https://doi.org/10.20378/irbo-51528

Realization of the "Internet of Things" - Towards an Engineering Model for technology-based Supply Chain Information Services

Helena Preiß

Fraunhofer-Institut für Integrierte Schaltungen IIS und Zentrum für Intelligente Objekte ZIO, Dr.-Mack-Strasse 81, 90762 Fürth,
helena.preiss@iis.fraunhofer.de

Alexander Pflaum

Fraunhofer-Institut für Integrierte Schaltungen IIS und Zentrum für Intelligente Objekte ZIO, Dr.-Mack-Strasse 81, 90762 Fürth,
alexander.pflaum@iis.fraunhofer.de

Abstract

The contribution discusses the slow adoption of supply chain information services which are based on Internet of Things-technologies. It answers the question whether there are service engineering models available which can be use to design new services in a way that the results fulfill user requirements and ensure a fast adoption process. A matching between technology-induced requirements and the characteristics of existing models is conducted to identify their main deficits. This paper recommends to disassemble existing models into process steps and design questions, to add additional steps and questions from the technological point of view and to reassign them in a way that all requirements are fulfilled. It emphasizes that the resulting design platform would be of high value for practitioners as well as for the scientific community.

1 Slow Adoption of Supply Chain Information Services based on Internet of Things Technologies - an Introduction

During the last ten years Internet of Things (IoT)-technologies like Radio Frequency Identification (RFID), Wireless Sensor Networks (WSN) and Real Time Locating Systems (RTLS) gained a lot of attention in logistics and supply chain management.[1]

These technologies promise cost reduction through process optimization as well as additional turnover based on new value added information services for the customer.[2] While process optimization issues have been taken into account in the past,[3] the potential increase of a company's turnover has been neglected both by the industry and the scientific community. Today only a few information services based on IoT-technologies are offered[4] and up to now they have not been able to establish themselves within the market. A good example is EPCglobal's "Look-up Service".

The reasons for the slow adoption are not well understood yet. There are no empirical studies on that issue, but some reasonable guesses can be made. The companies are not able to convince the customer of the benefits of the offered service. And without perceiving an advantage a customer is not willing to pay money for an additional service. This is a question of marketing and cannot be solved in this context. A second reason is that the logistics industry is mainly customer driven.[5] Without the external pressure of customer requests logistic service firms are not willing to introduce innovations and develop new offerings. Thirdly, it is assumed that logistic service providers are not familiar with the chances and risks of IoT-technologies. So they either fear negative outcomes by introducing these technologies in their company or they develop services which are not accepted by the customers as they don't fulfill their requirements. For the last point, this paper wants to develop a direction for further research. What is well understood is the fact that service engineering models help to create services which meet customer requirements.[6] They have the ability to speed up adoption. There are several service engineering models published in literature but the question is if they are applicable for the development of services which are based on IoT-technologies? To answer this question the concept of service engineering is introduced in the next chapter. Afterwards the in-principal innovative character of IoT-technologies is proven.[7] In chapter four we deducted requirements which a service engineering model has to fulfill and we match these requirements with already existing models. Finally, we suggest a direction for further research in chapter five.

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[1] An overview is shown in Ferrer/Dew/Apte (2010), p. 417

[2] Vgl. Pflaum (2007), p. 301

[3] Vgl. for example Informationsforum RFID e. V. (n.d.), p. 6; METRO Group (n.d.), p. 7ff; Darkow/Decker (2006), p. 48ff

[4] Vgl. for example Original1 (2011); DHL Solutions & Innovations (2011), p. 1f

[5] Vgl. Hillbrand/März (2009), p. 18

[6] Vgl. Bullinger/Scheer (2006), p. 4f

[7] Vgl. Weiss (2004), p. 320ff; Pflaum (2001), p. 59ff

2 Service Engineering as the basic Design Instrument

Service engineering is a young discipline and can be defined as the systematic development and design of services with the help of suitable models, methods, and tools.[8] The broadness of the literature on service engineering and service development suggests that the right processes and methods are available. During the last thirty years roundabout twenty different process models have been developed and published in the scientific community. Additionally, the number of methods and tools supporting the particular steps of the sometimes sequential and sometimes iterative models is almost countless. So why not stop the discussion here and put existing theory to work? The answer is that one has to challenge the suggestion so hastily mentioned above. A look into the literature shows that fundamental contributions that build up a link between "revolutionary" or "in-principle" technological innovations like RFID – the in-principle character of the IoT-technologies will be discussed later on in the text – and service design are missing. Therefore the question is whether existing design procedures and methodology can really be used to develop IoT-based services in an effective and efficient manner or not. In case that the answer is "no" the question turns in how a procedure serving the requirements should look like. The following pages will give a comprehensive answer.

3 Remarks concerning the in-principle innovative character of IoT-technologies

To work out the special engineering requirements for information services based on IoT-technologies one has to understand their in-principle innovative character. The literature on technology and information management provides different definitions for "innovation"[9] and the term is difficult to handle from a scientific point of view. One dimension of innovation discussed in literature is its degree. Here "in-principle" and "gradual" innovations are distinguished from each other. In-principle innovations in the field of information and communication technologies feature four different main attributes.[10]

They

a) rest upon totally new technologies,
b) destroy existing know-how and require new competences,
c) change structures by complementary or even system innovations, and
d) deliver formerly unknown performance levels and cut costs significantly.

From the logistics and the supply chain management's point of view IoT-technologies hold all these attributes. Despite the implementation activities of companies like Wal

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[8] Vgl. DIN e. V. (1998), p. 11ff

[9] Vgl. for example Barnett (1953), p. 7; Roberts (1987), p. 3; Schmookler (1966), p. 2; Vedin (1976), p. 22

[10] Vgl. Weiss (2004), p. 320ff

Mart, Gilette, Metro, Deutsche Post, and other pioneers the larger part of potential users is not familiar with the benefits and challenges of the technology.

a) Totally new basic technology:

Today most logistics companies use barcodes to identify their products, cases, or pallets. In the aviation industry companies like Lufthansa Technik attach ruggedized barcode labels to spare parts to optimize logistics and asset management processes. Within the outlets of retail companies like Metro there is no single product which is not equipped with a small barcode label and most of the checkout systems would have problems without the printed machine readable identifier. Deutsche Post World Net would also be lost without barcode labels controlling the material flow running through depots and hubs. From the technological point of view optical systems are used today to transfer information between the barcode identifier and the reading device. But a line of sight is necessary and the degree of automation is limited when barcode is used. IoT-technologies do not use light but electromagnetic waves for communication between a microelectronic label and a base station. From the user's point of view the use of radio frequency technology has been unknown to the industry and is therefore an in-principle innovation. With the new technology the line of sight precondition loses its importance and a full automation of identification processes is possible.

b) Destruction of existing knowledge:

During the last 30 years companies developed and cultivated comprehensive know how concerning the adoption and implementation of barcode technology. Today nobody finds trouble in choosing the right barcode standard or to integrate a barcode-based solution into existing processes and information systems. The situation changes dramatically with IoT-technologies. The attachment of microelectronic labels to moving objects like containers, pallets, or products is nothing else but the first step towards a fundamental change of the IT-architecture which is in use today. Decentralization and mobility are the key words. Providing much larger storage capabilities than the classical barcode combined with data processing functions IoT-technologies allow decentralization of data bases and application software as well. Together with the different objects named above data and application software modules start to move through global supply chains. A lot of questions that have never been relevant in the barcode case have to be answered now. The easiest of them concerns the design of a reader gate which guarantees a robust and highly reliable automatic identification of items running through a gate in a logistics depot or hub. More complex is a second question, how to integrate worldwide distributed readers into an existing and supply chain spanning information system? Nearly insolvable seems the third problem of a sustainable design of the future's IT-architecture within a company. While standard competences in system integration and implementation are sufficient for the adoption of barcode, IoT-technologies require highly developed competences in systems and software engineering. Barcode knowledge does not help here. This is why companies like Lufthansa Technik, DHL, or the Metro Group cooperate intensively with scientific organizations.

For the moment this is the easiest way to access the competences which are necessary for adoption.

c) Changing existing structures:

Already a skin-deep look at existing implementations shows that there are a lot of complementary innovations coming together with the microelectronic label. New types of readers, middleware for their integration into existing information systems, new application software supporting modified or new business processes are needed to create benefit for the company. Hence, the IT structure changes significantly and the more the technology penetrates the company's business processes the more likely are changes of the organizational structures as well. For example, Lufthansa Technik created a new unit besides the existing IT department which is exclusively responsible for RFID projects within the whole organization. The implementation of the new technology in the Fast Moving Consumer Goods Segment of the retail market was one of the main reasons for DHL to set up the Innovation Center in Troisdorf which operates a large demonstration and test center with more than two thousand square meters. More than seventy employees are working for the Innovation Center today. The Metro Group on the contrary invested a lot of money into the Future Store Initiative. A countryside retail outlet was equipped with RFID technology and complementary innovations like in-house localization systems, fully automated checkouts, and mobile handhelds for the customer. Beyond that Metro Group and DHL Innovation Center launched the European EPC Competence Center, a test and demonstration lab which pushes especially EPC global conform RFID technologies and services. EPCglobal is the best proof of the in-principle character of the RFID technology. The company was launched by MIT's Auto-ID-Lab some years ago and it developed into a global organization which is one of the most important drivers of the technology. It runs its own IT infrastructure and offers first information services to customers from various industrial branches.

d) Higher performance levels and lower costs:

IoT-technologies deliver a higher performance compared to the barcode. A barcode is written once and can be read indefinitely often. The information coded into the bars and gaps is customarily limited to an identification number. On the contrary the microelectronic tag has the ability to store a larger amount of data which can be changed or extended as often as it is needed within a given process. But this is just one minor issue. More important is the fact that readers for IoT-technologies have the ability to identify some hundred objects at the same time automatically even if the tags are hidden in the packaging (bulk reading) while barcode scanners are limited to read only one barcode at the same time. In the barcode case a "line of sight" between the label and the scanner is needed and both have to be aligned with each other manually or by means of material flow systems. IoT-technologies on the other hand allow full automation of the identification process. The cost discussion is more complex compared to performance issues. On the one hand it is true that the cheapest microelectronic tag costs at least four times as much as a printed barcode label. On the other hand one must not forget that there are other types of costs which have to be taken into account. IoT-technologies can be used to reduce process and asset costs. For example, Lufthansa Technik was able to speed up in-house logistics processes by 70 percent and to reduce the number of spare parts. The resulting business case allows the application of ruggedized and relatively expensive microelectronic tags directly on the spare parts. DHL and Metro Group invested a lot of money into rolling-out the RFID technology in Metro's French cash and carry markets on the pallet level. Both companies report that cost reduction on the process-side allows an easy argumentation of the implementation costs.

4 Deficits of existing Service Engineering Models - Results of a Matching Process between technology-induced Requirements and Characteristics of existing Models

4.1 Deduction of Requirements for Service Engineering Models

Since we have shown that IoT-technologies are one of these in-principle innovations the question comes up how companies like Lufthansa Technik, DHL, and Metro can develop IoT-based information services which are able to meet the customer desires. The first thing needed is a procedure model which fulfills certain requirements. On the following pages we deduct these requirements directly from the in-principle character of the IoT-technologies.

Requirement 1: The starting point of the service design should be a well defined key problem of the customer.

The adoption of an in-principle innovation is connected with high investments which have to be justified by accordingly high benefits.[11] Addressing a minor problem within a company by means of high technology does not make sense. The real benefits hide behind real problems. Therefore, the first step of service creation should be the identification of a company's main problems and the second should be the discussion whether IoT-technologies deliver a significant amount of solution potential or not. In case that this discussion ends with a clear "yes", the starting point for a service design project is well defined. So, researchers and industrial companies should drive IoT implementation against the background of key problems the industry is struggling with. For example, MIT's Auto-ID activities have been motivated with core problems like shrinkage, out-of-stock, counterfeiting, recalls, recycling, unsaleables, and data accuracy.[12] Lufthansa Technik started its RFID activities to increase availability of existing spare parts, to minimize asset costs by reducing their number, and to boost the value of the company itself. Metro was initially motivated by increasing turnover via higher on-shelf-availability of high value products like razor blades for their customers. DHL

[11] Vgl. Decker et al. (2008), p. 157

[12] Vgl. Condea/Thiesse/Fleisch (2009), p. 955f; Staake (2005), p. 1607ff; Tellkamp et al. (2004), p. 19; Thiesse/Dierkes/Fleisch (2006), p. 48

again cooperated with Metro Group to gain a competitive advantage compared to other logistics service providers by means of a high-end tracking and tracing service.

Requirement 2: The service engineering procedure has to include the analysis of the already existing problem solution.

There is no problem which is not at least partially solved by an existing solution. For example, Lufthansa Technik uses a paper based information system to keep track of expensive spare parts. Installation and removal of every part of an aircraft are documented on a sheet of paper which also controls the logistics processes to and from the corresponding repair shop. Therefore, the transparency of the material flow is limited and the availability of spare parts from an IT's point of view could be enhanced by using microelectronic labels. DHL uses a barcode based solution for tracking and tracing which is working quite well on a national level. Problems arise in the international business. Here the company has to cooperate with partner firms which support their own information systems and tracking and tracing tools. The main challenge is the seamless integration of the different IT landscapes. Without fully integrated systems it is impossible to deliver full status information along the international transport chain. The implementation of RFID technology on a global scale and the construction of a global tracking and tracing service open for all business partners could be a better solution for their transparency problem.[13] Checkouts with integrated barcode scanners generate the information which is necessary for the implementation of continuous replenishment solutions in Metro's retail outlets. Unfortunately, there is no information how much of the remaining stock is located in the storage room or on the shelf in the sales room. RFID enabled shelves could solve this problem better. The precondition would be that microelectronic tags are attached to the products. But in all three cases a RFID-based system has to compete with the existing solution.

Requirement 3: Discussion of the added value which could be realized by implementing IoT-technologies together with a lead user.

The RFID hype which started in the late 90ies seems to be history. Discussions with technology providers like Siemens or Texas Instruments and technology users like Lufthansa Technik, DHL, and Metro make clear that investments into a development or implementation project have at any rate to be supported by a strong business case. Otherwise the risk of losing a lot of money with the implementation of the in-principle innovation would be too high. The design of an IoT-based information service for a customer or a market segment does only make sense if significant and quantifiable financial benefits can be pinpointed. The technology can be used to speed up or to shorten order-to-payment processes, to support controlling and financial activities, to enhance the data accuracy of a company's information system, and to safeguard the

[13] Vgl. Chikova/Simon/Loos (2008), p. 178ff

competitive position of a company.[14] The list of benefits provided by the literature is long. Therefore, the challenge is not to name the relevant benefits in a certain case but to find the lead user who is willing to quantify these together with the provider of the future service. On the one hand the examples used before show that this is not an impossible task. Lufthansa Technik Logistik works together with its parent enterprise Lufthansa Technik, DHL found a very enthusiastic cooperation partner in its customer Metro, and Metro itself uses the original customers of its future store as “lead users”. On the other hand companies like EPCglobal struggle with the establishment of new information services. The reason might be that lead users with precise ideas concerning the service and the benefits are missing here. But this is a complex question which should be handled in another scientific paper. In any case, the added value of a future IoT-based information service has to be quantified during the design phase to deliver the necessary business case.

Requirement 4: Good understanding of the technological state of the art as well as of the more important technological developments.

In contrast to gradual technical innovations the time period between practical tests of first prototypes and the broad industry-spanning implementation of mature products is much longer in case of in-principle innovations. For example, low-cost microelectronic tags for the identification of parcels in postal value chains are available since the late 90ies. Even though the price of a tag has been reduced from 50 to 12 Eurocents over the years through continuous development and optimization of the production processes the broad rollout never took place. The reason is that the tag-price is still not acceptable for postal companies and one has to make the assumption that it won’t be until RFID tags made out of polymer materials are available. This example shows that working business cases are connected with performance characteristics which are achieved during the technology life cycle. Therefore, an understanding of the technological state of the art is a precondition for a successful service design. In case of the postal services and the parcel application the business case does not depend on the technological performance but on the price of the product itself. In the case of the RFID implementation activities at Lufthansa Technik Logistik the project team learned that the strength of the business case increases with the decrease of the volume of the microelectronic tag which is attached to a spare part. The smaller the tag the larger is the scope of spare parts which can be identified using RFID. Before starting the development of their own tag, the company carried out a comprehensive state of the art study on metal mount tags to make sure that existing products really didn’t meet the previously defined requirements. DHL prepared a similar study on sensor enabled RFID tags years ago. Since there was no tag which met the market requirements the company started to develop its own technological solution. Meanwhile, the sensor tag is available. The company’s Innovation Center is currently setting up a temperature

[14] Vgl. for example Jedermann/Lang (2008), p. 120; Kleist et al. (2004), p. 4ff; Winkler/Kaluza/Blasl (2008), p. 347; Wolfram/Gampl/Gabriel (2008), p. 31ff

monitoring service for their customers which is based on this tag. Metro is one step behind the other two companies as far as item tagging is concerned. The basic technology which is needed to produce low-cost tags for fast moving consumer goods does still not exist. Experts assume that polymer tags meeting the requirements will be available in five to ten years from now.[15] Therefore, Metro confines itself to monitor the major technology developments and trends. These examples show that companies have two different alternatives. On the one hand they can wait until new products deliver the needed performance level or on the other hand they can try to develop their own solution together with a technology partner. In the Metro case there is nothing left but to monitor because of the polymer technologies position within its life cycle.

Requirement 5: The design procedure has to support the decision between existing functional equivalent technologies.

From the innovation management's point of view an IoT-technology must not be considered isolated. A closer look at the various IoT-technology shows that there are functional equivalent technologies which might be used for the same purpose. Tab. 1 summarizes these technologies and their functional profiles.

Nr.	**Technology**	**Functions**						
		Identification	**Bulk Reading**	**Data Storage**	**Sensors**	**Localization**	**Networking**	**Data Processing**
1	Radio Frequency Identification	X	X	X		X		
2	Sensor Tags	X		X	X			
3	Telematics Modules	X		X	X	X		X
4	Real Time Location Systems	X	X			X		
5	Wireless Sensor Networks	X	X	X	X	X	X	X

Tab. 1: RFID and other functional equivalent technologies

We already discussed the main functions of barcode, radio frequency identification, and sensor tag technologies. In connection with RFID we have to add that it is possible to localize long-range tags in-house with a special technical infrastructure today. Especially RFID technology competes with telematics modules when larger items like pallets or containers have to be tracked on a global level. Here integrated GSM and GPS

[15] Vgl. Wolfram/Gampl/Gabriel (2008), p. 132

modules deliver additional functions and add more value to the information service. Another technological alternative that has to be taken into account are real time locating systems or RTLS. The accordant tags are quite small and allow localization processes with a special resolution up to a few centimeters. Finally, there is the emerging technology of sensor networks or WSN. Microelectronic tags start to talk to each other, to carry out business logic, and to solve complex problems cooperatively. The question which arises here is which technology is the right one for a given problem or application scenario. Fig. 1 helps to explain the importance of this issue.

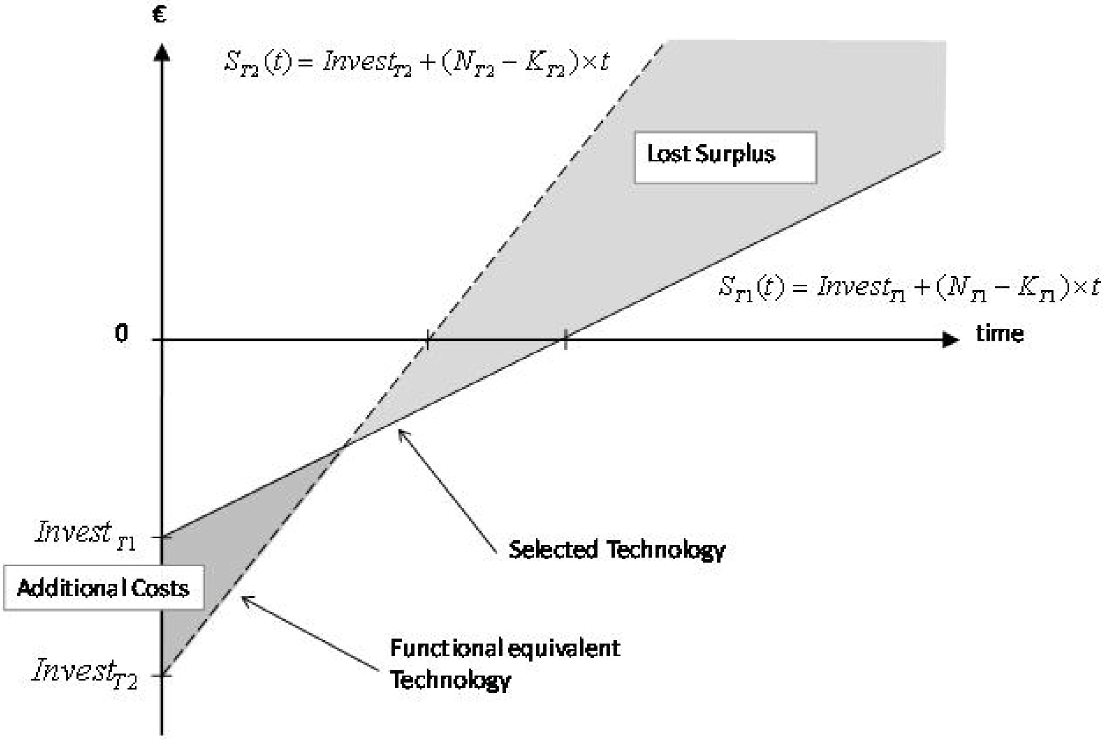

Fig. 1: The problem of technology selection

It shows the development of the surplus over time for two functional equivalent technologies on an abstract level. Technology one is connected with less investment costs than technology two. Vice versa the relation between current benefits and running costs for technology two is much higher than in case of technology one. If a person bases his or her decision on this data, he or she would choose technology two. However, the necessary liquid funds have to be available. In case that a user selects technology one he looses a lot of money which is represented by the grey area within the figure. The amount of lost money differs from case to case but it might be significant. The example shows that the service engineering procedure we are looking for must include a technology selection step. Ideally, all possible functional equivalent technologies have to be analyzed with regard to economic consequences. The decision between different technological alternatives is sometimes easy. Lufthansa Technik Logistik uses RFID tags because all other functional equivalent technologies need batteries on the microelectronic tag and therefore are not allowed by the International Air Transport Association. DHL’s temperature monitoring system could also be supported with wireless sensor networks but a standard, which is the precondition for technology implementation in global logistics processes, does not exist yet. In Metro's item tagging case none of the functional equivalent technologies delivers a reasonable business case.

Requirement 6: The service engineering procedure has to emphasize the development of the IT-system and to support this step with adequate methods and tools.

The implementation of RFID technology changes a company's IT architecture significantly.[16] The same is true for other functional equivalent technologies like wireless sensor networks and real time locating systems. Therefore, it is necessary to attach sufficient importance to the design of the information system within the service engineering procedure. Otherwise one might have to pay a lot of money for mistakes which are easily committed during early design steps like identification and definition of the necessary software use cases or deduction of detailed technical requirements. For example, one challenge is to create application software which helps to realize all the benefits that have been identified before. The idea to adapt standard software like SAP or another enterprise resource planning system could be a solution here. But the problem is that these costly adaptations could destroy the business case behind the service easily and it might be a better idea to support the service processes with innovative software concepts based on a service-oriented architecture (SOA). Against this background it seems interesting that the service company Deutsche Post World Net is one of the major drivers of SOA. We assume that Lufthansa Technik and Metro Group will also have to deal with this concept if they are really willing to set up high quality services for their customers based on their RFID infrastructure.

Requirement 7: Due to highly complex and often in-transparent cost structures the service engineering procedure has to emphasize economic feasibility studies and to support this step with adequate methods and tools.

We already stated that the implementation of in-principle innovations like RFID is always connected with complementary if not system innovations. In connection with economic feasibility studies this means that independent of the costs for the microelectronic label and the reader infrastructure there are additional efforts for integration platforms, software modules, integration activities, system adaptation, process redesign, service engineering, project management, and risk management.[17] Due to the complexity of the innovation problem there are difficulties to calculate some of these efforts properly and efficiently. But a well-developed business case with quantified benefits and costs is the precondition for a development or implementation project. An engineering procedure for IoT-based customer services has to address the economic feasibility intensively. However, the most important challenge here is not the devel-

[16] Vgl. Angeles (2005), p. 60ff

[17] Vgl. Smart/Bunduchi (2007), p. 3ff

opment of new calculation methods. Already existing concepts like the payback period rule, profitability rate, and internal rate of return can be used to generate valuable results. The more critical issue is to identify and estimate the different cost elements. The engineering procedure has to provide models which make sure that the cost considerations are comprehensive and that all important elements are taken into account. It also has to provide mechanisms which help to determine the size of the financial efforts behind the single cost elements.

4.2 Existing Service Engineering Models and their Ability for the Design of IoT-based Supply Chain Information Services

The literature on service engineering and development describes a lot of procedure models which could be used to design new customer services. These models promise a holistic approach to the service design process and foster the maintenance of a high quality standard. They aim on a structured development comparable to the design processes in the engineering disciplines[18] and two main forms of service engineering models can be distinguished. First, there are the linear models. They consist of a sequence of single steps where one step follows the previous one and they are characterized by high transparency and easy understanding. These benefits come for the price of an inadequate flexibility and the lack of a possible parallelization of the single steps. Necessary returns to a previous stage are not considered either. This special problem is solved by the iterative models. These models make such returns in the design process possible, deliver quick results on an abstract level, and high learning rates can be achieved. Nevertheless, iterative models also have disadvantages. The complexity grows and the management of the service engineering process becomes more difficult.[19]

Many models in both areas were developed and published. The question is whether these models meet the requirements that have been deducted in the last chapter or not. Tab. 2 shows the list of identified service engineering models in the first column, the first row repeats the requirements in a slightly abbreviated version. The matrix indicates which model fulfills which requirements. A look at the table reveals that none of the models is in the position to fulfill all the necessary requirements of a service development process for IoT-based services. A discussion on the requirements and the analyzed service engineering processes will help to understand the missing dimensions of the current procedures.

None of the analyzed models includes an explicit look on the customer's key problems with one exception [Edvardsson/Olsson (1996)]. Instead, many authors suggest a focus on the market situation. They assume that by knowing the market it is easier to appraise the wishes of the customers and to identify lacks of the existing offering. In the case of the IoT this approach won't be successful. Since the larger part of the potential market does not understand the new technology there is no awareness concerning the

[18] Vgl. Bullinger/Scheer (2006), p. 4

[19] Vgl. Schneider et al. (2005), p. 117f

benefits to be expected and there are no perceived lacks. The different business cases addressed in this contribution show that RFID pioneers always started from a problem's point of view. For Metro it was the not existing pedigree of a single product, DHL tried to cope with the shrinkage problem, and Lufthansa struggled with the missing transparency of global material flows. Following that line of thinking it is understandable that only four of the contributions mentioned below [Edvardsson/Olsson (1996); Krallmann/Hoffrichter (1998); Ramaswamy (1996); Tax/Stuart (1997)] put attention to a detailed analysis of the current situation. From our point of view this is a critical issue. If the current solution with its problems is not understood well enough the service engineers will not be able to realize the potential benefits coming with the implementation of IoT-technologies.

At first sight it seems strange that none of the models mentioned in the table meets the requirement concerning the discussion about the added value but there is a simple explanation. It is true that the literature on service engineering states clearly that the precondition for a successful service implementation is the added value perceived by the customer [for example Meyer/Blümelhuber (1998); Scheuing/Johnson (1989)]. But it is also true that the contributions refer to the service itself and not to the technology the service is built upon. From the technology and innovation management's point of view this doesn't go far enough. To justify investments into new technologies it has to be worked out which benefits or which added value can be attributed to the technological innovation itself and which can be ascribed to the design of the service process. A decision for or against the implementation of the new technology will be difficult to make without such a discussion. Furthermore, it is self-evident that the prerequisite for a comprehensive discussion on the origin of the added value is a good understanding of the innovative technology itself. Existing procedure models disregard this issue. Only four authors [Cooper/Edgett (1999); Edvardsson/Olsson (1996); Meiren (2001); Schneider/Scheer (2004)] mention the evaluation of the state of the art of the technology when it comes to the design of new services. The fact that technology selection doesn't play a major role in existing procedure models can be regarded as another fact proof that technologies as an enabler for new services haven't gained attention in service research yet. Only [Cooper/Edgett (1999)] discuss the problem of choosing the right technology but even here there is no hint concerning the handling of in-principle innovations like RFID.

Nr.	Model	Type		Requirements						
		Phase model	Iterative model	Focus on key problem	Analysis of existing solution	Discussion of value added	State of the art analysis	Technology selection	Design of IT system	Profitability analysis
1	Cowell (1988)	X			x					
2	Scheuing/Johnson (1989)	X								X
3	Kingman-Brundage/Shostack (1991)		X							
4	Edgett (1996)	X								X
5	Edvardsson/Olsson (1996)	X		X	X		X		X	X
6	Ramaswamy (1996)	X			X					X
7	Tax/Stuart (1997)		X		X					
8	DIN e.V. (1998)	X							X	
9	Meyer /Blümelhuber (1998)	X								
10	Jaschinski (1998)		X							X
11	Krallmann/Hoffrichter (1998)		X		X					
12	Cooper/Edgett (1999)		X				X	X	X	X
13	Johnson/Menor/Roth/Chase (2000)	X								
14	Meiren (2001)		X				X		X	X
15	Schreiner/Nägele (2002)	X			x				x	
16	Meiren/Barth (2002)	X								X
17	Bullinger/Schreiner (2003)		X							
18	Schneider/Scheer (2004)		X				X			X
19	Luczak et al. (2006)	X	X						X	

Tab. 2: Matching between requirements and existing procedure models

Even if technology itself has been of limited concern to the scientific community in the past, information systems which might be built upon different basic technologies are considered as one of the more important resources for high quality customer services for a long time. IT issues have been addressed by many authors and are included in several procedure models [for example DIN e. V. (1998); Luczak et al. (2006)]. The same is evident as far as profitability analysis is concerned. Services in a business environment can only be successful if the monetary outcome will be higher than the necessary investment. To prove this positive ratio a continuous economic monitoring is essential. This factum plays an important role within almost all introduced service engineering models [for example Meiren/Barth (2002); Schneider/Scheer (2004)]. This implies that the introduction of a new service can only be justified when both the customer and the company gain benefits.

5 Recommendations concerning the future Handling of Service Engineering Issues within the IoT Context

Existing service engineering models should not be applied to design processes without significant enhancements. From our point of view a new process model has to be developed. An applicable method would be to disassemble existing models, to identify main process steps and design questions, to create a new process chain, to assign the identified design questions to the process steps, and to add supporting methods and tools which help to answer the questions. The resulting “design platform” would be of high value for practitioners and scientists.

6 Literaturverzeichnis

Angeles, R. (2005): RFID Technologies: Supply-Chain Applications and Implementation Issues, in: Information Systems Management (Winter), S. 51-65.

Barnett, H.G. (1953): Innovation: The Basis of Cultural Change, New York.

Bullinger, H.-J.; Scheer, A.-W. (2006): Service Engineering - Entwicklung und Gestaltung innovativer Dienstleistungen, in: Bullinger, H.-J.; Scheer, A.-W. (Hrsg.): Service Engineering. Entwicklung und Gestaltung innovativer Dienstleistungen, 2. Auflage, Berlin, S. 3-18.

Bullinger, H.-J.; Schreiner, P. (2003): Service Engineering: Ein Rahmenkonzept für die systematische Entwicklung von Dienstleistungen, in: Bullinger, H.-J.; Scheer A.-W. (Hrsg.): Service Engineering. Entwicklung und Gestaltung innovativer Dienstleistungen, 1. Auflage, Berlin, S. 53-84.

Chikova, P.; Simon, B.; Loos, P. (2008): Potential Process Improvements in Supply Chain Management through RFID, in: Blecker, T.; Huang, G. Q. (Hrsg.): RFID in Operations and Supply Chain Management, 1. Auflage, Berlin, S. 175-194.

Condea, C.; Thiesse, F.; Fleisch, E. (2009): Assessing the Impact of RFID and Sensor Technologies on the Returns Management of Time-Sensitive Products, in: Business Process Management Journal 99, S. 954-971.

Cooper, R. G.; Edgett, S. J. (1999): Product development for the service sector, Cambridge.

Cowell, D. W. (1988): New Service Development, in: Journal of Marketing Management 3, S. 296-312.

Darkow, I.-L.; Decker, J. (2006): Technologien und Anwendungsfelder von RFID, in: Engelhardt-Nowitzki, C.; Lackner, E. (Hrsg.): Chargenverfolgung. Möglichkeiten, Grenzen und Anwendungsgebiete, 1. Auflage, Wiesbaden, S. 39-58.

Decker, C.; Bechthold, M; Weiss, L.; Chaves, F.; Beigl, M.; Roehr, D.; Riedel, T.; Beuster, M.; Herzog, T.; Herzig, D. (2008): Cost-Benefit Model for Smart Items in the Supply Chain, in: Floerkemeier, C.; Langheinrich, M.; Fleisch, E.; Mattern, F.; Sarma, S. E. (Hrsg.): The Internet of Things, 1. Auflage, Berlin, S. 155-172.

DHL Solutions & Innovations (2011): Simplicity in Temperature Monitoring, Troisdorf.

DIN e.V. (1998): Service Engineering - Entwicklungsbegleitende Normung (EBN) für Dienstleistungen. DIN-Fachbericht Nr. 75, Berlin.

Edgett, S. J. (1996): The New Product Development Process for Commercial Financial Services, in: Industrial Marketing Management 25, S. 507-515.

Edvardsson, B.; Olsson, J. (1996): Key Concepts for New Service Development, in: The Service Industries Journal 16 (2), S. 140-164.

Ferrer, G.; Dew, N.; Apte, U. (2010): When is RFID right for your service?, in: International Journal of Production Economics 124, S. 414-425.

Hillbrand, C..; März, L. (2009): Modellierung von Produktplattformen für Logistikdienstleistungen, in: Thomas, O.; Nüttgens, M. (Hrsg.): Dienstleistungsmodellierung - Methoden, Werkzeuge und Branchenlösungen, 1. Auflage, Berlin, S. 17-34.

Informationsforum RFID e. V. (oJ) (Hrsg.): RFID Leitfaden für den Mittelstand, Berlin.

Jaschinski, C. (1998): Qualitätsorientiertes Redesign von Dienstleistungen, Aachen.

Jedermann, R.; Lang, W. (2008): The Benefits of Embedded Intelligence - Tasks and Applications for Ubiquitous Computing in Logistics, in: Floerkemeier, C.; Langheinrich, M.; Fleisch, E.; Mattern, F.; Sarma, S. E. (Hrsg.): The Internet of Things, 1. Auflage, Berlin, S. 105-122.

Johnson, S.; Menor, L.; Roth, A.; Chase, R. (2000): A Critical Evaluation of the New Service Development Process. Integrating Service Innovation and Service Design, in: Fitzsimmons, J.; Fitzsimmons, M. (Hrsg.): New Service Development. Creating Memorable Experiences, London, S. 1-32.

Kingman-Brundage, J.; Shostack, L. G. (1991): How to design a service, in: Congram, C. A.; Friedman, M. L. (Hrsg.): The AMA Handbook of Marketing for the Service Industries, New York, S. 243-261.

Kleist, R. A.; Chapman, T. A.; Sakai, D. A.; Jarvis, B. S. (2004): RFID Labeling. Smart Labeling Concepts & Applications for the Consumer Packaged Goods Supply Chain, 1. Auflage, Irvine.

Krallmann, H.; Hoffrichter, M. (1998): Service Engineering: Wie entsteht eine neue Dienstleistung?, in: Bullinger, H.-J.; Zahn, E. (Hrsg.): Dienstleistungsoffensive: Wachstumschancen intelligent nutzen, Stuttgart, S. 231-261.

Luczak, H.; Liestmann, V.; Winkelmann, K. (2006): Service Engineering industrieller Dienstleistungen, in: Bullinger, H.-J.; Scheer, A.-W. (Hrsg.): Service Engineering - Entwicklung und Gestaltung innovativer Dienstleistungen, 2. Auflage, Berlin, S. 443-462.

Meiren, T.; Barth, T. (2002): Service Engineering in Unternehmen umsetzen, 1. Auflage, Stuttgart.

Meiren, T. (2001): Entwicklung von Dienstleistungen unter besonderer Berücksichtigung von Human Ressources, in: Bullinger, H.-J. (Hrsg.): Entwicklung und Gestaltung innovativer Dienstleistungen, Tagungsband zur Service Engineering 2001, Stuttgart.

METRO Group (oJ) (Hrsg.): Spektrum RFID, Düsseldorf.

Meyer, A.; Blümelhuber C. (1998): Dienstleistungs - Innovation, in: Meyer, A. (Hrsg.): Handbuch Dienstleistungs-Marketing, Band I, Stuttgart, S. 807-826.

Original1 (2011): Successfully combat product piracy. http://www.original1.com/; zuletzt aufgerufen am 29.04.2011.

Pflaum, A. (2007): Radio Frequency Identification als strategisches Instrument für Dienstleistungsunternehmen der Kontraktlogistik, in: Bohlmann, B.; Krupp, T. (Hrsg.): Strategisches Management für Logistikdienstleister, 1. Auflage, Hamburg, S. 290-306.

Pflaum, A.; Klaus, P. (2001): Transpondertechnologie und Supply Chain Management: Elektronische Etiketten - Bessere Identifikationstechnologie in logistischen Systemen?, Hamburg.

Ramaswamy, R. (1996): Design and management of service processes, Boston.

Roberts, E. B. (1987): Introduction: Managing Technological Innovation - A Search for Generalizations, in: Roberts E. B. (Hrsg.): Generating Technological Innovation, New York, S. 3-21.

Scheuing, E. E.; Johnson E. M. (1989): A proposed model for new service development, in: The Journal of services marketing 3 (2), S. 25-34.

Schmookler, J. (1966): Innovation and Economic Growth, Cambridge.

Schneider, K.; Daun, C.; Behrens, H.; Wagner, D. (2005): Vorgehensmodelle und Standards zur systematischen Entwicklung von Dienstleistungen, 2. Auflage, Berlin.

Schneider, K. (2004): Der Customer related Service Life Cycle, in: Zahn, E.; Spath, D.; Scheer, A.-W. (Hrsg.): Vom Kunden zur Dienstleistung. Methoden, Instrumente und Strategien zum Customer related Service Engineering, Stuttgart, S. 157-194.

Schreiner, P.; Nägele, R. (2002): Methodische Gestaltung kundenorientierter Dienstleistungsprozesse, in: Information Management & Consulting 17 (3), S. 72-76.

Smart, A.; Bunduchi, R. (2007): Identifying the Costs of RFID Implementation in Supply Chains, Executive Briefing 2007-11.

Staake, T.; Thiesse, F.; Fleisch, E. (2005): Extending the EPC Network - The Potential of RFID in Anti-Counterfeiting, in: Proceedings of the 2005 ACM symposium on Applied computing, New York, S. 1607- 1612.

Tax, S. S.; Stuart, I. (1997): Designing and Implementing New Services: The Challenges of Integrating Service Systems, in: Journal of Retailing 73 (1), S. 105-134.

Tellkamp, C.; Angerer, A.; Fleisch, E.; Corsten, D. (2004): From Pallet to Shelf: Improving Data Quality in Retail Supply Chains using RFID, in: Cutter IT Journal 17, S. 19-24.

Thiesse, F.; Dierkes, M.; Fleisch, E. (2006): LotTrack: RFID-based process control in the semiconductor industry, in: IEEE Pervasive Computing 5, S. 47-53.

Vedin, B.-A. (1980): Large Company Organization and Radical Product Innovation, Lund.

Weiss, E. (2004): Functional Market Concept for Planning technological Innovations, in: International Journal of Technology Management 27 (2-3), S. 320-330.

Winkler, H.; Kaluza, B.; Blasl, M. (2008): Use of RFID-Technology for the Improvement of Unloading Processes in a Waste Management Enterprise, in: Blecker, T.; Huang, G. Q. (Hrsg.): RFID in Operations and Supply Chain Management, 1. Auflage, Berlin, S. 337-353.

Wolfram, G.; Gampl, B.; Gabriel, P. (Hrsg.) (2008): The RFID Roadmap: The Next Step for Europe, 1. Auflage, Berlin.