On the role and potential of IoT in different industries

Analysis of actor cooperation and challenges for introduction of new technology

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***Abstract*— In this paper we study how IoT technology can be introduced and used in different sectors; industrial IoT, smart energy, smart homes, smart cities, health care and social care, sports and well-being. The research has given increased insights into opportunities and obstacles for the introduction of IoT in different sectors. The main obstacles are considered to be i) specific IoT solutions often tend to be a small part of the overall solution, ii) lack of knowledge about which overall services the IoT solution may be part of, iii) Fragmentation and insufficient scalability, iv) Distrust and hesitation among actors to share data and platforms and finally, v) fear of changing the own business model. The analysis of our cases indicates that most of the challenges occur due to the fact that the solutions initially have been developed using a single firm business model. In order to survive or grow a networked business model is needed.**

Keyword — Internet of things, Digital Society, Business ecosystems, Business networks, Smart cities and homes, smart energy, health and social care, sport and wellbeing, Industrial IoT.

I. INTRODUCTION

The concept of Internet of things (IoT) usually includes both technology and services based on connected devices and use of the collected data. In this paper we study how IoT can be introduced and used in different industrial sectors. We analyze different cases with IoT products and services in order to identify how different business aspects and conditions affect the ability for actors to make use of the new technology. We discuss in terms of IoT technology but the analyzed cases are about introduction of ICT solutions in general and this is just a part of the ongoing digitalization of products and services.

The objective of our research is to study the conditions for use of IoT in order to identify drivers and benefits as well as problems and challenges. Overall we want to identify common patterns and key challenges for introduction of IoT as a new technology. In order to do so we look into different industries; industrial IoT, smart energy, smart homes, smart cities, health care & social care, and finally sport & well-being.

We want to highlight the need to consider also the business model aspects when new technology is introduced. We claim that it is not "enough" that the technology works as expected.

The work is supported by the Swedish Innovation agency Vinnova and the Strategic Innovation Program IoT Sweden, research grant 2015-06151 .

978-1-5386-3197-3/17/$31.00 ©2017 IEEE

Introduction of IoT clearly can lead to improved efficiency but it is not only about technical performance. The improved working efficiency is also reflected in changed or new working processes, usually in combination with new roles and business opportunities for market actors. Ericsson, although being a technology oriented company, for many years has discussed digital society in terms of business transformation[1].

Digitalization is not only about increased efficiency but also about the opportunity to offer new services or to offer them in new way. The value of specific technical solutions must be seen in an overall context. A new technology may result in direct benefits within an actor´s existing business. But it may also be that the full benefit of a new solution cannot be achieved by providing the solution itself in isolation. A solution may need to be combined with other solutions (offered by other actors) in order to achieve the full benefits. This implies that you need to have an understanding of the customer's entire needs and how different actors can cooperate. This means that you need to study ecosystems and networks of actors (business networks) and how the actors interact.

So what do we mean with a business ecosystem? This term has been widely used that last five years, especially for mobile services [1]. It has also been used to describe and analyze IoT services, business and actors [2][3][4]. In this paper we will look into business ecosystems with a multitude of co-existing "businesses", each described by a value network. Our results support the assumption that there are several different ecosystems and industries in which IoT is included or can be included rather that IoT will have an ecosystem of its own.

The main contribution in the paper is discussing the introduction of new technology from three perspectives; i) how a new solution can be evaluated differently depending on the overall context, ii) how value can be assessed and iii) the problem with multitude of parallel solutions (fragmentation and stove pipes) and possible ways to address this.

The paper is organized as follows: First, we discuss theory and analysis approach. Then, we present selected cases of use of new technology that illustrate common patterns and challenges. This is followed by analysis of cases and collected workshop data. We conclude with discussion on patterns, drivers and challenges and with a summary section.

[1] https://www.ericsson.com/digital-services/offerings/digital-transformation

II. THEORETICAL FOUNDING AND RESEARCH APPROACH

A. IoT and business related research

The last five years there have been a number of papers discussing business aspects of IoT products and services [2][3]. Westerlund et al have looked into business models and business ecosystem aspects for IoT applications. They claim that the ecosystem structure is not clear with many multi-industry solutions and that actors still are looking for their roles. Andersson & Mattsson have developed a framework for understanding the network dynamics in order to develop and implement business models for service innovation in IoT [5].

One question is what components of the business model that can or should be used? Glova et al [6] focus on the value creation and value exchange and claim "*using this approach the business activity can be reduced to its core elements, which in the simplest case comprise the value proposition, distribution channels and the customers of the company".* Other researchers make use of the Osterwalder canvas [9] and apply this to different cases [7][8]. There are also academic thesis's that look into specific industries or sectors like smart cities [10] and health & social care [11].

B. Business models, business networks and ecosystems

Business model definitions usually consist of a number of different dimensions or components. Although they differ, we claim that they to a large extent cover the same aspects. It is a matter how you organize the analysis and what aspect you include in each component. For example the STOF model [12] has four main components or domains describing services, technology, organization and finance. Here the organization domain includes the value network. The business model definition used by Chesbrough and Rosenbloom [13] consists of six main components. One component is "firm organization and value chain" and another is "firm in the value network".

In an extensive literature review Wirtz et al from 2016 [14] propose a new way to look into business models and the also propose an integrated framework *"..based on analyzing business model definitions, perspectives and components in the literature, we newly define the concept and portray its essential components in a framework*." They look into three main different business model perspectives; technology, organization and strategy oriented definitions. The proposed integrated framework includes nine types of models with overall 20 different aspects covered. Important for our analysis is that one specific type of model is called Network model where business model networks and partners are included.

This leads to research on business networks, networked business models and business ecosystems. Business ecosystems are usually seen as a group of independent actors in the same industry. They can have direct relations as customers, suppliers or partners or active or potential competitors. Also standardization bodies and regulators and policy makers are included [16][17][18][19]. A study on how to identify sub ecosystems is presented in [22]. In this paper it is stated that the key difference between ecosystem and business networks can be seen in the variety of actors.

Another view is presented by Provan et al [23] saying that "*whole networks are bounded by including only those organizations that interact with one another in an effort to achieve a common purpose".*

The main finding from papers on networked business models is the discussions on the move from single firm business models to networked business models [15][20]. For our analysis it is important to capture multi-actor aspects of value creation and how the value network can be composed.. Citing the paper by Palo et al [21] about network-level business model *" by developing collective understanding of the business opportunities and shaping the action to exploit them".*

C. Research approach

For our analysis we need to identify what actors in the ecosystem that interact with each other, this includes being customer, supplier, partner or competitor. In our analysis we are interested to see what actors that do business with each other or cooperate in order to do business. We are also interested in to evaluate the importance of the new (IoT) solution that we study. Hence we need to look into the value proposition, i.e. what type of value that is offered to the customer, it could be an end-user but also an organization.

Since we look into specific services where the IoT solution plays a part it is natural to identify the activities involved, both the ones where a new IoT based solution plays an important role but also all other activities that make up the overall service. Examples of overall services in this paper are: waste management in a city, cleaning of an office building, maintenance of complex infrastructures like power plants or bridges, and municipality home care services for elderly.

Besides the activities and analysis we need to look into what actors that perform different activities "who is doing what?" Linked to this is to identify what actors that have relations, i.e. "who is doing business with whom?" This reasoning leads to concepts like the ARA model (Actors Resources and Activities) introduced by the IMP group[24][25] and the "Activity system themes" and "Activity systems" proposed by Zott and Amitt [26][27]. The "Activity systems" of a business model can be described from different perspectives, content, structure and governance. The content refers to what activities that are performed, the structure describes how activities are linked and the governance describes who performs the activities.

When we analyse our cases and structure the primary data the activities are analyzed from three perspectives:

a) What activities is actor involved in? And how large/important is the contribution of that actor?

b) What is the value of an activity and how important is the role of an actor performing that activity? And how important is a specific activity for the overall service?

c) What other activities are needed in order to exploit the value of a specific activity? And what actors are involved in these "Other" activities".

Item c) about other activities leads back to the discussion in section II B about key actors in the business network.

III. METHODOLOGY

A. Overall

The objective of our research was to study the conditions for use of IoT in different industries. We have a rich set of primary data from different industrial sectors collected at workshops and interviews 2016-2017. Most of the case studies and findings result from a Swedish research project. Besides academic researchers the project included big industry companies (Ericsson and Sandvik), one SME, providers of energy and telecom services (Vattenfall, Telia), Stockholm City, and an employer organization (Almega). The participation of these big organizations enabled us to get in contact with a large number of people with different experiences. Overall we organized 18 workshops with invited guests and around 20 separate interviews, see table I. In this paper the collected data is used in two ways: i) to present selected cases that illustrate key characteristics when IoT is introduced and ii) to present common pattern and challenges.

B. Data collection

We have described and identified cases and conditions from different sectors; industrial IoT, smart energy, smart homes, smart cities, health care and social care, and sports and well-being. At the workshops and interviews we collected information on what actors who were doing what, how actors interacted with each other and how working processes were changed (or not). People sharing insights about IoT related projects and initiatives provided the basis to identify drivers, benefits, obstacles and common patterns related to introduction of IoT products and services.

The informants were open about the mistakes and successes by the own organization and partners. They could also share insights about cases of general interest. We found that the technology "itself" usually works as expected but still there are obstacles for commercial break through. We want to identify these obstacles and to understand why this is an obstacle. The collected data enabled us to identify common patterns, challenges and problems and to select good cases that illustrate these patterns and challenges, see section VI.

TABLE I. SOURCES OF PRINARY DATA COLLECTION

Industry sector	Companies and organizations contributing to data collection
Smart cities	ABB, ElectriCity, Envac, Ericsson, Fortum InfraNode, Qlocx, Riksbyggen, Scania, Skanska, Stockholm City, Veolia, Volvo
Smart homes and smart energy	ABB, Ericsson, Electrolux, Ellevio, Fortum, HEBA, Intel, NCC, RISE, Telia, Vattenfall
Sport, health and wellbeing	Biosynch, Ericsson, Interactive Institute, Merck, MTC, RaceFox, The Swedish School of Sport and Health Sciences
Healthcare and social care	Alleato, Almega, Biosynch, Cenvigo, Hemfrid, Intel, Joicecare, Phoniro, Sensative, Stockholm city, Stockholm county council, Telia and Municipalities Nacka, Norrtälje, Södertälje and Uppsala
Industrial IoT manufacturing	ABB Corporate Research, ABB Robotics, Berotec, Clayster, Combient, EzeSys, Ericsson, Sandvik, SICS, Telia, Volvo

IV. CASES AND SOME OBSERVATIONS

In this section we present selected cases that represent key phenomena and challenges when introducing new technology. The challenges will be further discussed in sections V and VI.

A. The connected trash can – one example of urban furniture

To connect trash cans to a monitoring system has become a solution to avoid emptying half-empty trash cans and thereby save time and environment. The trash cans report when they are full. One provider of such a solar panel based solution is BigBelly[2] and this kind of system is in use in many Swedish towns, e.g. Uppsala. Since the trash can is connected the system has a feature where you can offer WiFi services to citizens. Other features may be information about the local area to visitors.

Will this be a complete solution with its own business with focus on efficiency for waste management? Or can you expect that it is the start of a larger service that can include all cleaning and care in an area? Equipment like trash cans are sometimes called urban furniture, other examples are; lamp posts, bus stops, ad signs and billboards. This urban furniture can be used as the basis for a connected infrastructure that can be used for different services without relying on mobile operator networks. Operators can also make use of the urban furniture instead of deploying own base stations [10]. This possibility for re-use of equipment is highlighted at the Bigbelly webpage "Bigbelly provides a public right-of-way platform to deliver Smart City solutions and host communications infrastructure".

B. The connected bolt – going from product to service

The Swedish startup StrainLabs'[3] has developed a connected bolt that opens up for a new type of business, smart monitoring and inspection. A sensor embedded into a cavity in the head of the bolt monitors preload and temperature. When it detects that a bolt is about to come loose, it alerts the user and preemptive action can be undertaken. Inspection today is a manual activity performed in the field, and poses several challenges. An offshore oil platform has a hundred thousand bolts in hard-to-reach places that need to be inspected over a 5 year period. A wind turbine has giant blades, high above the ground. The amount of time and money spent on inspecting and reporting on critical applications globally is staggering.

The CEO says in an interview: "We no longer sell a screw, we sell a service to monitor the screw connection"[4]. The StrainLab solution is an example how you can offer a service based on a connected device. This service represents a large share of a set of activities for monitoring and inspection. Another well-known example, where a product offer is replaced by a service, is the Rolls-Royces maintenance program for airline companies called 'Power by the hour'. This includes a complete engine and accessory replacement service on a fixed-cost-per-flying-hour basis.

2 http://bigbelly.com/

3 http://strain-labs.com/bringing-internet-of-things-to-bolted-connections/

4 https://www.nyteknik.se/startup/uppkopplade-skruven-larmar-nar-den-blir-los-6579513

C. The connected soap dispenser- a part of a cleaning service

SCA is a large private forest holding company producing solid-wood products, pulp, publication papers and renewable energy. One product is liquid soap for everyday handwashing in schools, restaurants, nursing homes, and public spaces. SCA also offers soap dispensers and other equipment for toilets. Soap dispensers can be connected using the Tork EasyCube™ concept focusing on improved cleaning[5].

Tork EasyCube is a cloud-based service that collects data from connected devices. Displayed in web applications, information directs cleaning teams to exactly where they are needed. SCA offers connected devices, visitor counters, real-time data collection and display and an analytics tool for optimizing operations. The solution is tested at amusement parks and zoos like Skansen and Furuvik and customer cases are presented at the SCA web site. Clear benefits have been identified for amusement parks that can handle unpredicted large variations in number of visitors [6]. However, for cleaning of regular offices the value with the connected soap dispenser is not so clear. Here the new technology is used to improve efficiency for toilet cleaning. This is one activity representing one part of the overall activities; cleaning, facility management, running an office or amusement park.

D. Connected vehicles

Connected cars and self-driving (or driver-assisted) cars have been discussed some years. Although concepts like the connected vehicle cloud[7] was presented some years the big break through is still to come for consumers. However, for professional use the situation is different.

Manufacturers of transport vehicles have looked into possibilities with connected vehicles for years. Companies like MAN, Volvo and Scania have developed and use solutions where you can track different types of data for example vehicle, engine, driving and driver information. Scania has a large number of connected trucks delivered to different transport companies[8]. Scania and others foresee a development path from connected vehicle to connected fleet, possibly leading to “transport as a service” instead of selling vehicles.

Vehicle manufacturers have different types of vehicles on the market, all having specific in-vehicle communication systems. This leads to potential problems for the transport companies that usually have trucks from many manufacturers. However, the actors in this sector have agreed on a solution that helps transport companies to handle this multitude. The Fleet Management System (FMS[9]) standard enables common interfaces and third parties to access to vehicle data. No matter which manufacturer that produced a vehicle, if it is equipped with an FMS interface (gateway), there is the same output for all vehicles.

5 http://www.torkusa.com/easycube/
6 https://www.tork.se/kundcase/furuviks-zoo
7 https://www.ericsson.com/digital-services
8 https://www.scania.com/group/en/scania-reaches-milestone-250000-connected-vehicles/
9 http://bus-fms-standard.com/Truck/index.htm

E. Digital and smart locks

Digital locks, or smart locks, is a growing market, which has so far mainly focused on offices, as access system to real estate buildings, and in various applications within industries. However, the digital locks offer opportunities in other sectors, primarily identified by companies focused on home care for the elderly. In combination with “keys” in mobile phones there is no need to collect physical keys before you visit the elderly. Attempts have been made in several rounds over the past 25 years but it is only now that there is an interest and understanding of digital locks in the home care sector. Another application area is delivery of goods to “delivery rooms or boxes”. The company Qlocx offers a solution where logistics companies and users have access to common “boxes”[10].

Technology solutions are emerging developing the opportunities to produce advanced solutions at attractive prices. This means that digital locks should be considered as part of a larger part because they could solve other needs if used in a more complex context. Digital locks begin to be accepted by insurance companies so that they can replace the old locks in all homes. In that case, the lock becomes a part in a significantly larger part. This means that digital lock will not automatically be "smart". Their role in a certain context has to be properly analyzed. For the individual villa owner, the individual lock is a fully adequate solution, but it may not be for a municipality.

F. Home care service

Demographic trends make social care management begin to understand that technological solutions will be needed to meet these challenges. Typical technical solutions are cameras and bed sensors, alarm systems and digital lock system specifically developed for home care[11]. There are several relatively new players who have seen that there is room for both the rationalization and quality improvements for the "user" or beneficiary, see section V. The meeting between technology companies and caregivers is not quite easy to handle. Technology companies do not know anything about how caregivers work or what problems they have, and caregivers know nothing about technology or what the technology could offer.

Nevertheless, despite the efforts of the technology companies to assume the needs of caregivers or the users, solutions tend to be a small part of a larger while they are presented as complete and independent. The technical solutions that caregivers choose to buy can neither communicate nor exchange information with each other. There will be fragmented and isolated islands of technology solutions that will eventually be expensive to maintain and manage. The challenge of the municipalities is to rise above the individual problems and instead try to look at the whole and identify where technology can come in handy and get strategies to achieve the goals that need to be set up for its business.[12]

10 http://www.qlocx.com/
11 http://accessh.org/wp-content/uploads/2015/11/Asa-Lowing.compressed.pdf
12 http://www.vasteras.se/kommun-och-politik/vasteras-utvecklas/valfard-och-halsa/e-hemtjanst.html

TABLE II. IDENTIFIED DRIVERS AND BENEFITS OF SELECTED CASES

Case	Drivers and benefits
A. The connected Trash can	Improved working efficiency Re-use of infrastructure
B. The connected bolt	Improved working efficiency Possible to offer new services
C. The connected soap dispenser	Improved working efficiency Possible to offer new services
D. Connected Vehicles	Improved awareness Improved up time
E. Smart locks	Improved working efficiency Possible to offer new services
F. Home care services	Improved working efficiency

V. ANALYSIS

The analysis section consists of three parts, each illustrating observed drivers, challenges and patterns. First, we present key characteristics of the selected cases. Next, identified patterns and challenges from all the data are summarized. Finally, we look deeper into smart locks in order to see the importance of the overall service context in which a technical solution is used.

A. What we can learn from the selected cases

Looking into the value proposition enabled or strengthened by the introduction of the IoT products or services some clear drivers and benefits can be identified. Improved awareness and control of activities leads to improved working efficiency and processes. This implies better resource utilization, improved uptime and reduced costs. In addition, the IoT solution also offer the possibility to be re-used for other purposes than the originally intended one. Finally, the IoT solution may lead to the possibility to offer new types of services, i.e. new types of revenues, see Table II.

In the selected cases we can also get more insights by studying specific activities and what actor that is doing what. This is related to the components of the value chain or network, e.g. business model aspects as "firm organization and value chain" and "firm in the value network" [13]. Here, we can also identify if the offer consists of one or several services and if one service is part of another one. Iin addition, we identify if the service can be offered standalone or not and if the IoT solution enables a new product and/or service, see Table III.

TABLE III. ANALYSIS OF MAIN ACTIVITIES FROM CASES

Activity under study	Who performs the activity	Standalone service or part of other one	Type of novelty
Emptying Trash cans	Municipality itself	Standalone	New product new service?
Monitor bolts in large systems	Bolt provider or System owner	Standalone	New product and service
Smart cleaning of toilets	Facility manager or facility manager	Part of overall cleaning	New service
Monitor heavy vehicles & fleet	Vehicle Manufacturer	Part of support and vehicle maintenance	Improving service
Access using smart locks	Homecare provider Delivery company	Part of home care and delivery	Improving service
To provide e-homecare	Hom care provider Municipality	Part of home care	Improving service

B. Identified patterns and key challenges

Besides drivers and benefits we have identified a number of obstacles and observed some recurrent patterns. These are all related to how new technology or a new solution is introduced in the market. Below we shortly describe these key challenges.

Being a part of a solution. A specific IoT solution often tends to be a small part of the overall solution or even "a part of a part" of the overall service. An IoT solution may be too small in order to be a sustainable stand-alone business. For a "part of a part solution" a lack of understanding of the overall picture (service) may limit the potential with the new solution.

Unclear business context. Another observed challenges is the uncertainty about "in what kind of business you are". Is the business about selling an IoT product, or providing a service based on the IoT product, or providing a type of overall service where the IoT product of service is just one component among others?

Market position. The need to and insight about change of role and/or market position is another challenge. For manufacturing companies it is typically about moving from selling and maintaining products to offer "something as a service".

Fragmentation. We can find a multitude of similar technical solutions, each with it its own dedicated infrastructure although it is deployed in the same location for a single customer. This fragmentation leads to scalability problems when a large number of solutions need to be deployed and maintained. This fragmentation of solutions can be observed in several areas; facility management, factories, home care services.

C. Use of smart locks in different business scenarios - An illustration of the importance of the overall context.

1) The smart lock in a lock context

Digital products must be included in a context that makes it a service and that some parts of the context may be part of another digital service [28]. Analyzing digital locks we can see that they must be installed and configured, keys need to be distributed and given permissions that may change over time, the lock needs to be maintained, the keys are included in an administrative tool either managed by the principal or included as part of the service. In case of problems, there is a support service that can be shared by other digital services, etc. In this context the smart lock itself is the major part of solution.

2) The smart lock in a home care context

Each actor who delivers a shared service to the home care service will try to understand the whole value chain being able to expand his own service and compete out of others. Linked to the lock solution itself are features like log-in/log-out and time reporting. Other discussed features are time planning for the home care staff and a shared "dairy" about the elderly [29].

An example is the Swedish lock manufacturer Phoniro[13]. Their ambition is to become a supplier of complete solutions for the care of the elderly. Phoniro has evolved from a digital environment where locks were their first digital solution for elderly care.

[13] http://www.phoniro.se/

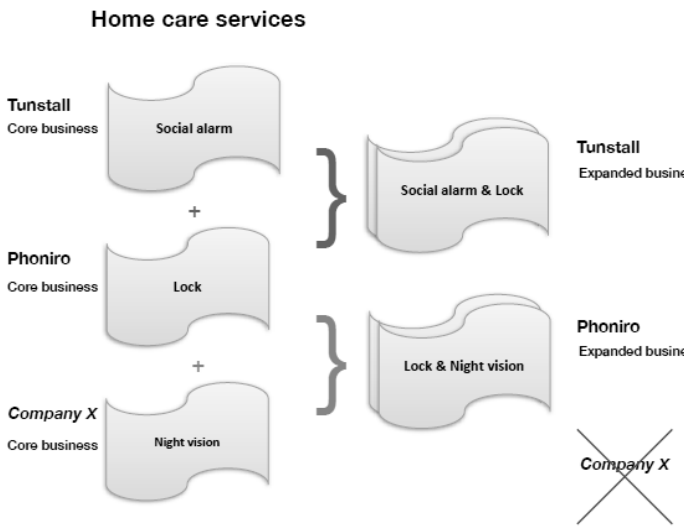

Fig. 1. Example of development of Home care business illustrating two routes of expansion for solution providers

The product portfolio of Phoniro now includes; digital cameras, surveillance, care tools and dose systems for medical management.

Other players in the same segment are in competition for lock to the home service market, such as Tunstall[14] founded in the UK, which began in Sweden to deliver security alarms. Both companies expand within the home service business the latter from a well-established security alert service, the other from a now well-established lock service.

Figure 1 illustrates the development of the home care services business where the two routes of expansion of the two companies are enrolled.

3) The smart lock in a municipality service context

The field of home care for the elderly is only part of the municipality's activities in an area. They run schools, sport facilities and other community service facilities as they also use similar services. We can see that they use all similar services, such as locks, and they turn to different users within an area. There are several players in a particular geographical area using similar services, and there may be reasons to ask who is best suited to offer a general access service?

Probably no company with elderly home care service as its core business is most suitable for access to schools, day care centers, health centers, stores, etc. If, on the other hand, the municipality chooses to procure access at the lowest level, a company in the care business is appropriate, but then the municipality will find that you have an access provider for each management activity.

In summary, this discussion of the invention" the digital lock" and it relations to the lock business, home care and municipality services illustrates several of the observed challenges. Moreover, the analysis also shows how these challenges are interrelated.

[14] http://www.tunstall.com/

VI. Discussion

In this section we will discuss how to assess the potential value of a new technical solution and look more into three of the identified key challenges; Being a part of a solution, Unclear business context and Fragmentation.

A. On the identified key challenges

1) Being a small or big part of the overall solution

One of the challenges we identified was the need to understand if the new technical solution represents a small or big part of the overall solution. This also includes to see of the solution is solving a small or big part of the overall problem. Most of the solutions with a connected device contributes to an increased awareness and enables the user to use its resources more efficiently. This applies to the "Screw connection monitoring", toilet cleaning and home care staff using cameras for night check-up of elderly. For all cases one type of value is that no staff is sent out if it is not needed.

In the cases of connected bolts and waste bins, and cameras for home care the benefits can be identified looking into existing activities. If you are "aware" you do not need to send out people "just to check". For the soap dispenser case the situation is more complex. The full value of the information from the soap dispenser is exploited when it is combined with some other information (visitor counting data) and put into an overall context. Hence, we can conclude that a solution that itself solves a limited part of an overall problem anyway can be very beneficial if it is put into the overall context. The other way around, if the overall picture is missing the added values is not clear, or can be low. Using the soap dispenser case again; high value can be seen when it is combined with visitor data in a high and varying load environment such as an amusement park. On the other hand, if the solution is used as a stand-alone feature in an environment with less frequent users, e.g. an ordinary office, then the potential value is much lower.

2) In what business are you?

For some solutions; like the connected bolt, the connected waste bin and night camera for home care, it is very clear in what business you are. For the mentioned examples the answers are: monitoring of installations with many bolts or screws, waste management and home care respectively. For the connected soap dispenser and the complete EasyCube concept the answer is not so clear. It could be any of the following types of businesses.

- Cleaning of toilets
- Cleaning of facilities
- Facility management in general
- Selling connected products to facility managers
- Offering *toilet refill services* (soap, towels, toilet paper)
- Offering *refill services* for a building (coffee, copy paper)
- Selling connected devices in general
- Selling systems for staff resource planning

If we compare SCA and StrainLab we see that SCA offers products and solutions that enable more efficient cleaning operation for the customer whereas StrainLab makes use of the connected bolt in order to offer a complete and new service.

3) On fragmentation and stove pipe solutions

What we knew before: The fragmentation with so called stove pipe solutions has been identified for many years. Well known examples from smart cities, facility management and social care services are reported from 2012 and 2013 [30]. Typically each solution, solving a specific problem or task is provided by one actor. The solution includes sensors, service platform and communication infrastructure.

The main problem is the complexity to deploy and maintain all multiple solutions. Clear evidence can be found form home care services. Representatives for IT departments of some Swedish municipalities say: "It is not feasible for us to maintain this multitude of different systems. An elderly person may have three or four different systems in their apartment and we have to ensure that they all work". These types of systems are typically social alarm, digital lock and camera for night surveillance, see figure 1.

What we have found now: Findings from the current research confirm that the fragmentation still is a key characteristic. In each of the different studied sectors we have found new or still existing cases of parallel stove pipe solutions. One example are from factories with multiple robots or "machines" in an assembly line, each machine is connected and monitored by the manufacturer of that machine. No common overall picture for the factory owner is provided since the machine manufacturers do not want to share data. Another example from sport and health is the multitude of sensors and apps that use different platforms. An individual may need to have several sensors each reporting data through a dedicated app with its own login and interface.

At the workshops we tried to find out the motivation and drivers for the fragmentation. Most actors did recognize the pattern of fragmentation and mentioned reasons include: i) A fear of losing or changing the relation with customers, ii) Distrust among actors to share platforms and data, iii) Hesitation to give "own" data to others, and iv) Lack of motivation to change the own business model.

B. Are we limited by technology or business aspects?

One question when analyzing new solutions and business related aspects influencing is if the new technology will "take off" commercially or not. At our workshops and at conferences many academic researchers and representatives from the industry claim that IoT solutions will work commercially if some technical feature is improved. Typically this includes security, energy consumption or radio coverage. However, as we see it, for IoT it is not about technical features or performance. We claim that there can be show stoppers in the business domain although the technology works as expected..

There are examples from other sectors where new technology does not take off although the technology works as expected. One example is the payment industry. Mobile payment services are not so wide spread in developed countries, but in developing countries mobile payments are very common [33]. Mobile operators in e.g. Kenya have offered payment services for years. In developed countries financial institutions have a strong position and telecom actors have problems to offer financial services.

NFC (Near Field Communication) for contactless cards is another example. The new technology is adopted but it does not lead to any major new businesses or services. The added value for end-users to use NFC for payments is not obvious. These examples illustrate how important the overall business context and end-user value are.

C. Actor and Business model aspects

1) Connected devices or connected "environments"

As mentioned above we need to consider the overall picture when we look into the potential benefits and added value of a new technical solution This typically includes both if the solution under study is a stand-alone feature or is a part of a bigger solution picture as well as if the solution represents a small or big part of the overall solution.

When designing a product or service offer we need to consider if we deal with single devices or a cluster of multiple connected device in a specific environment. Single device cases are e.g. the connected bolt, the connected waste bin, the connected soap dispenser or a connected body sensor. Each of the connected devices itself represents a relatively small to the overall activities, tasks or business. But the added value can differ substantially depending on how it is used.

Connected environments are for example a car, a truck, a home or a whole building. These connected environments, although with multiple connected devices, can be seen as one entity with specific needs or tasks. The connected entity is typically controlled by one actor, the manufacturer of the car or truck, the owner of the car, truck or home, or a facility owner. Hence, the added value of such a connected environment is more easily described in terms of the activities and requirements linked to such an environment. This leads back to business model issues.

2) Single firm or networked business model?

In our analysis we have looked into actors and activities. We have looked into how much an actor contributes to a specific activity and how important that activity is for the overall service. The value creation is central in this context. If a technical invention solves a defined problem (i.e. fills a smaller or larger need) one or a few players can handle this. However, if the main problem and the context are complex and a given solution solves only part of the whole problem, both comprehension of the whole picture and involvement of several actors are required.

Actors who can offer "a lot", i.e. that have a large part of the value network, have the ability to take care of the business themselves. They would not be as dependent on co-operation with others in the business network. On the other hand, players who can offer a smaller part of the overall service, i.e. they represent a smaller part of the value network, will be dependent on cooperation with others. Hence, the dependence in terms of other actors in the business network will be relatively larger.

The analysis of our cases indicates that most of the challenges occur due to the fact that the solutions initially have been developed using a single firm business model. In order to survive or grow some kind of networked business model is needed.

VII. Summary

The purpose of the research summarized in this paper was to identify the conditions for using IoT in different industries; industrial IoT, smart energy, smart homes, smart cities, health care and social care, sports and well-being. The research has given increased insights into business opportunities and obstacles for the introduction of IoT (and also digitilalization) in different sectors. The main obstacles are considered to be:

- Specific IoT solutions often tend to be a small part of the overall solution and hence it may be too small in order to be a sustainable stand-alone business
- Uncertainty and/or lack of knowledge about which overall services or business the IoT solution may be part of
- Fragmentation due to the diversity of parallel "closed" solutions that lead to insufficient scalability
- Distrust and hesitation among actors to share common and open platforms and to share data
- Fear of changing the own business model

The overall conclusion is that potential gains with IoT and digitization risk to not being achieved if actors continue to stick to the single-firm business model. We claim that cooperation and networked business models need to be considered for IoT solutions to be successful commercially.

VIII. References

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