SWOT weakness “W1: complexity and lack of interoperability” (Section 3.5.1) is representative. Opportunity “O3: software integration and data trading services” (Section 3.7.3) is chosen because of its specific proposition of offering data trading services, what I consider as an upmost priority if citizens really should get a stake in data’s value.

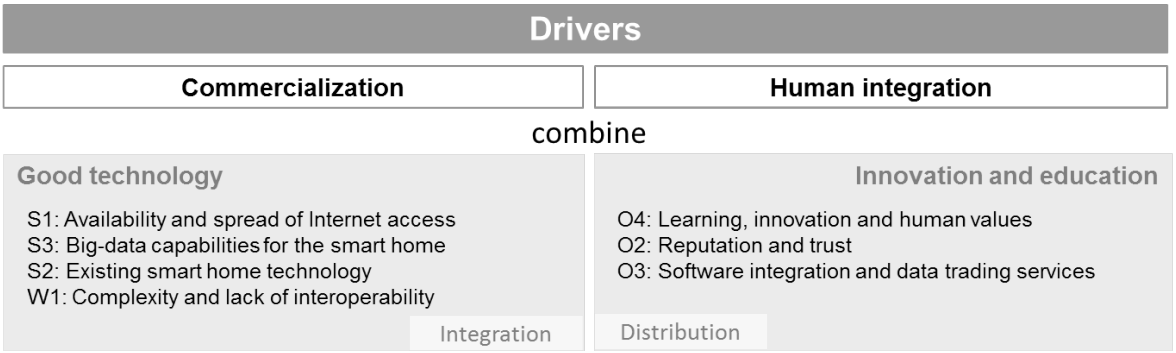


Figure 12: Context of tactic “combine”

Description

Combine the commercial and human data value system drivers by offering smart home products and services that are well adapted by users willing to pay for the value that is offered to them and enable users to more successfully develop personally, as well as allowing users to shape the system over time according to their needs. This should be achieved to utilize users’ feedback as an approach for distributed innovation. A secure, intuitive, adaptive, and extendable technology ecosystem will help assist and educate

smart home users in their daily life and personal development, both socially and economically. A smart home data trading platform will allow the control of data sharing and open new possibilities to enhance the big data based services and allow for direct economic return from own data assets that are traded.

Specific: Availability of a smart home offer that combines technology for education purposes and implements a feedback loop for user initiated innovative ideas. Create a space where citizens can try out and experiment with new smart home technology. Add social components by offering smart home application fields, such as friendship and family relationships (Section 4.5.1) and social engagement (Section 4.5.2). A cooperative organizational form would firmly anchor the principle of education, training, and information in its governance model (see Section 4.4.1).

Measurable: Number, functionality, design, and openness of smart home application fields that are integrated in the smart home system include a data-trading platform (a peer-to-peer platform for data). The number and satisfaction of users, the activity of user initiated usage ideas, and system enhancements as well as the volume of data trade transactions will provide for further measures.

Attainable: Collaborate with smart home technology ecosystem and data value providers to jointly form a complete smart home value system that uses existing technology and methods and develops new ones to overcome solvable integration challenges from a technical and organizational perspective. Starting on a local basis will be more realistic to realize proximity to the users and build trust among the value system collaborators as required for this venture. Development approaches, such as industrial cluster development, may be used to involve all relevant stakeholders.

Relevant: Technology should serve human needs and development. In contrast, citizens should control technology regarding all aspects and its influence as directly and timely as possible. Higher smart home solution adoption and the retention of customers results in relevant consequences for positive personal experiences with technology.

Time-Based: mid-term

6.1.2 Balance: Benefits and risks

Tactic

Balance benefits and risks for value creation. Secure and further increase the value created by big data capabilities for the smart home and mitigate the threat of inappropriate use of big data generated knowledge.

Selection

“S1: Availability and spread of Internet access” (Section 3.4.1) for the strategic pillar “good technology” (Section 4.4.2) and “T1: Inappropriate use of big data generated knowledge” (Section 3.6.1) for strategic pillar “profitable business” (Section 4.4.3) were selected as the main input for the tactic presented in this section. This focus reflects that on one hand, big data analysis has a lot of potential to realize great benefits for many stakeholders and businesses as well as for smart home users.

On the other hand, big data’s vastness and capabilities pose significant risks for citizens, if data value system players and government do not appropriately optimize these risks. The survey results suggest that—although the sample was almost equally divided regarding opportunity and risk perception—uncertainty exists regarding what the future of big data will bring (see Section 5.1.3.1.3). This is contained in the threat “T1: inappropriate use of big data generate knowledge” (3.6.1).

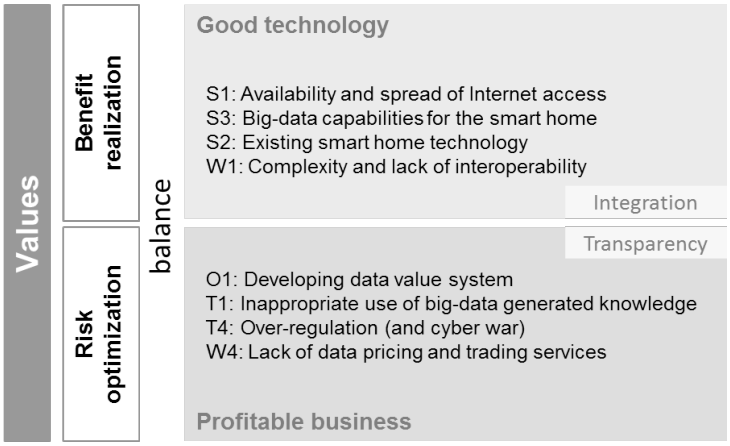


Figure 13: Context of tactic "balance"

Description

Analogous to the tactic in the last section, realizing the benefits of an integrated smart home system requires that the connected devices and appliances as well as the software interoperate as a whole, allowing for the application of big data analysis to the complete smart home data set. In addition, one must exploit the possibility to include as wide a range of smart homes as possible in the composite in order to expand the knowledge that can be gained from bigger data for the benefit of the smart home users. Also, one must use world-class data analysis skills.

Once privacy protection is provided uncertainty of users about the use of their data is reduced by a commitment for transparency about the management and use of data along the whole data life cycle, including retention, handover, or destruction of data according to the user's intention. Provide information on how knowledge is gained from what combinations of data created by and about the smart homes, the logic of algorithms, and the kinds of decisions that are taken by whom based on the big data predictions.

Specific: Provisions of in-home and inter-home data integration and big data analysis capabilities. Creation of binding policies committing to disclosing any information about smart home data created by and about smart homes to its users.

Measurable: Data valuation could be used to report on the realized value of data's option value as a measure for the success on how much data can be combined (big data principle: the more combinations possible, the more data's value is increasing) and how big data analysis is applied. Transparency regarding all aspects can be demonstrated by reports from the organization itself as well as from external auditors.

Attainable: It will be difficult to find specialists capable of performing data valuation. As is true for the consequent interoperation of smart home technologies and the integration of smart home data, the disclosure of any information about smart home data from data holders to its creators, i.e., customers/users, is unlikely to occur from today's data value system players. The actors would need to move closer together and citizens need to be key stakeholders, other than classical customers of smart home providing organizations, possibly equipped with some legitimate power (despite the lack of investment power) in order to guarantee they are consistently served regarding their information needs. Because market mechanisms do not necessarily guarantee to motivate businesses for more risk accountability and equip citizens with more power, the dialogue with government in order to take appropriate influencing measures toward this direction for the smart home sector, eventually in combination with possible smart city developments is important.

Relevant: Risk has a destructive effect on value creation, and value from smart home offers is the ultimate precondition for its adoption. On one hand, benefit realization in terms of benefits definition and giving the mandate to an organization to realize the benefits needs to shift more toward citizens in order to reap societal benefits as well. This would also make it more obvious who the beneficiaries of profits should be. On the other hand, organizations should be held accountable for risk optimization, while the government's role should be to intervene regarding benefit realization and risk optimization in a way to support the data value system maintaining or recreating balance in this regard.

Time-Based: Long-Term

6.1.3 Do both: Top-down and bottom-up governance

Tactic

Allow for both top down and bottom up governance. Improve reputation of smart home provision and build trust between value system players and citizens. Enable citizens to govern their personal data created by and about their smart homes.

Selection

For the composition of this tactic "O2: Reputation and trust" (Section 3.7.2) and "T2: Insufficient individual control of privacy" (Section 3.6.2) are important considerations. Trust damaging news is identified in the SWOT analysis, by the survey respondents' expression regarding a need for regulation and their numerous statements regarding privacy protection needs, which have given raise to this decision.

Figure 14: Context of tactic "do both"

Description

Corporations and government, as well as society as a whole, should provide the means of respect and protect personal data. Because big data is making it more difficult to pre-define personal data, a pure organizational view is unlikely to be successful to protect citizens' privacy over time. Organizational boundaries in terms of IoT, big data, and smart home specific data flows are blurred. Therefore, a more holistic view needs to be taken that systematically and individually considers and involves citizens in decisions related to smart home data governance. Democratic control shall be implemented as a trustful governance principle helping to recover or sustain the reputation of single organizations as well as the data value system as a whole.

Specific: Create user-interfaces for data pools based on re-negotiable (from user-side as well) opt-in options rather than limiting data sharing to consent agreements based on opt-out choices only (see also Section 3.5.3). Provide a personal data storage platform whose development and administration is democratically controlled by the data owners, i.e., the smart home data creators.

Measurable: One measure would be the number of data points included in the data-sharing platform. Auditable data governance functionality would provide for another indication of how the tactic for more individual control over privacy is implemented. The degree of involvement of citizens into how data is governed could be measured by activities around organizational policies, committees, and related definitions and decisions.

Attainable: A main challenge represents the different data value system stakeholders' understanding of what personal data is and who owns what type of data. In order to make sure that citizens own their smart home generated data, the different data interception possibilities related to the data acquisition strategies of data value system players need to be kept in mind. Also, a local development of a smart home value system will have to depend on technology ecosystem components from data value system players, which are difficult or impossible to commit to blindly in a citizen centric cooperative governance model.

Relevant: The tactic is relevant for sustainable smart home provisions because it suggests a governance model that, by using bottom-up and top-down activities, takes on a multi-stakeholder strategy for increased collaboration and inclusion of citizens who are the smart home data creators. The further development of the virtual world depends on how democratic the rules for its governance are set.
Time-Based: long-term

6.1.4 Institutionalize: Societal and business view

Selection
The SWOT analysis points "O1: Developing data value system" (Section 3.7.1) and "T3: Lack of transparency and dominance of data holders" (ection 3.6.3) have been determining for this tactic. Literature study, SWOT analysis, and survey results indicated a developing market around smart home offers and recognition of increasing value of data, but a sometimes unclear practice of data usage and sharing in the data value system.

Tactic

Institutionalize in an early stage governance principles for the data value system development that count in smart home owning citizens. Oblige governance activities to focus on transparency around how power is used to create value by and for the data value system's different stakeholders.

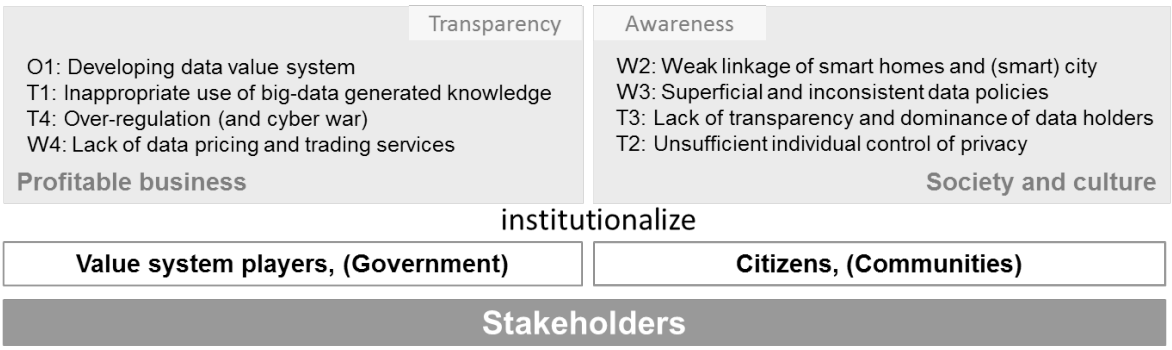


Figure 15: Context of tactic "institutionalize"

Description

The data value system around the IoT and big data is evolving. Existing players will find new ways to create value and business opportunities. Data holders are particularly well positioned to be successful. New entrants have to find unconquered data generation points for their data based service offerings or to offer a complementary service on top of data holder's data. Data creators, such as smart home users, need to be convinced to provide their data to the value system to receive services in return. Transparency from the provider side and awareness from the user side are required as a basis for the further development of the data value system. The tactic, therefore, proposes the institutionalization of governance principles into the system that implements effective approaches to reach this goal.

Specific: Go beyond, e.g., corporate sustainability responsibility reporting, and act as a citizen serving trust for data. Institutionalize a voting right for regular smart home user representatives in governance bodies. Whether it be firms or government actors, they perform consultations with all relevant data value system stakeholders (inclusive e.g., communities and NGO's) regarding how to drive the developing value system from an equitable sustainability perspective. Encourage citizens to participate for increased awareness, but provide appropriate means to allow them to do so in an efficient and effective way. This means that transparency must be directly built into smart home products and services, rather than being indirectly provided, e.g., as an independent information service.

Measurable: Organizational constitutions and governance policies would clearly state how transparency goals are reached amongst which stakeholders. Product and service administration functionalities and descriptions would further allow the judgment of the level of transparency provided. Results from consultations may be used to measure the degree of citizens regarding the offerings and practices of the smart home value system.

Attainable: It is understandable that data value systems' players' tendency for protection of business secrets in a competitive environment is unavoidable. Furthermore, the governance goal stated in this work is to create equitable sustainability value for citizens asking for a potentially difficult paradigmatic shift toward a multi-stakeholder view compared to an existing predominating shareholder-centric market. The institutionalization of such a new paradigm in the most effective way would require using and strengthening a cooperative legal form.
A smart home cooperative based on existing practical legal forms (see Section 4.4.1) would represent a feasible way to consequently empower citizens from a socially and economically sustainable perspective. In the data value system, difficulties in judging how the increasingly connected world and related data governance challenges can be controlled could be a good condition and time to propose a cooperative and start the dialogue how a multi-stakeholder cooperative could be realized and supported also from a competitive and regulatory point of view.

Relevant: The tactic's relevancy is high because it proposes fundamental shifts in how the data value system institutionalizes transparency and awareness through cooperation, including social and economic participation of citizens.

Time-Based: short- to mid-term

6.2 Thesis validation

Thesis as stated in Section 3.2:

The Internet of Things and big data are emerging. Citizen participation is important for sustainable smart home provision.

The survey respondents indicated a low importance of the "citizen participating organizational form" as a strategic pillar for smart home provision. However, as depicted in Section 5.2, higher risk perception and higher social application adoption likelihood (application fields of "friendship and family relationships" and "social enagement") are positive factors for a higher ranking of the "citizen participating organizational form". The result represent only a comparatively positive result because the absolute ranking position from this group of respondents also did not provide for a high ranking mean. Nonetheless, from a comparative perspective, the conclusion is possible that for respondents with overall sustainability sensitiveness (risk aware and adoptive in terms of social smart home applications), the citizen participating organizational form also provides a more valid alternative.

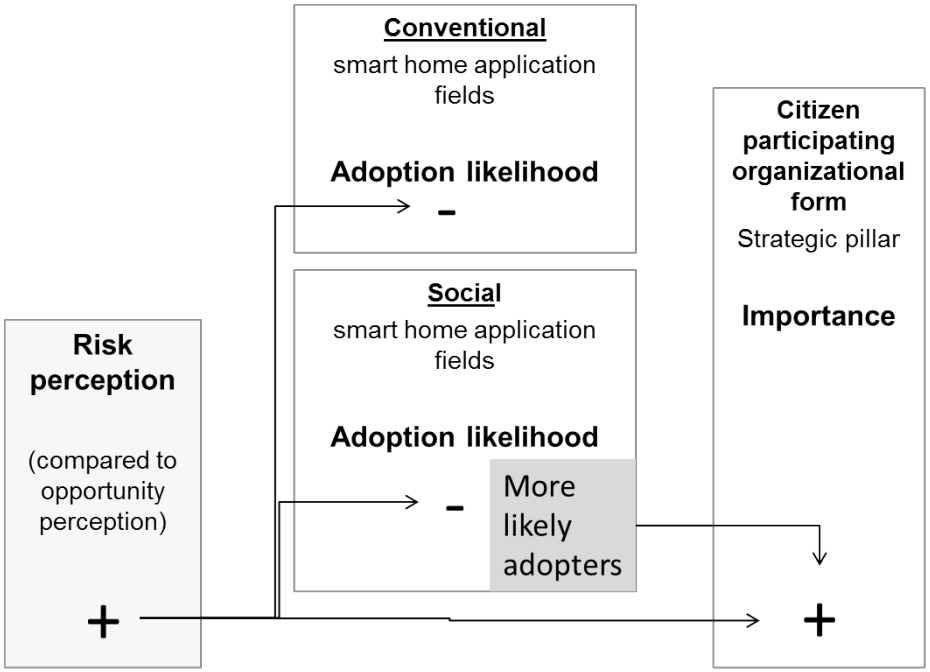


Figure 16: Impact of risk perception

Figure 15 summarizes the survey results related to the impact of risk perception on the smart home application field categories and the "citizen participating organizational form" as described above. The outlined relationship between risk perception and perceived importance of a "citizen participating organizational form" leads to the thesis supportive conclusion that a suitable governance mean for how concerns of citizens can be taken seriously and risks can be optimized is found. Risk optimization and benefit realization constitute important factors for value creation which is a starting point for both economic and social sustainability too.

6.3 Conclusion and outlook

6.3.1 Summary of conclusions

The work provided logically elaborated justifications for why a cooperative governance model is required for equitable sustainability in smart home provision. A smart home sustainability framework for strategic planning and the governance of smart home data was developed (Section 6.1), and it took the wider context of the IoT and big data into account. The increasing value of data (Section 2.4.1) that leads to an intensified commercialization of the digitized world does not stop at the private home's door.

Big data predictions on an individual and societal level will require a paradigmatic shift in how data is used and valued. The work did imply that data could become a good of public interest, just as is the infrastructure used to create, transport, and communicate the data. However, the work does not suggest waiting for regulatory intervention and instead proposes collaboration and the empowerment of citizens for controlling their virtual life while holding a stake in the value they create as smart home data creators.

A reinforcing relationship was found between risk perception and the importance of a cooperative governance model as a strategic option for smart home provision (Section 5.1.7). Personal values such as care for society and increased awareness regarding risks of the ongoing digitization and datafication of everyday life will be determining factors for citizen participation in the governance of smart home provision.

The rules of the growing smart home market in the future are not yet decided, neither in terms of the level of benefit realization nor in terms of risk optimization. This opportunity should be taken to actively create awareness about data governance and shape the smart home provisions from a holistic perspective. A cooperative legal form would provide for required organizational principles, such as democratic control and economic participation of its members (see Section 4.4.1).

A multi-stakeholder cooperative approach could solve adoption-hindering constraints, such as lack of interoperability, in short-term in minimum on a local level. Citizens would own their data, including its destiny, and secure peer-to-peer data market platforms could evolve empowering citizen economic participation.

Transparency and education are measures to reduce current uncertainty that will have immediate positive effects on the adoption of existing products and services on one hand. On the other hand, they open the way for a bottom-up approach for innovation that only can have a positive influence on finding the somehow still missing smart home use case. Therefore, the proposed framework with its comprehensive data value system view and multi-stakeholder cooperation at its core might provide a useful tool for strategy discussions for any stakeholder who has an interest in healthy development of the IoT, big data, and sustainable smart home provisions.

6.3.2 Critical considerations and outlook

Futuristic topic

The difficulty of this master thesis was in the fact that support of the thesis required the evaluation of several topics that are not yet commonly experienced. The combination of these topics (smart homes, big data, and multi-stakeholder cooperative smart home provider) required a great deal of imagination and interpretation (see also survey result in Section 5.1.5.2).

Therefore, the construction of a citizen participating smart home data value system relied on significant judgments from the author, although literature study and survey research was used. However, the systematic development of the framework for a sustainable smart home provision intended to make the cooperative governance model as a requirement for equitable sustainability transparent and verifiable as the different considerations and strategic elements were put into a logical context with each other. Review of the supervisors of this work further shall verify the suitability of the approach chosen.

Responding to the thesis validation, one has to be aware of the fact that the time could not yet be ripe for mass adoption of smart home solutions and a related cooperative organization. Careful consideration is necessary to approach the realization of such a multi-stakeholder cooperative. Specific cooperative administration experiences, cluster and community development, as well as policymaking expertise would be required to bridge different interests and to combine skills and diverse technology in a competitive and secure way for the successful formation of a more sustainable smart home technology ecosystem and data value chain.

Broad topic
It is unrealistic that smart home data flows can be brought under control entirely, including the interception possibilities that exist by using smart phones, for example. The creation of a too closely controlled system, in the sense that it would create new barriers for interoperability or data silos that are against the idea of the open Internet and big data should be avoided. A detailed evaluation of available technologies and standards, as well as feasibility studies, would be required to concretize the ideas introduced in this work.

Similar to the goal of awareness creation, marketing research could bring more insight into who the likely adopters are from a demographic point of view and how a smart home offer should be presented to which group of customers. Analyzing a broader range and more in-depth approach to different data value systems' stakeholders could be used to assess the emergence of new business models and the evolvement of existing business models. From a strategic planning perspective, instead of tactics, more specific strategic objectives, including measures for strategic management, could be developed.

Further research could be performed to identify existing and planned examples of smart technology provisions that are compatible with different sustainability goals. For existing cooperatives in similar or related sectors (e.g., a residential building cooperative that starts offering smart home services) and other organizational forms of governance practices and their effects on the value system they operate in, further research could be conducted. Smart city projects provide for good study objects for the identification of possible interdependencies, synergies, and interactions between home and city infrastructure as well as between citizens and local governments.

Outlook
While this work was addressing a currently futuristic topic, the smart home technology ecosystem will continue to develop and the data value system overall needs close monitoring and re-evaluation regarding sustainability measures and governance models that are suitable for respective for digital economies and societies.

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Appendix A: Smart home provider analysis

Source: Company websites (summarizes by author, April 2014)

Company website	Connected device platform	Application enablement platform (Installation on control device)	Application fields, software
Staples connect (free app)	Hub Open for other manufacturers	Smartphone, table, PC	Safety & monitoring, environmental control, lighting
Philips hue	Own products Protocol bridge	iPhone, Galaxy S2+, Sony Xperia	Lighting, Health and wellbeing, security and safety
Smartthings (free app, HW cost)	Open for other Zig-Bee, Z-Wave and Wifi-devices Physical hub	iOS, Android	home and family, lights and switches, doors and locks, damage and danger, motion
Revolv (only HW, free app)	Hub Partnering with other manufacturers (Philips hue, belking,	iPhon e only	Lighting, audio, thermostats, keypads and remotes, light switches, power outlets, door and window sensors, security, shades
Insteon HUB (free, only HW (hub and devices cost)	Hub 200 insteon products, RF and electric wire	Smart phone or tablet (iOS, Android, Windows)	Control devices, build scenes, create schedules, set your thermostat, monitor cameras, check sensors (door, window, water, smoke)
Vera (no fee for services, only hardware cost)	Cibtrikker Compatible with over 900+ Z-Wave Certified Devices. (The Vera system uses a proven and reliable world-standard wireless technology called Z-Wave. It works much like Wi-Fi does, but it is specifically designed for home automation.)	iOS, Android	Camera, Thermostat , Door Lock , Multi-Sensor, Door & Window Sensor , Lamp Module , Plug-In Energy Meter , Whole Home Energy Meter
HomeSeer (software costs)	HomeSeer home automation gatway, controller (Z-Wave compatible)	Own touchscreen tabletop device, PC	Remote, light, door locks, appliances, power occupancy, climate, manage sensors, garage door, RSS data, water control, security, audio/video, netcams, energy management, control according to weather
Control4	Control4 Controller Requires Control4® OS 2.4 software Integration with Sony receiver possible	Control4 Operating System (OS) on any smart phone, tablet, or computer	Audio/video, lighting, climate, security,
Crestron	Crestron Network hub	customizable user interfaces for iOS® and Android™ mobile platforms, PC	Control from anywhere, Manage lighting, Control door locks, Control appliances, Detect occupancy, Control climate, Manage sensors, Control garage doors, Monitor RSS data, Water control, Security integration,

		(Windows)	Control audio/video, Monitor netcams, Energy management, Control irrigation
T-mobile (starterkit mit Homebase)	Own producsts		Thermostat, socket switch, smoke detector
Swisscom	Quing home router, adapters	Own touchscreen and remote control	Comfort, Security, efficiency,
Nest	(integratable with Mercedes, Jawbone, Whirlpool, LIFX lighbulbs and Google) with	Smartphone, tablet, PC	Thermostat, smoke detection

Appendix B: Adoption likelihood for smart home application fields

Source: Survey research (author)

Appli-cation fields	0 very unlikely		1 unlikely		2 maybe		3 likely		4 very likely		Sum	Rank
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %		
ADOENT	6	5.2%	6	5.2%	13	11.3%	46	40.0%	44	38.3%	346	1
ADOEDU	3	2.6%	9	7.8%	18	15.7%	47	40.9%	38	33.0%	338	2
ADOCOM	4	3.5%	7	6.1%	26	22.6%	42	36.5%	36	31.3%	329	3
ADOCOS	8	7.0%	15	13.0%	30	26.1%	31	27.0%	31	27.0%	315	4
ADOSEC	4	3.5%	9	7.8%	27	23.5%	48	41.7%	27	23.5%	292	5
ADOENV	18	15.7%	18	15.7%	28	24.3%	26	22.6%	25	21.7%	290	6
ADOHEA	4	3.5%	14	12.2%	37	32.2%	38	33.0%	22	19.1%	252	7
ADOFRI	15	13.0%	22	19.1%	42	36.5%	24	20.9%	12	10.4%	226	8
ADOSOC	13	11.3%	32	27.8%	39	33.9%	25	21.7%	6	5.2%	209	9

Legend for application fields: ADOENT = Entertainment, ADOEDU = Education, learning and home office, ADOCOM = Comfort, ADOCOS = Cost savings, ADOSEC = Security, ADOENV = Environmental protection, ADOHEA = Health, fitness and wellness, ADOFRI = Friendships and family relationships, ADOSOC = Social engagement

Appendix C: Open-ended answers: Structure and key word idenification

Source: Survey research (author)

D = Answers to question 1: "It's a race going on, a race for data and information that are already known as the oil of the present time."?

S = Answers to question 2: “Regarding the previous question (ranking of the smart home full-service provider strategic pillars): What has made the decision (s) for you most difficult?for you most difficult?”

A = Answers to queston 3: “Your additional thoughts, experiences or questions?”

Compatibility with personal values
- *Better search and information*
o D „Diese Daten können genutzt werden um mir ein besseres **Suchergebnis** oder Angebot zu machen.“
o D „Stimme ich vollkommen zu. Diese Informationen können helfen, die **richtigen Informationen, zur richtigen Zeit dem richtigen Kunden zur Verfügung zu stellen**.“
- *Personalized advertisements*
o A wenn **"personaliesierte" TV-Werbespots** gespielt werden, um so besser. Dann ist es vieleicht nicht mehr so langweilig...
- *Reasonable price*
o S “Regarding the "Profitable Business" category: I assume that I am approaching this as a consumer; in this capacity I don't care if companies are profitable in offering Smart Home services, I just want to enjoy a competitive, **reasonably priced product**. Were I supposing myself to be an entrepreneur selling a Smart Home service, I would probably have different rankings (profit would obviously become a major concern).”
- *No interest in smart home*
o S „Allgemein **bin ich nicht für Smart Home**, daher ist die Frage für mich Sinnlos.“
- *Interest, but personal values (sinfulness) not yet met*
o D “as the **value add is not fully obvious** it is hard to judge the consequences.”
o A „Machen wir was **sinnvoll** ist oder was möglich ist?“
o S „Die richtige Priorität zwischen die Form (**Technologie**) und den Inhalt (**Zweck** der Services) zu bestimmen.“
o A “Waiting without patience for **technology** to lead that scope”
o A „Keine Erfahrungen persönlich, lebe technologisch bewusst noch im letzten Jahrhundert. Mich **faszinieren jedoch die neuen Möglichkeiten**. Wenn diese **in einer Weise genutzt** werden können, in welcher die **Lebensqualität auf jeder Ebene** berücksichtigt wird, finde ich das spannend. Mit 'jeder Ebene' meine ich, dass dies nicht zu einer noch stärkeren Verarmung von persönlicher Kommunikation führt, zu noch weniger Bewegung, zu noch mehr Verlust von sozialkompetenz weil weniger **zwischenmenschliche Interaktion** nötig wird.“
o S “**Beliefs and values versus actual behavioural reality**.”
- *General relationship opportunity / risk*
o A „Ich finde, das ist ein umfangreiches u. spannendes Thema, wobei es **viel Positives, aber auch Negatives** gibt“
o D „Korrkte Aussage. Einerseits **Zusatznutzen** andererseits aber auch Gefahren (gläserne **Konsument**)“

o A „Ich finde, das ist ein umfangreiches u. spannendes Thema, wobei es **viel Positives, aber auch Negatives gibt**“
o D/S „Ich finde der Mensch/Kunde geht fahrlässig mit seinen Daten um. Spagat zwischen **Vorteil der Technologie** und Gefarhr des gläsernen Menschen!“
o D Korrkte Aussage. Einerseits **Zusatznutzen** andererseits aber auch Gefahren (**gläserne Konsument**)
o D „stimmt schon; je mehr Informationen über zB einen Kunden oder über ein Kundersegment verfügbar sind, desto **besser kann das Kundenverhalten vorausgesagt** und z.T. auch **beeinflusst** werden“
- *Example relationship opportunity / risk*
o A „wenn **"personaliesierte" TV-Werbespots** gespielt werden, um so besser. Dann ist es vieleicht nicht mehr so langweilig...“
o D “Very true. Nowadays, firms pay big money just to get your contact details to be able to flood you with **useless commercials**. Worth the effort ? no. Worth the energy waist ? no.”
Trouble-free, safe and easy to integrate technology
- *Simplicity, security, standard (trust)*
o S “It was difficult to say what would be the least important. This very much depends in the context. But **easy to use is the key (see iphone)“**
o S „Einen wahren mehrwert vorausgesetzt, steht und fällt alles mit den drei Punkten: - **einfachheit - sicherheit - vertrauen zum anbieter**“
o A „Smart Home setzt m.E. eine Hardware voraus, die unabhängig von implementierter Software sicher gegenüber Schadsoftware (auch unbekannter und zukünftiger!) und Hackerangriffen ist. Smart-Home-Anwender werden kein IT-Sicherheitspersonal sein, sondern ihre **Infrastruktur eher kritiklos anwenden**, deshalb muss sie in sich **technisch sicher sein, etwa wie ein Auto oder andere Verkehrsmittel**.“
o S “**user friendly services that is both secure and eco friendly**.”
- *Interoperability, compatibility*
o A „Zu Smart Home insbesondere Möglichkeiten und Grenzen, **Kompatibilität und Austauschbarkeit** mit verschiedenen Systemen etc“
o A „Ein essentieller Faktor für die praktische Verwendung von Smart Home Lösungen ist die Verwendung in einem Mietverhältnis, resp. deren **Einbau und Verbindung mit bereits bestehenden Installationen**.“
o A “todays world does not support smart homes very good as there is a lot of **legacy in the building (ie cabling).** any solution will **need to make the transition easy** in order to be successful. otherwise the cost of implementation are too high”
o S „**INteroperabilität** fehlt“
o D „Sie trifft zu. Deshalb besteht ein Bedarf an einem "Hahn", mit dem man den Fluss des "Öls der heutigen Zeit" kontrollieren kann. Mit derzeit verfügbarer **Hardware ist das nicht möglich, von der Software ganz zu schweigen**.“
- *Data overload*
o D „Informationen sind wichtig für fast alle Berufe und die persönliche Entwicklung. Der **Umgang mit Daten ist aber nicht immer einfach** und angenehm.“
o A „Menschen werden an den Punkt kommen wo sie sich **überfordert** fühlen von der heutigen Technik und deren Moeglichkeiten, dann wird es ein Bewegung geben **"back to the roots" "keep it simple but smart".“**
o D „Sehr zutreffend, wird sich aber höchstwahrscheinlich in den nächsten Jahren wieder etwas einpendeln (z.B. Interesse an Facebook oder die Zeit, welche man dafür aufbringt, **E-Mail Fluten usw. sollten abnehmen**).“
o D “Its true. I personally dont like to be **overloaded by data** and information. I

pick the information I need very selective but I am also happy to be able to have information available via my smartphone anytime. People should be very selective with data usage and should avoid to become addicted to e.g. their smartphone (I sometimes got complaints form my wife ;-)). Conclusion for me: Use the great new technologies, but in a smart way, to be balanced."
- *Conventional smart home applications*
o A „Einfache und ersetzbare **Geräte wie TV** werden schnell Smart Home-mässig unterwegs sein. Einige andere Geräte werden jedoch stark abhängig von innovativen Lösungen sein"
Useful and transparent results
- *Useful results from data analysis (big data capabilities)*
o D „Daten sind nur gut, wenn sie auch richtig **ausgewertet** werden können."
o D "True, especially due to the growing computing power; however, **not many people/business can leverage these data to be useful** information at the moment."
- *Consistent results*
o D "Very apt. On a cautionary note I would like to add here is, **data collected today will be obsolete tomorrow**. Say data collected by social networks for the music people like today and people will in 10 years time will be totally different, same as we grew up."
- *Need for information (since results difficult to observe)*
o A „Es wäre wünschenswert, auch die Information (z.B. Angebote, Verträge, Reporting) über solche Services zu beleuchten - je abstrakter und vernetzter der Service, desto **transparenter die Information**."
Uncertainty
- *No uncertainty*
o A „Ich gehe aber sehr bewusst mit der digitalen Welt um und glaube zu wissen was "möglich" ist und was nicht. Bin nicht naiv und technisch genügend versiert."
- *Technology security, data protection*
o A „Was passiert bei **technischen Pannen**? Welche Risiken birgt die **Vernetzung**?"
o A „Des Weiteren stellt sich die Fragen nach der **Sicherheit der gesammelten Daten** --> Telefoniert ET unbemerkt nach Hause? Gibt es **Gesetze** die uns schützen werden?"
o A „Es besteht die Gefahr dass in **korrupten Gesellschaften**"
o A "I'm little bit concerning about the side of **security** about IT because if someone is super professional, how we can **protect by their attacks**."
- *Emerging, intransparent data value system (generally unclear future consequences)*
o S „Dass die Thematik so **umfassend und ungreifbar** ist."
o D "I think it's true, and that we **don't oversee the consequences** of what comes with data and information"
o D "as the value add is not fully obvious it is **hard to judge the consequences**."
o D „Ich stimme diese Aussage zu. Wobei wir sind noch nur in der **Anfangsphase**."
o D "very true - we have **no idea yet what this will actually mean**"
o D „Da ist etwas wahres dran und auch etwas **unmessbares, ungreifbares**."
o A „Es wäre wünschenswert, auch die Information (z.B. Angebote, Verträge, Reporting) über solche Services zu beleuchten - je abstrakter und vernetzter der Service, desto **transparenter die Information**."
- *Awareness of citizens*
o D "Indeed, **consumer are not fully aware** what happens with their personal information."

○ D „Die Wahrheit lässt sich nicht verleugnen. Es ist **vielen nicht klar was mit Informationen alles gemacht werden kann**.“
○ D „Dass die Aussage Richtigkeit hat. Die meisten **Nutzer sind sich nicht bewusst** (inklusive mir selber), was die Menge an gesammelten Daten/Infos noch für Auswirkungen haben können.“
○ D “You don't need to dig to deep for that oil...as **people give away their data deliberately**.”
○ D “Big data is a great opportunity but also a risk since personal data could be used against you or a company. The **digital natives must be aware of the risks** the incur when leaving data uncontrolled on Internet”
Severity of outcome
- *General: Scarying*
○ D „Das Rennen ist zweifellos im Gange. Was nicht abzuschätzen ist, ob mit den Daten so viel Geld zu machen ist, wie mit Öl. Das Resultat wird vielleicht ein anderes sein, aber der **Einfluss** durch die Datensammlungen **wird sehr gross sein**.“
○ D „**Very scary**“
○ D “**Gefährlich**”
○ D „Die ganze Daten-Sammlerei ist tatsächlich **beunruhigend**.“
○ D „**Tragische und gefährliche Entwicklung“**
○ D „teilweise auch **beängstigend**“
○ D „**Leider** die Wahrheit.“
○ D „**beängstigend** !“
○ D “it is **little bit danger**.”
- *Superficial and inconsistent data policies (W3)*
○ D „Die Aussage ist korrekt. Zusätzlich: Der **einzelne verliert mehr und mehr die Kontrolle über seine eigenen Daten**.“
○ A “I believe that a topic like **smart home is heavily depending on the data and its exchange**. In our current political legislation (with different laws in different countries) the consumer will not have any control what happens with his/her information. The likelihood that it will be used against the original intention is high.”
○ D „das stimmt, es ist aber sehr wichtig **wer die Daten mit welchen Zielen nutzt**“
○ D Ich denke, dass es **immer schlimmer** wird mit dem Daten sammeln. Und das diese **Daten sehr teuer verkauft werden**.
○ D „Jeder verliert somit seine eigene identität. (meine meinung) der staat weiss alles über einen, woher man kommt, was man macht, (gemacht hat), usw. und andre Daten sind im internet auch schnell zu finden. Drüberhinaus werden diese Daten einfach **an dritte weiterverkauft** und man erhällt endlosen Müll im Briefkasten von Firmen mit denen man noch nie in kontakt getreten war diese aber ihren vollen Namen Adresse und Telefonnummer kennen.“
○ A „Es wäre wünschenswert, auch die Information (z.B. **Angebote, Verträge, Reporting) über solche Services zu beleuchten** - je abstrakter und vernetzter der Service, desto transparenter die Information.“
○ A “I believe that a topic like smart home is heavily depending on the data and its exchange. In our current political legislation (with different laws in different countries) the consumer will not have any control what happens with his/her information. The likelihood that it will be **used against the original intention** is high.”
○ D “We are already at a point in our daily lives through social media that **so much data is used and stored by 3rd party members**.”
○ D „Die Frage ob der Anbieter sich **ethisch korrekt verhält oder Gewinnmaximierung** im Vordergrund steht (etwa der **Verkauf von**

personifizierten Daten an Dritte)“
- *Inappropriate use of big data generated knowledge*
o A „z.B. Bezahlt meine **Krankenkasse** noch meine Krankheit, wenn mein Fitnesssensor seit 10 Jahren merkt dass ich zuviel ungesunde Nahrung aufnehme? :)“
o D “Very true, especially the **correlation of different data sources** for profiling will become more and more important and obviously also **more risky**.”
o D “If data is **interpreted in the right way**, it can provide many information about a user, especially very private & **confident information**.”
o D „Ist absolut zutreffend. Erkenntnisse aus (unstrukturierten) Daten werden mittelfristig zur **primären Entscheidungsgrundlage** und zu einem wichtigen **Wettbewerbsfaktor**. Kritisch sind dabei die **Fähigkeiten zur Analyse, Triage sowie zur Plausibilitätsabschätzung**.“
o D „stimmt schon; je mehr Informationen über zB einen Kunden oder über ein Kundersegment verfügbar sind, desto besser kann das Kundenverhalten vorausgesagt und z.T. auch **beeinflusst** werden“
o D “**Big data** is a great opportunity but also a **risk since personal data could be used against you** or a company. The digital natives must be aware of the risks the incur when leaving data uncontrolled on Internet”
- *Unsufficient individual control of privacy*
o D/S „Ich finde der Mensch/Kunde geht fahrlässig mit seinen Daten um. Spagat zwischen Vorteil der Technologie und **Gefarhr des gläsernen Menschen!**“
o D „Korrkte Aussage. Einerseits Zusatznutzen andererseits aber auch Gefahren (**gläserne Konsument**)“
o A „die grosse frage wird sein, ob die nutzer es hinnehmen, dass datenmassen gesammelt und genutzt werden (und auch missbrauch/fehler passiert) und dies als "normal" betrachtet wird. oder ob die tendenz zu **privatsphäre**/datenschutz weiter zunimmt und dieses geschäftsfeld zunehmend eingrenzt“
o D “True. Problem is how the data will be used. In the current political environment in established Western democracies, no such a big problem (i.e. as long as data is primarily used to tailer commercial offerings to consumers). **In less democratic environments**, or if our current environment were to become less democratic which is a possibility, **potentially very problematic**.”
o D “That race has pretty much been decided by now - major players are unlikely to surface in the foreseeable future. The corresponding **security is considerably behind**.”
o D “**Big Brother** is watching you”
o S „Es birgt aber auch Risiken vor allem im **kriminellen Bereich**.“
o A “Nothing, **safety must come first, then personal benefit**, later the rest.”
o D „Jeder **verliert somit seine eigene identität**. (meine meinung) der **staat weiss alles** über einen, woher man kommt, was man macht, (gemacht hat), usw. und andre Daten sind im internet auch schnell zu finden. Drüberhinaus werden diese Daten einfach an dritte weiterverkauft und man erhällt endlosen Müll im Briefkasten von Firmen mit denen man noch nie in kontakt getreten war diese aber ihren vollen Namen Adresse und Telefonnummer kennen.“
o D „Die Aussage ist korrekt. Zusätzlich: Der **einzelne verliert mehr und mehr die Kontrolle** über seine eigenen Daten.“
o A „**Immer die Wahl haben**, mitzumachen oder auszusteigen (später ev. wieder einzusteigen)“
- *Lack of transparency and dominant data holders*
o D „**Ungleiche Machtverhältnisse**.“
o D „Basierend auf dem businesscase von verschiedenen Unternehmen (Google, Apple, Samsung,...) lässt sich bereits erkennen, welcher Wert

personenbezogene Daten haben. **Andere Unternehmen werden dies sicher auch noch erkennen**.“
o D “That **race has pretty much been decided by now - major players are unlikely to surface in the foreseeable future**. The corresponding security is considerably behind.”
o A „Wissen ist Macht und Daten bzw. ausgewertete **Daten welche man nutzen kann sind Macht**.“
o D **Knowledge is power**
o D “The **leaders in the market** for data and information **will become very wealthy and powerful**.”
- *Missing regulation or overregulation*
o A “I believe that a topic like smart home is heavily depending on the data and its exchange. In our current political legislation (**with different laws in different countries) the consumer will not have any control** what happens with his/her information. The likelihood that it will be used against the original intention is high.”
o D „Die Frage ist was mit den Daten passiert und **in wieweit es noch moeglich ist** Einfluss darauf zu nehmen, wie sie **geschuetzt oder reguliert werden.**“
o D “**Data protection** is much more in focus (ask NSA). **Not sure whether we will see more data collection**”
o A „die grosse frage wird sein, ob die nutzer es hinnehmen, dass datenmassen gesammelt und genutzt werden (und auch missbrauch/fehler passiert) und dies als "normal" betrachtet wird. oder ob die tendenz zu **privatsphäre**/datenschutz weiter zunimmt und dieses geschäftsfeld zunehmend eingrenzt“
o D „Sie trifft zu. Deshalb besteht ein **Bedarf an einem "Hahn", mit dem man den Fluss des "Öls der heutigen Zeit" kontrollieren kann**. Mit derzeit verfügbarer Hardware ist das nicht möglich, von der Software ganz zu schweigen.“
o D “Agree. Personal data is the currency of today's digital market. And like any currency, it needs **stability and trust**.”
o A „Es braucht einen **rechtlichen, verbindlichen, verlässlichen Rahmen** für alle Beteiligten, da die neuen Möglichkeiten viele offene Fragen aufwerfen (wer darf welche Daten, wann, wie lange, wozu verwenden).“
o S “Schutz der **Persönlichkeitsrechte, Datenschutz** (because it is S, this is a governance need that was brought up)”
Equitable sustainability
- *Profit orientation*
o D „Verifizierte Daten haben ein **unglaubliches Marktpotenzial** und werden verwendet werden um daraus **Profit zu machen“**
o D „Stimme ich zu, Data Mining wird immer mehr genutzt um das Verhalten sowie Trends bei der Bevölkerung festzustellen und daraus mittels gezieltem Marketing **Profit zu schlagen“**
o D “Anyone who owns the information, then it **makes its profit**.”
o D „die firmen heut zu tage sind alle **zu sehr nur noch auf profit aus** und stellen andere wichtige punkte erst an anderer stelle auf.“
o S „Ob mitgestalten **auch am Gewinn partizipieren** meint.“
- *Social dimension*
o S „Die Komplexität des Themas sowie die aktuellen Diskussionen im Umfeld zu Big Data (Sicherheit, Wertewandel, **Gesellschafts- und Wirtschaftveränderung** etc.)“
o D „**Antrieb der cirtuellen Welt“**
o S „Der **Widerspruch zwischen sozial und profitabel“**

○ D „Die Frage ob der Anbieter sich **ethisch korrekt verhält oder Gewinnmaximierung** im Vordergrund steht (etwa der **Verkauf von personifizierten Daten an Dritte**)“
○ A “Instead of Smart Home, I would like to think/consider of **Smart Ecosystem**.”
○ A “Many people do not have one specific career any longer and the 9-5 work approach is changing. Part of the problem is in the title (Smart Home) - **how this technology will be integrated in different urban societies** (rental versus home owners and refurbishment - means the **tech will not be about home but about people** and their electronic equipment).”
○ S “key are **cultural shifts** in our thinking to enable Smart-Homing.”
○ S „Innovation vs. Gute Technologie: Letztere ist noch nicht zu haben, also muss sie **erfunden werden**, was auch eine **Erziehungskomponente** beinhaltet.“
○ S “**Eco, Soiety, culture and benefit to every living being is most important** in designing any future products. This is be a baseline for all organizations.”
○ A „Wie mit der Einführung des Öls brauchen wir Zeit und phasenweise **Angewöhnung an den vernünftigen Einsatz von Big Data**. Wie mit dem Öl entstehen **Schäden und Risiken, welche nicht erst dann aufgenommen werden sollten, wenn sie sich bereits negativ ausgewirkt haben**.“
○ S “Smart Home should **support our daily life** and not increase/replace the amount of effort or resources which we already use today.”
○ D “I agree, that it is very wrathful. The difference is, that these information things will not pumped out. In this meaning it has **better future, depends our moral**.”

Appendix D: Declaration that the project is the candidate's own work

I hereby declare that this project is entirely my own work and that I have not used and sourced other than those indicated.

Mathias Sager