

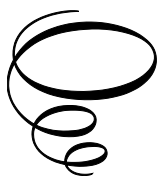
Digitalization in Business and Management

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Edited by

Kannan Paulraj and G. Venkateshwaran

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CHAPTER 1

DIGITAL TRANSFORMATION AND INDUSTRY 4.0 IN PROPERTY AND CASUALTY INSURANCE: STRATEGIC ADAPTATION AND TECHNOLOGICAL INTEGRATION

SAI ATMARAM BATCHU

Abstract

The digital transformation propelled by Industry 4.0 is reshaping traditional business models and operational structures across various industries, including property and casualty insurance. As the insurance sector grapples with emerging challenges like high customer expectations, competitive pressures, and regulatory shifts, integrating digital technologies becomes essential for maintaining market relevance and achieving operational efficiency. This study explores a systematic approach for property and casualty insurers to navigate Industry 4.0 by leveraging frameworks and technologies like the Internet of Things (IoT), data analytics, and digital maturity assessments. We examine how these tools can optimize claims processing, risk assessment, and customer engagement, proposing a maturity model for insurers to evaluate and enhance their digital readiness. By addressing section-specific requirements, such as regulatory compliance and data security, this research offers a blueprint for insurers to develop agile, technology-driven strategies that cater to the evolving demands of the modern insurance landscape.

Acronyms

[II4.0MM]

BAS	Building Automation Systems
BIM	Building Information Modeling

BMN	St. Gallen Business Model Navigator
BMS	Building Management Systems
CPS	Cyber-Physical-Systems
DIHK	German chamber of Industry and Commerce
DRA	Digital Readiness Assessment
DT	Digital Transformation
I4.0	InitIndustrie 4.0 Initiative
I4.0	Industry 4.0
II4.0MM	Individual I4.0 Maturity Model
IIC	Industrial Internet Consortium
ISIC	International Standard Industrial Classification of All Economic Activities
IoT	Internet of Things
KPI	Key Performance Indicators
PR	pull request
RAMI	Reference Architecture Model for Industry 4.0
SME	Small and medium-sized enterprise
UN	United Nations
WEF	World Economic Forum

1 Introduction

T, the IoT, Smart Factories, I4.0. Many words describing a vague *ex ante* declared *revolution* of the economy that many scientists and professionals are discussing. There is a big interest from the public and private sectors with many consulting companies offering services to their customers regarding strategy, implementations, project management and technological support [1]–[4]. Nonprofit organizations and governments are also becoming active. Examples are the German governments *I4.0Init* [5] initiative or the *IIC* [6] based in the United States.

However, most are focusing on a few core industries, not following a systematic approach of evaluating the effect of the impending changes on all sections [1], [7]. Many industries, e.g. construction, although interesting, are often left out or considered only in separate specialised sources [8]. Even the nation wide initiative *I4.0Init* is specialised and focuses only on a subset of the whole variety of sections in the economy [9].

A complete list of all economic sections has been developed by the United Nations in the *ISIC* [10]. A formal overview including all sections defined in this empirically based paper can ensure the complete coverage of all sections regarding their potential for I4.0 and DT. The research question therefore is the following:

What guidelines exist for each section regarding the implementation of an I4.0 strategy?

This question consists of three key aspects that will be put together to create a structured strategy development process:

- **Find frameworks**, initiatives and consortia adequate for a wide variety of businesses offering a holistic view on I4.0 and DT
- **Evaluate each section** to find suiting frameworks
- Individualize recommendations based on a **companies state of digitalization**.

The expected result is a systematic overview of all sections and frameworks that can be used as guidelines for developing I4.0 strategies independent of a companies section or size.

A. Methodology

To answer our research question we approached the three mentioned aspects of the question systematically. First we performed a literature review, reviewing a total of 58 frameworks, guidelines and other forms of guidance literature. Out of these 58, 28 were written by for-profit companies, 21 were academic papers and 18 from associations or consortia, with some papers falling into two categories. We selected those that had a holistic view on many sections or that covered those sections that were usually left out by most others. Initiatives that involve a large amount of global enterprises were considered more relevant than frameworks developed by a single business or research team, simply because they have a bigger global influence. From now on we will call these resources simply “framework” as they represent such a structure.

Secondly, to ensure considering all relevant types of business in our evaluation, we used the ISIC developed by the United Nations to start our filtering of frameworks, mapping the aggregated, globally defined 11 groups of economic sections [10, p.274f.] to those that were found in the literature review. Where possible, we match a section to a framework that is directly applicable, otherwise evaluating whether a frameworks recommendations can be applied also to the section that was not specifically mentioned in the literature reviewed.

Finally we suggest an industry-focused, applicable model for businesses to rate themselves as well as their competition, so they can compare their current maturity state with a target state of digitalization. We focus

on three categories: technology & operations, business model and culture, as suggested by the WEF white paper [11].

2 Background

In the following chapter we will introduce some fundamental knowledge necessary to understanding the topic as well as our approach of developing recommendations for each section. We will first define a clear terminology that will be used in the remaining chapters. Afterwards, an adaptation of the recommendations given by the WEF are described which we consider the core ingredients of a digital strategy [11]. Finally, the most holistic frameworks, applicable to many sections, will be briefly introduced and described.

A. Terminology

Defining the terminology is important because of the mixed use of many different terms to describe similar concepts in both literature and colloquially by professionals.

- **Internet of Things:** Citing [12], the IoT is “the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment”.
- **CPS:** The term CPS refers to the “tight conjoining of and coordination between computational and physical resources”. They “far exceed those of today in terms of adaptability, autonomy, efficiency, functionality, reliability, safety, and usability”. They are expected to “provide large-scale, distributed coordination (e.g., automated traffic control), [be] highly efficient (e.g., zero-net energy buildings), augment human capabilities, and enhance societal well being” [13]
- **Cloud Computing** is a “model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction” [14].
- **Digitalization:** [15] simply calls it the “process of information conversion from the physical to the digital plane”. Gartner however extends this by describing it as the “use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital

business”. The term digitization is sometimes used as a synonym to digitalization but we will stick to the term digitalization as suggested by [15].

- **Digital Transformation:** A term that is being described as *“the use of technology to radically improve performance or reach of enterprises”* [1] by the MIT Center for Digital Business can better be put in context by describing it as *“the global accelerated process of technical adaptation by individuals, businesses, societies and nations, which comes as a result of digitalization”* [15], [16].
- **Industry 4.0:** Is derived from the German *Industrie 4.0* and describes the German initiative with the same name. It is also sometimes used as a synonym for digitalization in the manufacturing section [17], however mostly in the German speaking regions. We consider it as the DT of the manufacturing section.
- **Industry:** An industry is *“defined as the set of all production units engaged primarily in the same or similar kinds of productive activity”* [10]. This is important to differentiate from the German *“Industrie”* which is largely equivalent to the more specific *manufacturing industry*. We will, to avoid confusion with the term industry 4.0 and to follow a systematic approach, use the term ‘section’ to describe groups of industries. The term has a more abstract connotation and has also been used by UN in ISIC [10].
- **Section** The ISIC defines sections as *“categories intended to facilitate economic analysis”* [10]. It is the highest level of categories, subdivided into *divisions, groups and classes*, offering a four layer classification scheme of all economic activities independent of country or type.

IoT, I4.0, CPS and Cloud Computing can be considered initiators or enabling technologies that lead to an increase of digitalization in business and society. This increased digitalization, which can be considered a continuous process, now causes a sudden surge in adaptation and investments by businesses and consumers alike into these technologies that have such wide effects on all aspects of society that it is considered a transformation or revolution [18]. Figure ?? summarizes the different terms and their interrelation.

B. State of digitalization

We suggest a model to challenge a business to rate itself regarding its “state of digitalization”. Companies should objectively rate themselves

using their current state and their goal state as a scale and then compare themselves with competitors to create a benchmark.

We suggest to consider three key aspects as core challenges for succeeding during the DT which are an adapted form of the four core aspects suggested by the WEF¹ [11]:

- 1) *Technology and operations*: The concept of digital transformation suggests that the entire business goes digital. It also implies that companies will have to adapt to a range of new technologies each of them potentially affecting an organizations core business. These technologies are not yet standardized nor established and some might be considered obsolete again in the near future. While businesses need to innovate to ensure they differentiate from their competitors, they also need a stable core business to reduce risks. Open standards and technologies that have been widely accepted can offer these securities. The business also needs to improve its operational performance, using technology to both improve savings and create space for new business models and countering disruptive competitors [11, p.15ff.].
- 2) *Business Models*: Disruption describes what technology innovation does to markets when combined with a novel business model. A new technology can lead to a complete overhaul of existing markets and it is usually accompanied by a business model that catches existing market players off guard [19]. [20] suggest that a core challenge for businesses it not only to be a technological leader but also to develop a new business model that challenges existing market participants and helps a business to differentiate its product from the rest. The model describes what a value or utility a firm offers, how it generates it, how it makes money off of it and who the potential customers are. A common issue for successful businesses is the *Innovator's dilemma*. Businesses need to be willing to disrupt even themselves in order to compete [11], [21].
- 3) *Culture and Leadership*: [19], [22] argue a core task of preparation is the adaptation of the organizational culture to enable openness to innovation and adaption to new market environments. Businesses need to be "results-oriented", allow their employees to have the "freedom to increase innovation" [22] and avoid a culture that "*promotes hierarchy and maintain[s] the status quo*" [19] because it will cause the business to be exposed to market disruptions.

C. Frameworks

Both the industry and the academic world offer a variety of frameworks, concepts, consulting services and guidelines for businesses, institutions and even cities to employ to optimize their utility from the Digital Transformation. We focused our attention on frameworks that are applicable to a variety of sections to ensure we define recommendations applicable to businesses independent of region, industry or size. We chose four frameworks as applicable to most industries and want to summarize them in the following chapter.

- 1) *Industrie 4.0*: The German Industrie 4.0 initiative was created by the German government to improve Germany’s economical position in the global market. According to the *Plattform Industrie 4.0*, I4.0 is a specialization of the *Internet of Things and Services* and applies to a subset of all industries, mainly focused on industrial production and manufacturing [9, p.41].² Although it is specifically focused on the manufacturing section, it is the most comprehensive initiative we found involving BITKOM e.V., VDMA e.V. and ZVEI e.V., three industrial associations representing IT,² This is somewhat coherent with our definition although we see I4.0 rather as a result from digitalization than a trigger for it. However, these two terms are only vaguely defined among professionals and all of it is a continuous process, affecting each other and leading to the continuous progress of technology as a whole.

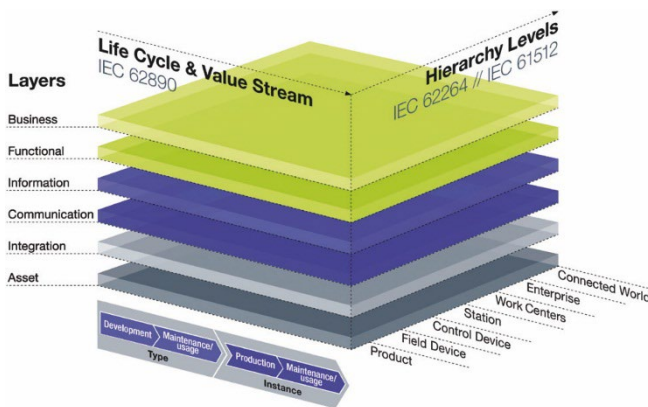


Fig. 1-1 RAMI from [9] [9]

Electronics and digital economy in Germany [23]–[25]. The initiative offers both recommendations and best practices for individual organizations [9, p.40ff.] as well as describing the strategic plan of progressing the I4.0 on a national level for the German government [9, p.15ff.]. It therefore offers a wide range of both high level overviews all the way do very detailed implementation advise on the factory floor. The following list summarizes the core goals [9, p.8].³

- Standardization
- Reducing of complexity
- Wide band infrastructure
- Security
- Work culture and organization
- Education
- Legal constraints
- Efficiency

The I4.0 initiative offers several artifacts to support organizations in the transition to a digitalized organization as well as to facilitate the coordination between organizations and industries in researching and developing standards and technologies.

The most prominent framework is the RAMI which has been created as a guideline to avoid definition of multiple, redundant and conflicting standards and communication strategies [9, p. 41].

The RAMI framework focuses on three dimensions *layers, Life Cycle & Value Stream and Hierarchy Levels*. By layers, the framework takes reference do different layers of abstraction from a system engineering perspective [26]. The “Layers” described are typical IT abstraction for reducing complexity in large systems with numerous components. The “Life Cycle & Value Stream” dimension describes the phases a product goes through from the initial idea and development to the³ It should be noted that only some of these goals are relevant to individual businesses trying to improve their strategy while others are global environmental necessities. Wide band infrastructure and education are two main topics that demand administrative action.

Final production and usage. It is compliant to IEC 62890, a governance standard for life cycle management of products. The “Hierarchy Levels” are referencing to IEC 62264, the international norm for the integration of enterprise IT and control systems in manufacturing. It has been extended with two additional levels, “Product”

and "Connected World" to adequately represent the environment of I4.0 environments [26].

- 2) **Industrial Internet Consortium:** The IIC is an "open membership organization with 250 members from 30 countries, formed to accelerate the development, adoption and widespread use of interconnected machines and devices, intelligent analytics, and people at work" [27]. Its goals are as follows [28]:
 - Creation of use cases and testbeds
 - Develop reference architectures and frameworks
 - Influence the global development standards process
 - Facilitate open forums
 - Build confidence around approaches to security.
- 3) **Integrating IIC and I4.0:** Both the IIC and the I4.0Init have announced collaboration efforts to ensure their goal of common standards and structures is achievable. While the IIC's efforts are targeted at a higher level of abstraction, the I4.0Init's focus is more narrow, focusing on the manufacturing and production sections.

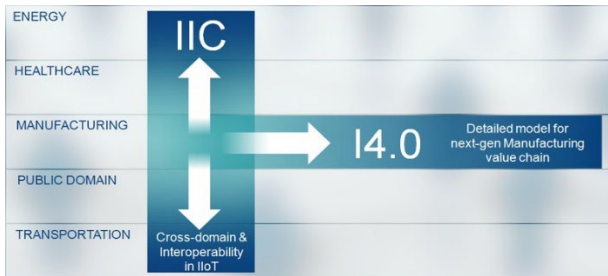


Fig. 1-2 Cooperation of the IIC and the I4.0Init from [27] [27]

- 4) **St. Gallen Business Model Navigator:** Since both previous models, the I4.0Init and the IIC primarily address the *technology and operations* dimensions of a digital strategy, the BMN is a resource to help companies evaluate their own and their competitors business models. It focuses on the business model of a company, suggesting that a company can not rely on its products quality and performance alone to succeed but that companies must also reevaluate their business model and those of their competitors. Figure 3 shows the 4 dimensions the framework focuses on. Alongside the concept,

55 existing business model types are added that have been inspired by businesses and products of the past. The idea is to reevaluate a businesses own products and capabilities and confront them with various other business models to see new ways of engaging customers and increase profits. Examples of patterns are *Open Source*, *Pay what you want*, *Razor and Blade* or *Robin Hood* [20].

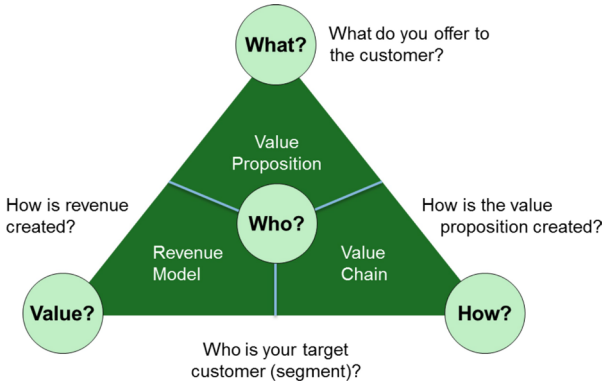


Fig. 1-3 Business Model definition - the magic triangle from [20] [20]

- 5) *Leading Digital*: Technology, operations and business model have been covered, but a business is also strongly influenced by its culture which in turn is strongly influenced by its leadership. While the WEF recommends adapting a business culture and focusing on “*attracting and retaining talent in the digital age*” [11], it focuses on attracting millennials and developing the workforce from a human resources perspective. During our literature research we found surprisingly little on the development of corporate culture in regards to I4.0 and DT. [22] performed a number of interviews, collecting recommendations by industry experts with an average of 17 years of work experience, summarising the responses with recommendations for more “*trial & error environments, more employee freedoms, less hierarchy and a two-world IT*”. [16] encourage a top down approach for shaping a companies culture by communicating goals clearly and often, have the management lead the way in the digital engagement, find digital champions in an organization and amplify their network impact and finally identify quick wins to affirm the strategy of transformation by showing results fast.

3 Section Specific Application of Frameworks

This paper is based on the organization of the economy in several sections. The International Standard Industrial Classification of All Economic Activities (ISIC) provides a high level set of sections which are ultimately leading to particular industries. In this paper, we use a consolidated version of those 21 sections which result in 11 groups, which are stated out below: [10, p.271, table 4]

- 1) Agriculture, forestry and fishing [ISIC: A]
- 2) Manufacturing [ISIC: C]
- 3) Mining and quarrying; Electricity, gas, water supply and other industrial activities [ISIC: B,D,E]
- 4) Construction [ISIC: F]
- 5) Wholesale and retail trade, transportation and storage, accommodation and food service activities [ISIC: G,H,I]
- 6) Information and Communication [ISIC: J]
- 7) Financial and Insurance activities [ISIC: K]
- 8) Real estate activities [ISIC: L]

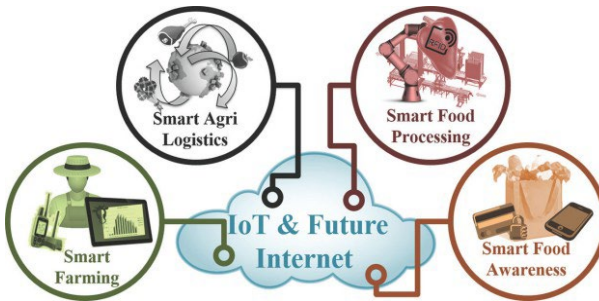


Fig. 1-4 Using of Agriculture 4.0 digital solutions from [30] [30]

- 9) Professional, scientific, technical, administrative and support service activities [ISIC: M, N]
- 10) Public administration and defence, education, human health and social work activities [ISIC: O,P,Q]
- 11) Other service activities [ISIC: R,S,T,U]

A. Agriculture, forestry and fishing

The agricultural section is highly influenced by I4.0 innovations. Examples are smart agriculture, smart farming, vertical and horizontal integra-

tion of the supply chain to provide sustainable food chains and automated processes to deliver high-quality food. Farms and food companies are increasingly developing towards high-tech factories and large-scale production, intensively relying on digital technology [29, p.129-151] IoT technologies and sensors are used to monitor agricultural status and development by enabling digital tracking and tracing processes to provide food safety, quality management, optimize food production and manufacturing. Growing consumer claims concerning food quality and food availability are pushing the agricultural section forward [29, p.131].

To get an initial impression of the IoT progress and level of digitalization in the agriculture industry, figure 4 states out how many German companies in that industry are using and/or planning to use IoT and digital solutions to optimize their agricultural business [30].

In general, smart farming and the use of IoT technologies are increasing crop yields. Precise data about utilised agricultural area, weather and real time tracking of active machines and systems are leading to higher food quality and more efficient use of resources.

Challenges of the agriculture, forestry and fishing section are linked to the ecological/climate change regarding consumer concerns and the globally increasing demand of food. I4.0 concepts are used to face those challenges.

Domains like smart farming, smart Agri-logistics, smart food processing and smart food awareness are used to describe the development of IoT impact on the section as shown in figure 5 [29, p.133].

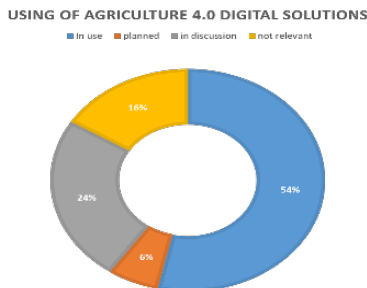


Fig. 1-5 Domains which are impacting the industry from [29, p.133] [29, p.133]

The RAMI, goals and guidelines of the I4.0 and IIC initiatives can be applied at a general/strategic level in the Agriculture, forestry and fishing industry. It is important to determine technical standards and platforms to get IoT and digital solutions connected with customary activities in that industry. Nevertheless, it is important to gather industry-specific infor-

mation on how to get IoT implemented in business processes. The following frameworks can deliver more specific guidelines for the agriculture, fishing and forestry industry:

- The PRECOS framework linked with IoT technology [31]
- SmartFarmNet IoT platform [32]
- Virtualized Food supply chains [33]

B. Manufacturing

The manufacturing section is the most discussed section in the literature. It is the focus section of the I4.0 initiative and many companies such as McKinsey actually see I4.0 as a synonym for the digitalization of the manufacturing section [17,]. Little beneficial advice can be given by us for this section as it is being focused on by the I4.0 initiative itself and the suggestion should therefore be to follow this frameworks approaches as well as the IIC publications regarding the cross section specific interests [34,].

C. Mining and quarrying; Electricity, gas, water supply and other industrial activities

The section of supplying basic utilities such as electricity, gas and water is a complex system in each vertical and horizontal level. Each level brings with it potentials and problems, but a generalized description is the task of finding a transportable base resource, extracting and delivering it to end consumers. The section therefore requires extraction activities, industrial processing capabilities, supply chains and the "*operation of transmission [and] distribution systems*" [10, p. 166ff] for various utilities such as gas, electricity, water and others.

The electricity grid especially has been a focus of studies due to the politically demanded changes in energy sources and delivery [35, p.12ff]. Regarding the delivery of products that are not using a continuous delivery network such as the electricity or water supply grid, the recommendations by the WEF can be applied that focus on logistics' improvement of efficiency and describe a "*race to build a dominant global [logistics] platform*" [36]. Regarding the industrial processing capabilities, again the I4.0init offers many guidelines and best practices.

The extraction of minerals in the form of mining and quarrying have been the focus by [37] who describe mining as a section that has suffered from decreasing profitability due to a continuous price competition and competitors continuously improving their productivity. They imply that mining can greatly benefit from the classic building blocks of digitalization

such as increased precision through sensors and downstream analytics to improve *“material and equipment flow”* and create a *“deeper understanding of the resource base”*. Automation, robotics and analytics can help improve efficiency and reduce downtime. Big improvement potentials become obvious when we look at the amount of data used for decision making which is a meager 1% of the total data collected [37, p.7].

Literature suggestions, aside from the works of the IIC and I4.0Init are therefore:

- Digital Transformation of Industries: Logistics [36]
- How digital innovation can improve mining productivity [37]
- Future Energy Grid: Migrationspfade ins Internet der Energie [35]

D. Construction

According to a poll of the German chamber of Industry and Commerce (DIHK) on March 2016 [38,], the sample of companies linked to the construction and building industry rate their level of Digitalization on a scale from 1 to 6 as a 3.5, which is 0.2 points less than the average across all industries. [38, p.5] This states out, that representatives of the construction industry know, that they generate advantages, when they use digital solutions and IoT [38, p.7-8], but are not implementing those fast enough.

The IoT impact on the construction or building industry is linked to terms like smart cities, lean construction management and smart resource management in construction processes. The main focus of digitalization processes in this domain is to reach higher levels of sustainability and energy efficiency [39]. Intelligent buildings are the transformational core in this industry. Regarding development in this industry facing the smart city topic, IoT is very important and a leading driving force impacting the progress in development. Lean construction management and smart resource management is linked to more traditional construction progresses, so generally IoT is used to expand innovation in those areas and is not transforming it itself.

Current examples of digital tools which support processes like planning, analysing, monitoring, and optimizing the construction of objects are e.g. BIM and also BAS, which served the purpose reliably in the previous decades but need to be transformed to models, which cover IoT progress and technological standards throughout integrating industries and operations [39].

The BIM and specifically the *road map for digital Design and Construction* [40] are frameworks, which can be used to get digital pro-

cesses involved in the industry regarding holistic perspectives or progress. To get this in connection to the current impact of the digitalization on the industry, the Federal Ministry of Transport and Digital Infrastructure makes the use of BIM mandatory for public infrastructural projects. [40]

BAS and building management systems BMS are used to integrate many different data resources and construction processes to offer an *"economy of large scale with expertise in the system control and automation engineering domains"* [39, p.475] This states out, that these systems are being developed and are facing the challenges of I4.0. On the other hand, the industries' best practices are legacy habits with small innovation progress e.g. because of the close relationship to the public administration section and administrative barriers [41]

In this paper, we can only state out general information about specific models, but the initiative *"building smart"* [42] and their so-called *"international home of openBIM"* is recommended to get further information regarding the assessment and status of I4.0 progress in construction or building- industry focused businesses. Additionally, we can recommend the *BIMiD reference construction process*, which delivers an example of digitally planned construction project [43]



Fig. 1-6 Schematic Illustration of the BIM Reference Process from [40] [40]

To sum up, the construction industry can get general guide- lines to transform operations and processes, culture and business models using the frameworks introduced in chapter II-C. This can be applied to generate strategic transformation in the industry and the core goals of I4.0 are analogous to the construction-industry specific ones. Profound effects or

viable addition can get achieved by applying the described models BIM, BAS, and guidelines by industry-focused initiatives.

E. Wholesale and retail trade, transportation and storage, accommodation and food service activities

This group is a collection of three sections defined by ISIC. The first section, wholesale and retail trade, includes all "*services incidental to the sale of [...] goods*" [10, p.179] as well as the specific task of motor vehicle repairs. The second section, transportation and storage, includes all tasks related to logistics and storage of both objects and passengers. [10, p.194] The last one is focusing on the "*short-stay accommodation for visitors*" as well as the "*provision of complete meals and drinks fit for immediate consumption*" [10, p.202]

Wholesale and Retail have seen high efficiency improvements through integrated supply chain systems with suppliers, sensor based indoor navigation and improved customer experiences with on-the-fly cashier systems [44], [45] by large chains like Tesco. On the other side of the spectrum, small and medium size businesses found their opportunities in niche markets, playing on their strength of agility and ability to quickly innovate and answer changing consumer demands [46]. This section is a perfect example of the two sides of DT: Rapid efficiency increases challenging competitors prices and diverse business models adapting to changing customer demands and creating new markets.

The second section, transportation and storage, often also called logistics, offers large optimization potentials. As reported by [47] in the New York Times, Uber, a digital pioneer in on-demand drive-hauling services, is actively working on autonomous trucks for logistics which has been demonstrated by an autonomously driving truck transporting goods 120 miles without the need of a driver in October 2016. Amazon recently introduced 'intelligent' robots in their warehouses, greatly reducing the walking distances of *pickers*, employees who collect products for orders. [48]. Drones are being investigated as alternatives for delivering parcels and analytics can help fill many of the empty trucks that can make up for up to 50% of a fleet's return trips [36].

The third section, accommodation and food service activities, has already seen its fair share of digitalization fueled disruption with AirBnB disrupting the accommodation market and companies like foodora and deliveroo offering services trying to remove the location component of food services [49]. Both are strategic markets that can be expected to stay, as long as humans eat, travel and sleep, but the model of serving these demands can differ greatly from current business models. Existing

businesses need to challenge their business models and be willing to disrupt their own business to avoid competition from doing so.

For all three sections in this group, the recommendations of the IIC and I4.0Init are valid. Especially the IIC recommendations regarding vertical integrations of value chains in their architectural recommendations [34] are valuable for all three sections due to their direct link with supply chains and logistic companies. In addition the following literature recommendations can be made:

- The Business Model Navigator: 55 Models That Will Revolutionise Your Business [20]
- Leading Digital [16]
- World Economic Forum White Paper Digital Transformation of Industries: Logistics Industry [36]

F. Information and Communication

Included in the information and communication section is, next to information technology and software, which are some of the main drivers of the digitalization, also publishing, motion picture and sound recording activities. These industries have seen what digitalization and disruption means in several cases, ranging from online music and movie streaming services like Spotify and Netflix to more distributed yet still substantial changes such as online publishing and blogging. Blogs and social networks have shifted consumer expectations and challenged established companies such as newspapers and magazines that quickly had trouble competing with these free alternatives which solely relied on advertisement for financing themselves and which had enjoyed much stronger network effects than traditional publishing.

Overall it can be summarized that this section struggles with disrupting new entrants to the market that challenge existing business models with new, digital alternatives. Businesses should therefore focus their efforts on reevaluating their business model as well as their culture with the frameworks provided in chapter II-C. Regarding the information technology and software development industries, advice will be given in chapter III-I.

G. Financial and insurance activities

The financial services industry, including financial service activities, Insurance, reinsurance, pension funding and activities auxiliary to Financial and insurance activities [10] are facing transformation throughout

digitalization processes. The final Report of the WEF addresses the future of financial services regarding the impact of disruptive innovations and IoT [50] and is dividing the financial services industry into 6 functions and 11 Clusters of Innovation [50], which are influencing and are influenced by disruptive innovations and digitalization progress. The functions are: Payments, Insurance, Deposits & Lending, Capital Raising, Investment Management and Market Provisioning [50].

The clusters of Innovation are: Emerging Payment Rails, Cashless World, Insurance Disaggregation, Connected Insurance, Alternative Lending, Shifting Customer Preferences, Crowd funding, Empowered Investors, Process Externalisation, New Market Platforms and smarter & faster Machines [50].

Furthermore, the progress in several functions is currently shaping new business opportunities, e.g. fintech start-ups or more integrated business processes which are generating more values for the economy and the requirements of the society. Typical barriers of the industry and the implementation of innovations like IoT are Accountability, Privacy, Security, Interoperability and Reliability. [50]–[52]

The pressure of innovating legacy processes in this industry is already latent. To get profound results, the transformation requires changes in areas, which are linked to each other. Therefore, integration is elementary for success. As it is stated out in the paper of [53] *"The transformation normally requires important changes in processes, organization structure, and company systems, and must involve all business and IT areas"* [53, p.4]. Accenture's *European Financial Services Digital Readiness Report* also confirms, that financial services firms need to change their processes all over the their organization across the four core business areas plan, make, sell and manage. [54, p. 9]

Regarding these profound changes in the financial and insurance activities, it has to be stated out, if the IIC and I4.0 Frameworks can be applicable to accomplish the progress. The RAMI itself is not suitable for the financial services industry, because it cannot outline specific challenges and conditions of that section. Extending those frameworks with the following, more detailed ones, is recommended:

- 1) Six themes touching multiple clusters of innovation across functions [50]
- 2) The DIGITAL framework by Arthur D. Little [53,]
- 3) Digital Readiness Assessments Framework by Accenture Research [54]

The first is the described in the WEF Report [50] from [50] about the future of financial services and their functions. The six important themes that lead to I4.0-progress in financial and insurance activities are streamlined Infrastructure, automation of high-value activities, reduced intermediation, the strategic role of data, niche & specialised products and customer empowerment. Applying those themes may help the financial industry to implement the chances and potential of fast developing processes based on digitalization and IoT.

The *DIGITAL framework* by Arthur D. Little [53,] presents the main goals of digitalization and their respective measurement KPI in the financial services industry. It is structured in seven parts which are in succession building the word *DIGITAL* [53]: development of new Products, incentivize sales to current clients, generate new clients, image: positioning as an digital company, transfer operations to digital channels, automation of operations, loyalty and churn of clients. The best long-term improvements are stated out in the digital Image and the Transfer of operations to digital channels [53]

Accenture Research developed a Digital Readiness Assessments Framework [54], which emphasizes that there is the need to change both inside and out. Therefore it is important to fill the gap between planning to get digital and fully merging the plan with the business reality. The framework can be seen as a strategic recommendation for decision-makers of the industry and is defining three key areas of change: Define - or redefine - the business, become integral to the online experience and Change the operating model [54].

H. Real estate activities

Organizations related to the real estate industry face mostly similar challenges like the construction industry. The ISIC defines two activity groups in this industry: Real estate activities with own or leased property & Real estate activities on a fee or contract basis [10]. Other activities, like the real-estate broker or property management can use IoT to automate monitoring current status of real estate objects or energy supply on the spot.

In this paper we suggest to use the recommended frameworks of the construction section, combined with the section *Other service activities*.

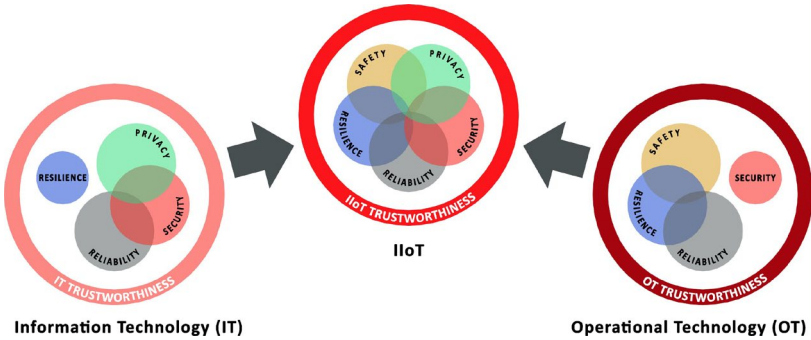


Fig. 1-7 IIC Security Framework from [56] [56]

I. Professional, scientific, technical, administrative and support service activities

Professional services such as legal support, administration, engineering and architecture are affected very little by the effects of digitalization and industry 4.0 in the sense that they aren't the ones getting digitalised but rather are the ones pushing forward this transformation. It is therefore not logical to apply I4.0 concepts to this section, however it is important for those professionals to be knowledgeable about the factors of it since they are major players regarding its planning and implementation. They should therefore have a broad high level knowledge about the overall trend with specialized knowledge for their focus industries.

In the phase of designing the DT there are many relevant topics. Managing roles focus on the planning and controlling of the business branches and activities. Such tasks can greatly benefit from knowledge derived from the information exposed through sensors and analysed with tools from data science enabling "*real-time business and operational decisions*" [34, p.84].

There are also big aspects such as security, governance and controlling activities that can benefit from the DT. As [55] note, The IoT leads to many unnoticeable devices spread around public places that monitor and log a variety of information which can be considered a necessary tool but also a source of privacy invasion. Strong security measures need to be deployed to ensure all dimensions of the *IoT trustworthiness* are covered which are explained in detail by the IIC in their Security Framework [56].

To summarise, the section is a major player in the design of the DT but is not directly affected by it in the sense of it being the subject of transformation. Professionals and businesses in this section are therefore advised to build up knowledge about the DT and familiarise themselves with the

core concepts of I4.0. The two frameworks by the IIC and the I4.0 initiative are an excellent guideline for this.

J. Public administration and defence, education, human health and social work activities

This group is a collection of three sections defined by ISIC. The first section "Public administration and defence; compulsory social security" "*activities of a governmental nature, normally carried out by the public administration*" [10, p.243]. The second section focuses on all activities regarding education, independent of level or form of communication and includes public and private education. The third section covers all activities regarding health care, ranging from hospitals to residential care and even social work activities that aren't performed by health care professionals [10, p.254ff].

The first section, public administration activities, is under high pressure from its citizens to supply digitally available services. The German government set in motion a set of laws directing all administrations to redesign their processes towards digitally available services for citizens, companies and other stakeholders [57]. Although these activities usually involve services rather than manufacturing, the security guidelines developed by the IIC and I4.0Init are elementary to this section. A government must uphold the highest standards of security, especially with personal and sensitive data of its citizens as well as with defence related activities. Culture and business models are less significant although innovation, even in the public section, is becoming more important [58].

The second section, education finds its best example in Arizona. The Arizona State University is considered a "*hotbed of data-driven experiments*" [59] and uses large scale data analytics to improve students college life and education efficiency. Timetables are customised for every student, micro feedback allows highly precise control over students learning progress which reduces overall drop out rates. The whole education section offers big opportunities in data analytics but many institutions in the public domain don't have the funding to initiate large scale projects for collecting and analyzing data as the Arizona State University. Many schools in Germany are struggling with much more basic requirements such as building and fire safety, totaling about 32 billion in accumulated required financial support to support basic requirements [60]. This opens opportunities for private education businesses like Udacity, offering online education for computer science topics offering nano-degrees that are accepted by many big companies instead of a tertiary education [61].

The third section, human health and social work activities has also been influenced strongly by IoT technologies and consumer grade health products. [62] found that many physicians as well as insurances started hooking into the variety of fitness trackers currently available on the market to develop higher precision treatment and insurance plans. [63], a neuroscientist analyzed her sons diabetes with high precision tooling to better understand the disease but was shocked by her sons physician who could not make use of the data. The United States initiated the Open Data initiative aiming to provide large population scale data-sets for researchers to find answers for epidemics, education, energy problems and many other topics.

For this group of sections we recommend the following literature, due to the heavy reliance on security concerns as well as data analytics potentials:

- Interview with Dhanurjay Patil, white house chief data scientist of the Obama administration [58]
- Security recommendations by IIC and I4.0Init
- Speech of [63] about high precision diabetes tracking [63]

K. Other service activities

The ISIC defines this section as a residual category including Arts, entertainment and recreation Activities; membership organizations, repair services for personal equipment as well as cleaning and beauty services [10, p.262ff.].

These categories of economic activity, aside from the membership organizations, are composed mainly of SME. Such businesses rarely have the capacity to compose a complex implementation of a digitalization strategy which causes the I4.0 and IIC frameworks to be not suitable.

The limited resources of SME are located in financial capital, expertise of the staff and the impact on the economic environment [64]. Therefore the investment in digital transformation or implementation of IoT and digitalization processes are to a great extent blocked by the limited resources.

Other examples of the entertainment or arts industry may have the chance to utilize IoT and can apply the I4.0 frameworks combined with IIC guidelines.

This industry is difficult to encapsulate, so the more generic frameworks are recommended. Analogies to other frameworks of adjunct industries should be determined. While technical implementations of the complex I4.0 standards are cost intensive and mostly not applicable, SME should ensure their management is aware of the impending changes and considers those dimensions that are influenceable with less financial

resources, culture, management and business models. Recommended literature therefore are the non technical frameworks from chapter II-C.

4 Individual I4.0 Maturity Model

To enable an individual I4.0 strategy and applicable guidance, the section-specific frameworks provide general information in the respective section to achieve essential concepts. One key element is missing to make these concepts lead to an individual strategy to get I4.0 processes implemented in the organization of the reader of this paper: The competitive environment in this specific industry combined with the individual state of digitalization. To solve this, we gleaned insights to outline the II4.0MM. The objective is to receive an individual scheme on a strategic level, industry-specific and connected to the status quo of the considered organization & competition, to implement relevant and effective I4.0 processes and ultimately transform to sustainable solutions.

The following maturity model insights are the basis for the II4.0MM, but are either only focusing on manufacturing- specific I4.0 or not aggregating all relevant data

- 1) Industry 4.0 Maturity Model [65]
- 2) The Connected Enterprise Maturity Model [66]
- 3) The Digital Advantage: How digital Leaders outperform their peers in every industry [67]

The II4.0MM is structured into 3 steps, which are described subsequently, enriched with the appropriate frameworks and studies.

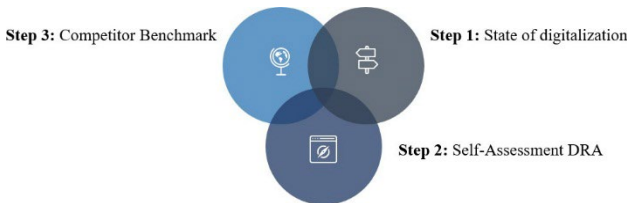


Fig. 1-8 II4.0MM 3 Steps: State of Digitalization, Self-Assessment (DRA), Competitor Benchmark

It is important to define what is meant with the term *II4.0MM*. In this paper, we combine the three key aspects of the state of digitalization, which are described in chapter 2.2, with self-assessment tools to get the benchmark of the competition in the considered industry to shape an

applicable model. This can be used to get strategic leaders converted to implement digital and IoT processes in their respective organization. Other studies may call it *digital Readiness*, which is not focusing on I4.0 or DT in detail.

The first step of the II4.0MM is to determine the general type of digital maturity. The method we recommend is delivered by the four Types of Digital Maturity by [67, p.4]:

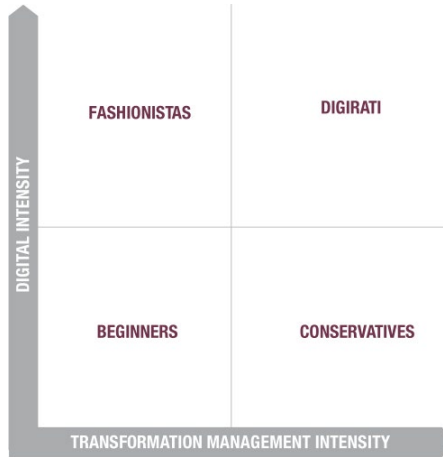


Fig. 1-9 Four Types of Digital Maturity: Fashionistas, Digirati, Beginners, Conservatives from [67] [67, p.4]

Those four types are distinguished by the affiliation to two dimensions: digital intensity (technology-enabled initiatives) and transformation management intensity (leadership capability) [67]. Extending those dimensions with the business models as the third key aspects of the state of digitalization, we can see an analogy to our predefined model (chapter 2.2). Every organization can classify themselves into one described type by answering specific questionnaires [67].

The second step is to deploy a self-assessment DRA [65] [68] [69]. The solution of the DRA might strengthen the predetermination of the digital maturity type or reveal new chances or challenges regarding the implementation of I4.0 measures. The II4.0MM suggests to use one of the following self-assessment DRA:

- 1) Digital Readiness Assessment: Does your business strategy work in a digital world? [70]