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The Industrial Internet: Business Models as Challenges for Innovations

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Abstract

Internet of things innovations and the industrial internet these days become more and more decisive factors of future success for companies. Especially manufacturing oriented SME will face the challenge to develop innovative technology driven business models alongside technology innovations in this field which will be essential for future competitiveness. Failing in developing these technology driven business models in an internationally highly competitive environment will have a serious impact both on companies and on the society. Hence, securing economic stability and success of these technology driven business models is an indispensable task. To identify challenges for innovative industrial internet business models first it is necessary to understand what the industrial internet means to the leading parties and applying companies and start-ups in the field. Second, challenges from general business model development will be outlined. In a third step risks and challenges in business model development will be discussed with regard to the special characteristics of technology driven business models in the context of the industrial internet and the important role of the technological key component of the business model. Especially the capability to deal with an integrated consideration of the indivisible linked dimensions of economic and technological aspects of these business models is questioned. In the fourth place the specific challenges for industrial internet business models are derived. On the basis of these results it is also discussed what might be done to handle these challenges successfully with the goal to turn them into chances. The need for future research on the integration of the risk management perspective into the development of these technology driven business models is derived. This will help established companies and start-ups to realize great technological innovations for the industrial internet in sound and successful innovative business models.

Keywords: Industrial Internet; Business Model; Challenge; Risk; Innovation

1. Introduction

With the rise of the industrial internet the world will face a new era of innovation and change [1]. Internet of things innovations and the industrial internet these days become more and more decisive factors of future success for companies. This will impact global industrial systems by making use of the power of advanced computing, analytics, low-cost sensing and a new stage of interconnections between machines, devices and people. One of the main enablers is the internet. The increasing fusion of the analogue world with the digital world of machines holds the potential to bring about profound transformation to global industry, and in turn to many aspects of daily life [1]. Cisco predicts that by 2020 there will be 50 billion "things" connected to the Internet, up from 25 billion in 2015 [2]. Conservative estimations for the worldwide spending at $500 billion by 2020, and which then points to more optimistic forecasts ranging as high as $15 trillion of global GDP by 2030 [3], [4]. So with $20.5 trillion approximately 30 percent of today's global GDP can be influenced.

These innovations promise to bring greater speed and efficiency to industries as diverse as aviation, rail transportation, power generation, oil and gas development, and health care delivery. But innovations themselves need to be brought to market. Here the business model as a means for the commercialization of innovative products or services plays an important role [5] und [6]. Business

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models can be considered as success factors for innovations [7] and they are highly relevant for strategic management decisions of companies [8]. Especially manufacturing oriented small and medium sized enterprises (SME) will face the challenge to develop innovative technology driven business models alongside technology innovations in this field which will be essential for future competitiveness. And even worse - new digital upstarts are threatening the bottom lines, growth prospects, and even business models of traditional service providers [9]. Failing in developing technology driven business models around industrial internet innovations in an internationally highly competitive environment will have a serious impact both on companies and on the society. Hence, securing economic stability and success of these technology driven business models is an indispensable task. To identify risks and challenges for innovative industrial internet business models it is necessary to understand what the industrial internet means to the leading parties and applying companies and start-ups when it comes to business models. In this paper we focus on the perspective of producing SME, especially in Germany as the most important country in Europe concerning manufacturing GDP share and with economic growth potential due to industrial inter innovations of about $66 billion in manufacturing sector till 2025 [10]. The change towards new business models is not just trigged by the demand side. Based on increasing digital capabilities, roles like software producers and network operators gain importance, and new roles like data aggregators or platform operators are emerging. Following these changes, the business models of incumbent companies are under thread of being undermined by data-driven companies such as Google, Amazon, or Apple. Perhaps more alarmingly are recent accounts that Germany is lagging behind America and China in implementing this new paradigm [11].

Based on expert interviews first we will try to understand what the industrial internet means to the leading parties and applying companies and start-ups in terms of business models. Second, risk potentials and with that challenges for industrial internet business models will be evaluated based on an element based understanding of the industrial internet. In a third step examples for risks and challenges for industrial internet business models will be outlined before in a forth step examples for success factors for the development and implementation of industrial internet business models based on statements of our interviewees are presented.

Nomenclature

CPS	Cyber Physical System
GDP	Gross Domestic Product
GE	General Electric Company
HMI	Human Machine Interface
IIC	Industrial Internet Consortium
IoT	Internet of Things
IP	Internet Protocol
IT	Information Technology
M2M	Machine to machine
MES	Manufacturing Execution System
SME	Small and Medium Sized Enterprises
VR	Virtual Reality

2. Theoretical Background

2.1. Industrial Internet

General Electric Company (GE) as leading company of the North American Industrial Internet Consortium (IIC) provides the following definition for the industrial internet: „It is meant as integration of complex physical machinery with networked sensors and software. The industrial Internet draws together fields such as machine learning, big data, the Internet of things and machine-to-machine communication to ingest data from machines, analyze it (often in real-time), and use it to adjust operations" [12]. In the German industrial internet landscape the term "Industry 4.0" was established and is widely used. This term indicates the perception of the industrial internet as a fourth industrial revolution, after the steam-engine, conveyor belt, and programmable controllers [13]. In the U.S. literature, the terms Industrial Internet [14] or Internet of Things (IoT) [15] are used with a similar connotation. Basically all these notions united in a common core principle which is the implementation of cyber-physical systems (CPS) for industrial production. CPS are networks of microcomputers, sensors and actors embedded in materials, machines or products that have been connected along the value chain [15, 16, 17]. CPS are networks of microcomputers, sensors and actors that can be embedded in materials, devices or machines, being connected through the internet [18]. The technology stack consists of a classical device layer, i.e. the physical device and the added logical capability of embedded sensors and actors, a network layer for the transmission and transport of information, a content layer that contains the data and meta data, as well as a service layer for the application functionality [15, 19, 20]. Global availability of real-time data will enable new linkages and precise alignment of processes beyond company boundaries [18, 21]. This structure enables integration across multiple companies along the value chain, establishing highly flexible and dynamic value creation networks [22]. The real-time data stream can be analyzed for decision-making purposes and to flexibly control the devices along the entire value generation process [10, 18].

In order to detail the understanding of the industrial internet and to create the opportunity to make things more graspable an element based definition for the industrial internet is proposed based on the Industry 4.0 notion of [10]. An element based definition allows a more detailed view on which aspects of the industrial internet are relevant in the context of business models for the industrial internet. Therefore the adapted version of the definition of constituting dimensions and elements for the industrial internet was used for our research.

Dimension	Element	Description
Embedded Systems, Cyber Physical Systems (CPS)	M2M	Potentials of the connection and networking of equipment for better data exchange in the sense of achieving total optima (e.g. the utilization, productivity and / or resource efficiency) instead of the relevant part optima individual machines).
	Intelligent Products	Intelligent objects collect data about their condition and the environment permanently. During the production phase of the product that capacity for decentralized self-organized coordination of order assignment, material and information flows is used. In the use phase, the collected data is used e.g. for coordinating inspections, maintenance and servicing.
	Sensors and Actuators	Sensors convert process states into information and are therefore sources of information. Actuators are information sinks as they transform information into the process energy.
Smart Factory	Social Machines	Environment in which people and technology interact. As a result, products or actions are generated which would not be possible without the involvement of both units.
	Manufacturing Execution System (MES)	A manufacturing execution system (MES) is a close to the process operating level of a multi-layered manufacturing management system. The MES is distinguished from similar efficient systems for production planning, the so-called ERP (enterprise resource planning), is directly connected to the distributed systems of process automation and enables the management and of production in real time.

	Plug and Produce	Quick and easy replacement of machinery and components. On the basis of standardized interfaces and interaction protocols machines and components can be easily replaced and configured. The configuration of an intelligent machine and component is done through communication with other machines and components.
	Low Cost Automation	Simple, easy automation simplifies e.g. by assembly-handling wizard handling heavy or bulky parts. This is a support for the working people.
	Virtualization (VR)	Generation of virtual (which means non-physical) things such as an emulated hardware, an operating system, data storage or network resource. This allows for example, resources of computers (especially in the server space) transparent summarize or split, or execute an operating system inside another.
	Human Machine Interface (HMI)	Controls the human-machine-interaction and represents an interactive use interface of the machine to the user.
Cloud Computing	(Near) Real Time Data	Real-time refers to the operation of a computing system, wherein the programs for processing applicable data are constantly ready for operation, such that the processing results are available within a predetermined very short time period. The data may be incurred depending upon the application according to a random distribution in time or at predetermined time points.
	IPv6	Internet protocol of the 6th generation. This is the basis for the development and implementation of industrial internet technologies. It turns over its predecessor protocols a sufficiently large address space available to address all intelligent objects unambiguously.
	Mobile Apps	Computer programs for mobile devices, which can be used to edit a useful or not desired system functionality or technical support.
	Big Data Applications	Collection, analysis and evaluation of large amounts of data linking a variety of sources with a high processing speed for generating an economic benefit.
Robust Networks	Broadband Connections	Broadband transmission is referred to in the LAN area as the circuit independent channels in the frequency range from 1 MHz to 500 MHz.
	Mobile Networks	Collective term for the operation of mobile radios, so-called public cellular mobile services.
	Mobil Devices	Mobile devices and mobile terminal equipment are devices that are due to their size and weight without major physical exertion portable and completely flexible concerning location.
IT Security	Data Security / Privacy	Protection against improper data processing, protection of the right to self-determination, protection of the privacy of data processing or protection of privacy of users or third persons and organizations.
	Information / Knowledge Security	Characteristics of information processing and information storage (technical or non-technical) systems that ensure the protection goals confidentiality, availability and integrity. Information security is to protect against hazards or threats, avoidance of financial losses and minimizing risks.

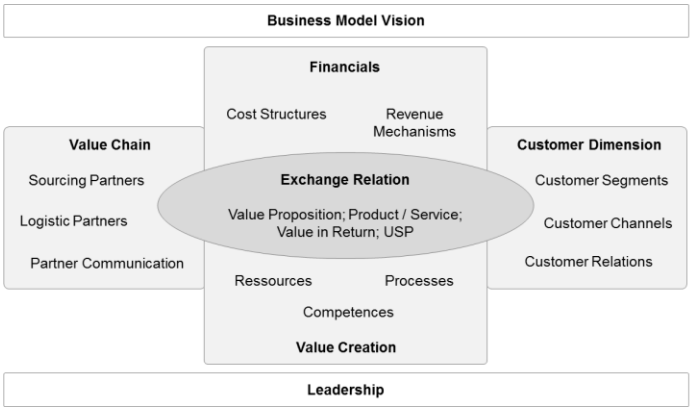
2.2. Business Models

There are various definitions of business models that support the abstract understanding of what a business is about and what the most relevant elements. But even after several years of research in the field of business models, there is still no generally accepted definition of the term itself and the describing elements of business models. Some examples for definitions of business models are shown in the table below taken from [23]:

Authors	Business Model Definition
Amit/Zott	The business model depicts the content, structure and governance of transactions so as to create value through the exploitation of business opportunities.
Chesbrough/Rosenbloom	The business model is the heuristic logic that connects technical potential with the realization of economic value.
Magretta	Business models are stories that explain how enterprises work. A good business model answers Peter Drucker's age old questions: Who is the customer? And

	what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?
Johnsen/Christensen/Kagermann	Business models consist of four interlocking elements that, taken together, create and deliver value.
Wirtz	The term business model names the image of the value creation system of a company.
Teece	A business model articulates the logic, the data and other evidence that support a value proposition for the customer and a viable structure of revenues and costs for the enterprise delivering that value.
Osterwalder/Pigneur	A business model describes the basic principle through which an organization creates transfers and captures value.

Analyzing numerous scientific sources written by different authors, diverse structures of business models and descriptions of their purpose can be observed, see e.g. the meta-analysis of [23, 24, 25, 26]. What almost all of the various definitions for business models do agree on is that business models are composed of different elements or components [27]. Business model components have been conceptualized in different ways and different levels of aggregation [22]. Recent categorizations propose a more dynamic view of the business model as a constantly evolving system [28, 29]. And first initiatives deal with the dedicated development of business models for the industrial internet. GEMINI for example is a German Government funded research initiative together with industrial partners which tries to develop feasible business models within the context of Industry 4.0 [30]. The instruments being created by GEMINI enable the participating companies and organizations to develop and implement individual business models by providing them with methods, processes and IT tools. Nonetheless up to now there is now dedicated definition of elements for industrial internet business models. Therefore for this article and the underlying research the following understanding of a business model was used based on [26]:



For the further examination of the importance of industrial internet elements for respective business models only the core dimensions and their elements exchange relation, customer dimension, financials, value creation and value chain were considered. The impact on the business model vision as well as on leadership during the implementation was not part of this research. These core dimensions will be defined by the following elements based on [23]:

Dimension	Element	Description
Exchange Relation	Value Proposition	The value proposition arises from the provision of services (product / service) and by the satisfaction of customer needs and is the central value proposition to the customer.
	Product / Service	The specific product or the specific service the customer receives (service user). The offered products / services within the business model are used to satisfy the customer's needs.
	Value in Return	Describes a value or consideration, which is provided by the customer as part of the business relationship in return for obtaining a product or a service to the service

		indicator (e.g. money, information or exchange for another product).
	Unique Selling Proposition (USP)	Describes the differentiating feature of a product / service offered, which exerts a special incentive to buy compared to the competition from the addressed customer perspective.
Value Creation	Resources	The resources represent material or immaterial factors that are used within a business model in order to create value. They flow directly or indirectly into the value creation of the business model.
	Process	A process is a set of tasks that must be done in a certain order along the value chain of the business model. Processes have certain defined results and allow to reach the customer segments to build customer relationships, maintain them and to generate revenue.
	Competencies	The skills are used to create the services to create value, reach the customer and build and maintain customer relationships.
Customer Dimension	Customer Segments	The customer segments include the customers a company reaches and serves with its business model. The customers differ in their needs, their willingness to pay and their value to the business model.
	Customers Channels	The customer channels can be distinguished in communication and distribution channels. The communication channels are used to get into contact with customers and inform them about the benefits and the potential benefits; the communication channels also serve that customers can get in touch with the company. The distribution channels are used to transfer products/value to the customers in order to establish a benefit for the customer. Distribution channels include delivery and service channels.
	Customer Relations	The customers enter into a relationship with the business model. Customer channels are used to contact customers, build relationships and generate and strengthen customer loyalty. Depending on the customer segment different forms of customer relationship mechanisms can be relevant.
Financials	Revenue Mechanisms	Revenues are generated through the sale and delivery of products or services. They are characterized by their structure and mechanism. The revenue structure describes from which customers / partners and what services the business model generates revenues.
	Cost Structures	Costs incurred in the operation of a business model and are shown in a cost structure. Costs incurred by the partnership, the use of resources, capacity building and the execution of processes.
Value Chain	Sourcing Partners	Means upstream partners in the value chain, where goods/services are purchased from. For example, resources, components or complete systems, which are necessary for providing the value proposition for the customer. The procurement channels are used to transfer the resources provided by partners in the business model.
	Logistic Partners	Partnerships with companies across the value chain of the business model, which allow or carry out the flow of material and goods. These goods can provide the value proposition for the customer.
	Partner Communication	The communication channels are used to get in contact with the partners, to communicate with these partners and to inform them of the business models product/services and value proposition.

3. Methodology

Studies on the element based analysis of the impact of industrial internet on respective business models do not exist so far. The focus of this study is to gain new insights rather than to confirm existing knowledge. Therefore guideline interviews are used to collect data. The aim is to receive a first indication on which aspects of the industrial internet are relevant to business models for the industrial internet, especially from the perspective of producing SME. Therefore 15 semi-standardized personal interviews with partners from different organizations were conducted. Standardized interview questionnaires were used containing open questions, selection questions and numerical rating questions using Liker scales [31]. The duration of each interview was approximately one hour. The following table gives an overview over the distribution of all interviews partners in terms of their company's main branch. Interview partners from industry contain SME as well as larger companies.

Type of Organization	Number of interviewees
Machinery and equipment manufacturer	4
IT	3
Research establishment	3
Component supplier	2
Medical device manufacturer	2
Other organizations	1
Sum	15

The research questions support the overall purpose of understanding the relevance of specific industrial internet elements for respective business models as defined in order to derive insights on where potential risks and challenges for the development and implementation have to be expected. Therefor these four steps were undertaken in each interview:

- Evaluation of the Relevance of Industrial Internet Elements for Business Models
- Evaluation of Risk Potentials based on Industrial Internet Elements
- Collections of Examples for Risks/Challenges for Industrial Internet Business Models
- Estimation of Key success factors for Industrial Internet Business Models

4. Challenges/Risks for Industrial Internet Business Models

4.1. Evaluation of the Relevance of Industrial Internet Elements for Business Models

Before starting the discussion on risk potentials and challenges for industrial internet business model with the interviewees a basis for this discussion is needed. This basis was created by deepening the understanding of the relevance of industrial internet elements for respective business models. The central research question was following:

- For each industrial internet element where do you see a high relevance for business models for the industrial internet? Please indicate the five most impacted business model elements for each industrial internet element from your point of view.

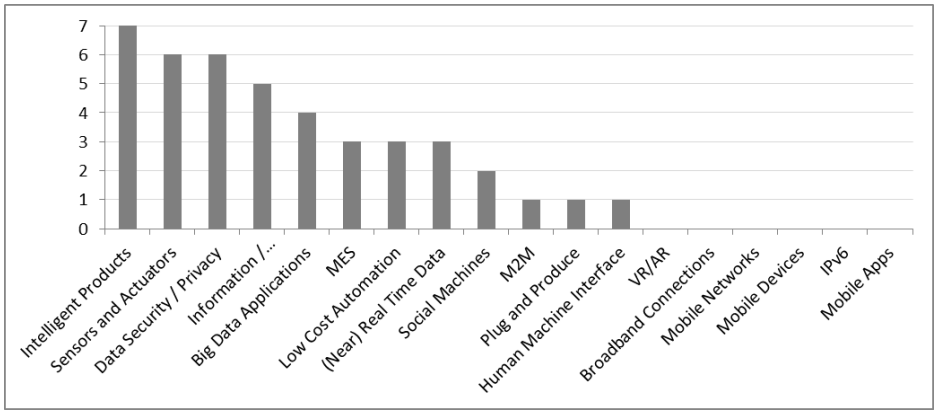
All interviewees were introduced to the descriptions of the industrial internet and business model elements shown in chapter two. Each of the respondents had, per industrial internet element, maximum five times the possibility of voting “high relevance” for business model elements influenced by the respective industrial internet element from the view of the respondent. Thus, each respondent in total had voted 54 times high relevance over all 1: 1 relations between the Industrial Internet elements and business model elements (18 industrial internet elements and five “high relevance votes” per industrial internet element). For each 1: 1 relationship between industrial internet elements and business model elements thus a theoretical maximum sum of 15 "high relevance" votes over all respondents was achievable.

For all 15 interviewees this results in a number of 810 high relevance votes over all 18 industrial internet elements for 15 business model elements. In this way, a sound basis was created for the identification of the essential elements for Industrial Internet Business Models. For the overall determination of the relevance of each industrial internet element with regard to the individual business model elements the sum of all votes from all 15 interviewees was calculated. All ratings were considered equal. For the analysis and display of relevance the following scale is used:

Sum of high relevance estimations over all 15 interviewees	Relevance of Industrial Internet Element for Business Model Element
x >= 10	high
5 <= x < 10	medium
x < 5	low

In the following chart the result of the evaluation of the relevance of industrial internet elements for business model elements is presented. Shown is the respective number of business model elements

where a high relevance over all interviewees was seen (sum of "high relevance" votes over all evaluations ≥10 per industrial internet element).

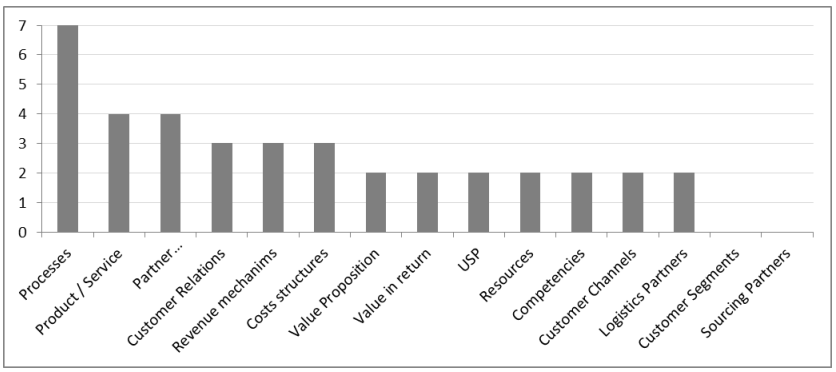


For details of the element to element evaluation results please see Annex A.

The five most influencing industrial internet elements are intelligent products, sensors and actuators, data security /privacy, information / knowledge security and big data applications. The chart shows that e.g. for the Industrial Internet Element Intelligent Product was rated seven times with high relevance for Business Model Elements from a minimum of ten out of 15 respondents. This means that the element Intelligent Product can be considered to be highly relevant for industrial internet Business Models from the perspective of the interviewees. The Industrial Internet Element Sensor and Actuators was rated six times as highly relevant for business models as well as the Industrial Internet Element "Data Security / Privacy" and so on. The following table shows the top five rated "highly relevant" Industrial Internet Elements and their corresponding business model elements which they were rated highly relevant for. For a detailed overview over all element combinations please see Annex A.

Industrial Internet Elements	Business Model Elements (seen as impacted)
Intelligent Products	Value Proposition; Product / Service; Value in return; USP; Customer Relations; Revenue Mechanisms; Logistics Partners
Sensors and Actuators	Value Proposition; Product / Service; USP; Resources; Processes; Cost Structures
Data Security / Privacy	Product / Service; Processes; Customer Channels; Customer Relations; Revenue Mechanisms; Partner Communication
Information / Knowledge Security	Product / Service; Processes; Customer Channels; Customer Relations; Partner Communication
Big Data Applications	Processes; Revenue Mechanisms; Logistics Partners; Partner Communication

Most three top influenced business model elements are processes, product / service and partner communication as can be seen in the following table.



4.2. Evaluation of Risk Potentials based on Industrial Internet Elements

After having learned about the relevance of industrial internet elements for respective business models the next questions was about risk potentials. The central research question was following:

- For the highly relevant rated industrial internet elements – how would you evaluate the probability of occurrence of risks and their possible impact on respective business models? Please indicate your estimation on a scale from 1 (low) to 5 (very high) for both dimensions.

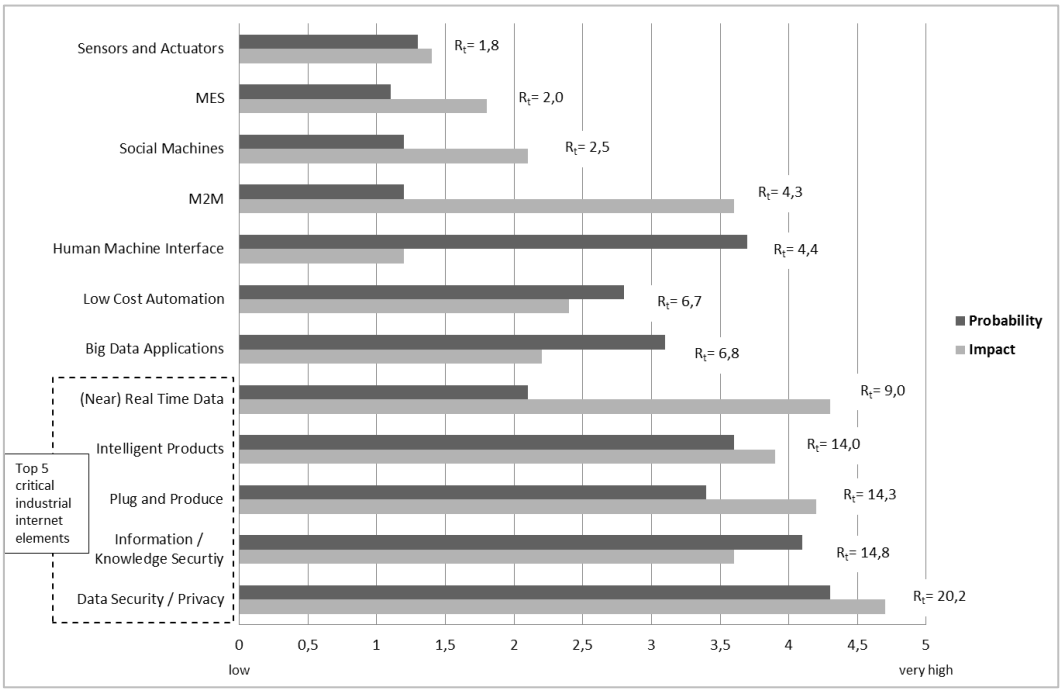
The evaluation was conducted individually by each respondent based on his own high relevance votes. For both dimensions probability and impact a five point Likert scale was used [31]. Only those industrial internet elements were evaluated for which the individual respondent had voted at least one 1:1 relationship between industrial internet element and business model elements with high relevance. For the aggregation over all 15 interviewees the arithmetic mean over all 15 individual evaluations was used. The definition of risk potentials used for the evaluation of risk potentials of industrial internet elements with regard to business models was based on [32]:

$$R_t = {\sum_{i=1}^{15}(R_i)}/{15} = {\sum_{i=1}^{15}(P_i \cdot I_i)}/{15} \quad (1)$$

The table below gives explanations for equation (1):

Equation component	Explanation
Rt	Overall risk potential for the industrial internet element with regard to business model risks caused by the respective industrial internet element 0≤Rt≤25
Ri	Risk potential for the industrial internet element by individual interviewee with 0≤Ri≤25
Pi	Estimation of the probability for the occurrence of business model risks caused by the respective industrial internet element with 0≤Pi≤5
Ii	Estimation of the impact for potential risks for business model risks caused by the respective industrial internet element with 0≤Ii≤5
i	Individual interviewees (i=1…15)

The results show that top five highest risk potentials and therefore the greatest challenges in implementing industrial internet business models were expected for the elements data security / privacy, information / knowledge security, plug and produce, intelligent products and (near) real time data. The chart below shows the aggregated evaluation for overall risk potential for the industrial internet element as well as for estimation of the probability for the occurrence of business model risks and the Estimation of the impact for potential risks for business model risks.



The industrial internet element "sensors and actuators" was considered to be very important with six "high relevance" votes. But in the risk evaluation it was rated quite low with a risk value of 1,8. It is not believed to cause problems in the development of technology driven business model for the industrial internet. This fits to the perception in other publications that the hardware infrastructure itself is perceived to be a quite uncritical component in the industrial internet solutions [4]. Further interesting is that the industrial internet element intelligent product was seen in the top five concerning risk potentials and it was rated as the most relevant industrial internet element for business models. Therefore this element should be treated with special care when designing and implementing industrial internet business models.

4.3. Collection of Examples for Risk/Challenges for Industrial Internet Business Models

In a third step we asked the15 respondents about examples for risks and challenges for the industrial internet elements with regard to respective business models. The central research question was following:

- What are the main risks and challenges for business models coming from the industrial internet elements? Please name examples if possible related to business model elements.

The following table shows the answers for examples for risks/challenges for industrial internet business models for the top 5 rated industrial internet elements in relation to the business model dimensions. The method used was open question. The answers to these open questions were analyzed by the qualitative content analysis [33]. The following table shows the examples named for the top five industrial internet elements concerning risk potentials presented in 4.2. They are data security / privacy, information / knowledge security, plug and produce, intelligent products, (near) real time data.

Industrial Internet Element	Examples for Risks/Challenges
Data Security / Privacy	Value Creation
	▪ Stealing of sensitive data
	▪ IT competences
	▪ Necessary digital security infrastructure
	▪ Breakdown of production processes
	▪ Regulatory risks by rigid law
	Customer Dimension
	▪ Trust in technical solutions and data security
	▪ Loss of sensitive customer data
	Value Chain
	▪ Stealing of sensitive data
	▪ For startups getting access to established conservative SME
	▪ Disturbance of value chains and transportation
Information / Knowledge Security	Exchange Relation
	▪ Rise of open standards endanger USPs (software solutions might be copied easier)
	Value Creation
	▪ Prevention of digital information drainage, esp. concerning manufacturing know-how
	Customer Dimension
	▪ Vulnerability of communication channels to third parties
	Value Chain
	▪ Digital information drainage, esp. concerning manufacturing know-how
Plug and Produce	Value Creation
	▪ Lack of standardized software interfaces
	▪ Finding and implementing the best suitable software solution

	Customer Dimension ▪ Multiplicity and complexity of existing machines and devices ▪ Customer tolerance in learning/introduction phase concerning misfits/breakdowns
Intelligent Products	Exchange Relation ▪ New players are threatening to replace incumbents (Google: autonomous driving) ▪ Increase of competition ▪ Individualization of products ▪ Perception: Industrial internet just seen as means to boost efficiency, not for new products or USPs
	Value Creation ▪ Experience in the development of specialized hardware and embedded software (esp. in producing SME) ▪ Integration of software and hardware competence, esp. for traditional producing SME ▪ Hacked intelligent products and loss of functional or personal data
	Customer Dimension ▪ Loss of customer interface (e.g. after sales services) ▪ Customer acceptance of new service concepts
	Financials ▪ Thinner margins ▪ To convince investors of economic potentials (esp. startups) ▪ Lack of experience in innovative pricing mechanisms
	Value Chain ▪ Shift in the share of value added ▪ Fragmentation of existing value chains
(Near) Real Time Data	Exchange Relation ▪ Complexity and multiplicity of possible applications (hard to identify useful ones, because highly individual)
	Value Creation ▪ Acquiring qualified employees/experts (esp. SME) ▪ IT competences in producing companies ▪ Modeling and analytical competences ▪ Identifying and implementing the best suitable software solution
	Customer Dimension ▪ High effort to convince traditional producing SME of added value ▪ Deep and direct integration in customers' processes
	Financials ▪ SME might not invest in new necessary equipment / IT infrastructure ▪ Future pricing of services which customer feels to get already for free today
	Value Chain ▪ Disruption of existing value chains ▪ Fragmentation of existing value chains

4.4. Estimation of Key success factors for Industrial Internet Business Models

Finally, we asked the interviewees for their opinion what might be the most relevant success factors for the development and implementation of business models for the industrial internet. The method used was open questions for keywords and a brief explanation. The answers to these open questions were analyzed by the qualitative content analysis [33] and clustering of answers. The central research question was following:

- What are from your point of view the main success factors for industrial internet business models? Please name them with a short explanation.

The following table gives an overview for answers we received key success factors with short explanations based on the input of all 15 respondents. Six clusters were identified as key success factors for industrial internet elements, presented without any special order: Show cases, networking, funding, competences, early prototyping (of the business model) and customer access.

Key Success Factor	Explanation
Show Cases	Show cases were described to be needed to explain partly complex and very innovative product/service ideas and concepts to non-professionals in industrial internet environment, e.g. investors.
Networking	Networking was described as import to gather information and contacts needed in order both identify and estimate market potentials and customer needs for highly innovative products/services with no existing comparable value propositions or to get access to funding providers.
Funding	Esp. for young and dynamic companies like startups and spinoffs the financial aspects play a major role. Often these companies struggle to finance their pre-market launch activities and have not yet regular revenues from product. Achieving a positive cash flow fast is one of the top goals.
Competences	Having the right people with the right competences is very import for every company. But especially for smaller and young companies with very innovative products/services. Existing and today settled companies might face the challenge to deal with the shift of needed competences in the future, e.g. producing SME with a lot of mechanical engineering expertise who will need a lot more software competences in the future.
Early Prototyping	The agile development of business model concepts and the setup of respective prototypes and testing is necessary to understand in early phases the specific drivers for success in the respective environment and to learn about customer preferences.
Customer access	Esp. it was described as hard to get into contact with certain customers, esp. for startups to get access to rather conservative producing SME. To make sure that access to "lead customers" to understand specific customer and market demands and to set up show cases for demonstration and communication purposes is very important esp. for startups.

5. Conclusions

This paper supports the analysis of industrial internet business models. It describes the relevance of industrial internet elements for business model elements. On this basis risk potentials and with that challenges for the development and implementation were identified and possible success factors were identified. The industrial internet will built a basis for highly innovative business models. But when developing industrial internet business models, it is very important to consider the identified risks and challenges in an early stage. This will help to avoid expensive mistakes, esp. for producing SME which are usually financially weaker than larger corporations. Simultaneously management priority should increase the tolerance concerning financial payback periods and consider also positive side effects like image of the company. Managers should view the development of industrial internet business models independently from product development processes and establish a dedicated business model development process that considers the identified linkages between industrial internet elements and business model elements. However, there are industrial internet elements that seem to be more relevant for industrial internet business models than others. The agile development of business model concepts and the setup of respective prototypes and testing is necessary to understand in early phases the specific drivers for success in the respective environment and to learn about customer preferences. Here a strong customer focus is very important and should be secured by the use of respective agile and user oriented methods.

Managers should also make sure to identify and establish access points to potential customers, funding partners or technology providers. Furthermore competences in terms of "the right people" should be identified within the company or partnered with in order to guarantee the best possible team to set up the industrial internet business model. These teams should be equipped with dedicated resources and lead or guided by top management.

Organizations like the IIC in North America or the Platform Industry 4.0 in Germany play an important to support the access to industrial internet know-how especially for SME. They should provide companies with information, tools, techniques and good practice examples as a basis to develop their own industrial internet business models or to adapt their existing business models accordingly. Political support in terms of research grants, financial support for innovative business models or as well in terms of networking platforms will help here, too. With the global competition around standardization for industrial internet applications companies willing to implement business models in the industrial internet will have to strongly consider requirements for standards and norms when it comes to interfaces with partners in their value chain.

Our research is of course not without limitations. Our research design is of explorative nature and thus provides a rather high-level analysis based on individual standpoints of the interviewed persons. It derives conclusions from qualitative information and relies on the respondent's insights and experience from their respective organization. We used a convenience sampling approach building on interviews with SME and large companies and associations from Germany. Regarding the validity, we aimed at ensuring a high quality of inputs by selecting interviewees with a high level of seniority and relevant knowledge and experiences in the context of the industrial internet and business model development. Mirroring the corporate perspective by interviewees from industry associations we collected a second perspective. After 14 interviews, we perceived a saturation regarding the underlying phenomena. We expect that the general findings will apply to other established companies outside our study. On more granular levels, differences will exist due to individual companies' conduct. Our methodological approach could not capture the effect of these differences in full detail. This is subject of further empirical research.

Further it is important to develop a fundamental understanding of the special characteristics of industrial internet business models and to go a step further than generic element descriptions. Together with the necessity for an individual context-related potential evaluation for companies willing to develop and implement industrial internet business models the company specific environment for these business models should be analyzed and considered as well. One approach to support companies could be to provide tools to help evaluate the company specific future potentials when implementing industrial internet business models as well as the evaluation of the current company maturity stage for the industrial internet. Furthermore suitable risk management tools for business model development for industrial internet taking the strong interrelations between technological and economic aspects into account need to be developed. Only the early identification of risk potentials allows the setup of effective risk avoidance and handling measures. This will help established companies and start-ups to realize great technological innovations for the industrial internet in sound and successful innovative business models.

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		Business Model														
		Exchange Relation				Value Creation			Customer Dimension			Financials		Value Chain		
Industrial Internet		Value Proposition	Product / Service	Value in return	USP	Resources	Processes	Competencies	Customer Segments	Customer Channels	Customer Relations	Revenue mechanims	Costs structures	Sourcing Partners	Logistics Partners	Partner Communication
Embedded Systems/ CPS	M2M	○	○	○	○	○	●	○	○	○	○	○	◉	○	○	○
	Intelligent Products	●	●	●	●	○	◉	○	○	○	●	●	○	○	●	○
	Sensors and Actuators	●	●	○	●	●	●	○	○	○	◉	◉	●	○	○	○
Smart Factory	Social Machines	◉	○	○	○	○	●	●	○	○	○	○	○	○	○	○
	MES	○	○	○	○	●	●	◉	○	○	○	○	●	◉	◉	◉
	Plug and Produce	○	○	○	◉	◉	●	◉	○	○	◉	○	◉	○	◉	○
	Low Cost Automation	○	○	○	◉	◉	●	●	○	◉	○	○	●	○	◉	○
	VR/ AR	○	○	○	○	○	◉	◉	○	○	○	○	◉	○	○	◉
	Human Machine Interface	○	○	○	○	○	●	◉	○	○	○	○	◉	○	○	○
Robust Nets	Broadband Connections	○	○	◉	○	○	○	○	○	◉	◉	○	◉	○	○	◉
	Mobile Networks	○	◉	◉	○	○	◉	○	○	◉	◉	○	○	○	○	○
	Mobile Devices	○	○	○	○	○	◉	○	○	○	○	○	◉	○	◉	○
Cloud Computing	(Near) Realtime Data	○	○	●	○	○	●	◉	○	◉	◉	◉	◉	◉	◉	●
	IPv6	○	◉	◉	○	○	○	○	○	◉	○	○	○	○	○	◉
	Mobile Apps	○	○	○	○	○	◉	◉	◉	○	○	○	○	○	◉	◉
	Big Data Applications	◉	◉	○	○	○	●	◉	○	○	○	●	○	◉	●	●
IT Security	Data Security / Privacy	○	●	○	○	○	●	○	○	●	●	●	◉	○	○	●
	Information / Knowledge Securtiy	○	●	◉	○	○	●	○	○	●	●	◉	◉	○	○	●
		Relevance:	●	high	◉	medium	○	low								
				>=10		>=5<10		<5								