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Consultants' Tools to Manage Digital Transformation:
The Case of PWC, Siemens, and Oracle

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ABSTRACT

Digital transformation since 2010 has provided a huge worldwide market with digital consultants as top players. Digital transformation is a socio-economic phenomenon subject to lengthy surveys and actual cases on behalf of digital consultants between 2010-2020. By the end of the 2010s, digital transformation management had been reviewed in scientific journals. This is an instrumental case study about digital transformation at PWC, Siemens, and Oracle as digital technology providers and consultants. Worldwide, digital technology induces digital transformation with the purpose of value creation, motivating companies. Digital consultants are top players. Digital transformation frameworks and digital maturity studies show the dimensions, stages, and scales of digital transformation. Roadmaps, programs, and projects guide the specific steps from one maturity stage to the target. Business cases are used to compute customer value. Customer value is stipulated in customer contracts in as-a-service business models. Digital transformation solutions are marketed using these tools.

KEYWORDS

As-a-Service Business Model, Business Case, Co-Creation, Digital Maturity, Digital Transformation Management, Digital Transformation Solution Marketing, Program, Project, Roadmap, Value-Based Contract

INTRODUCTION

Digital transformation is the name of a booming global market, that mas grown from millions of users until 1985, for the first platform or mainframe terminal, to hundreds of millions of users until 2010, for the second platform or the Lan/ Internet and client/ server, and therefrom to billions of users for the third platform, cloud, social, mobile and analytics (IDC, 2017). The market is expected to nearly double from 1.3 trillion USD in 2020 and therefrom 2.3 trillion USD sales in 2023 (IDC, 2019). The impact of digital transformation pervades across society, making analysts such as Organization for Economic Cooperation and Development (2020) or the World Economic Forum (2020a, 2020b) write about the digital transformation economy generated by the digital transformation market. Market reports show cloud technology emerging since 2008 and growing in the future (Statista, 2021b). Many digital transformation technologies have emerged in this decade, for instance, according to Gartner (2012, 2013, 2015, 2016, 2018, 2019, 2020). Internet of Things in 2012; big data in 2012; cloud computing in 2013; Internet of Things platform in 2015, 2016; digital twin in 2018; blockchain in 2018; artificial intelligence in 2019, 2020. Digital technology in terms of IDC's third platform technology leads to digital transformation in all aspects of human society including business organizations. The market

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for digital technology is refered to by IDC as the market for digital transformation. It is not technology per se that is revolutionary, but its impact on all aspects of society including business organizations. Digital transformation is a predicted and constructed phenomenon by digital consultants, IT suppliers, articles in Harvard Business Review, books. Managing digital transformation is a key strategic topic and the realm of management consultants. Digital consultants have worked closely with organizations, have engaged in surveys and have use cases to refer to as basis for their advisory. Digital transformation use cases are scarce, and marketed by IDC (IDC, 2021). Harvard Analytics Services (2014, 2016, 2019, 2020a, 2020b) note use cases enable companies to make digital transformation decisions and predict return on investment. Laggards in digital transformation have issues understanding impact and are therefore challenged in their investment decisions. Digital transformation empirical studies are in 2021 opportune. Literature review shows digital transformation is accepted terminology in scientific journals, indexed Web of Science, Elsevier, other. Whereas consultants have worked closely with organizations worldwide throughout their digital transformation journeys since 2011, scientific journals have noted the phenomenon later on with fewer resources. The literature review section in this article focuses on digital consultants and scientific journals. Managing digital transformation introduces new management tools, proposed by both digital consultants and scientific journals alike. Transformation maturity scales are overviews of what is to be transformed, from the starting point to the final point. They show transformation dimensions, transformation maturity stages and the shape of each dimension at every stage of transformation. The how to transform is given by roadmaps, who define the main milestones and overarch transformation programs and projects. Transformation targeted states are digital enterprises and value creating networks. Scientific literature reviews about digital transformation (Nwaiwu, 2018) also show that the literature review is focused on the following: assess current state of digitalization; what to transform; how to transform; origin of theoretical framework, which may be business or academia; whether the framework is scientifically validated or not. The goal of this article is to create an instrumental overview approach to managing digital transformation, that takes into account literature review and the practice of a digital transformation expert, Siemens, advised by PWC.

DIGITAL RELATED CONCEPTS: DIGITAL TECHNOLOGY, DIGITALIZATION, DIGITAL TRANSFORMATION, DIGITAL DISRUPTION

The most proeminent digital market analyst, IDC, identifies three platforms of digital transformation and argues this technology gives the digital economy across the world. Digital transformation induced by information technology may be defined by IDC's platforms: the first platform comprises the mainframe terminal and has millions or users; since 1985, the second platform comprises the Lan/ Internet and client/ server and has hundreds of millions of users; the third platform lasts since 2011, the change extends to billions of users and comprises cloud, big data analytics, social business, mobility and technology accelerators; the latter consist of robotics, natural interfaces, 3D printing, Internet of Things, cognitive systems, and next generation security (IDC, 2017, 2020, 2021a). Proeminent authors Porter from Harvard Business School and PTC CEO James Heppelmann (Porter & Heppelmann, 2014, 2015) note that smart connected products or intelligent connected devices working across the Internet of Things are to usher a new wave of information technology induced transformation. IDC (Dell, 2014; IScoop, 2020). IBM (2017) note the fourth platform, to comprise smart industry solutions. IBM (2017) anticipates a fourth digital platform comprising the ambient and cognitive computing platform, built upon the third wave, which means in essence cloud computing, but will be different in many ways allowing for 10s of billions smart devices in the next phase. Another proeminent market analyst, CIMdata (2020c). argues social, mobile, big data, analytics, cloud and the Internet of Things are leading to smart connected products in all industries, and a smart connected world. The overall market for digital technology is called by CIMdata (2020a, 2020b, 2020c). IDC (2019, 2020b, 2021). Markets and Markets (2021). Mordor Intelligence (2021). Accenture (2017a, 2017b).

World Economic Forum (2020a, 2020b) digital transformation. The most noteworthy market analyst, IDC (2019, 2020b). estimates the overall market for digital transformation to reach 1.3 trillion USD in 2020 and therefrom 2.3 trillion USD sales in 2023. Statista confirms this estimation. In 2017, the digital transformation market was valued at $0.96 trillion and it will increase to $2.3 trillion in 2023 (Statista, 2021a). Reports about digital transformation technology and market players varry by market analyst. In one view, Markets and Markets (2021). the digital transformation market is defined as the outcome of changes that occur with the application of digital technologies: cloud computing, artificial intelligence, big data and analytics, mobility and social media, cybersecurity, Internet of Things, blockchain and robotics. Market players are: Microsoft (US). SAP (Germany). Cognizant (US). Adobe (US). Dell EMC (US). IBM (US). Google (US). Marlabs (US). Accenture (Ireland). Broadcom (US). Equinix (US). Oracle (US). HPE (US). HCL Technologies (India). Tibco software (US). Alcor Solutions (US). Smartstream (UK). Yash Technologies (US). Interfacing (Canada). Kissflow (India). Emudhra (India). Process Maker (US). Process Street (US). Happiest Minds (India). Scoro (UK). Brillio (US). Aexonic Technologies (US). The customers of the digital transformation market are: banking, financial services, and insurance; healthcare; IT and telecom; education; retail; media and entertainment; manufacturing; government; others, such as transportation and logistics and travel and hospitality (Markets and Markets, 2021). Mordor Intelligence (2021) includes the following technologies in digital transformation: industrial robotics, Internet of Things, 3D printing/ additive manufacturing, advanced human machine interface (HMI). big data and analytics, machine learning and artificial intelligence, other technologies. According to Mordor Intelligence (2021). the market for digital transformation comprises the following market players: Accenture PLC, Google LLC, Siemens AG, IBM Corporation, Microsoft Corporation, Cognex Corporation, Hewlett Packard Company, SAP SE, EMC Corporation, Oracle Corporation, Adobe Systems Inc. Customer industries are: automotive; food and beverages; information technology; telecom; BFSI; retail; other end user industries.

In Information Resources Management Association encyclopedias, digitalization (Khosrow-Pour, 2018) has several definitions. One is the integration of digital technologies into everyday life by the digitization of everything that can be digitized. Another one is the adoption of digital technologies to modify a business model. Digitalization may aim to create a value from the use of new, advanced technologies by exploiting digital network dynamics and the giant digital flow of information. It may be the use of digital technologies to upgrade processes. Digitalization may also be defined as the process by which companies reorganize their work methods and strategies to obtain greater benefits thanks to the implementation of new technologies. Digitalization comprises the changes and transformation in the world as a result of information and communication technologies. It may mean the integration of digital technologies into everyday life by the digitization of everything that can be digitized. The literal meaning of digitalization gives an apparent idea of development and technology dependent world. Digitalization is 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. Digitalization is the process of converting information into a digital (bits – 0,1) format (i.e., readable by computers). This allows any information to be stored, processed, and transmitted easily by using a network of computers. Digitalization refers to the adoption in use of digital technology by the key market players such as distributors and producers, film practitioners and associations, cultural policymakers, and politicians. It means the integration of digital technologies into everyday life. Digitalization also means the process of making digital everything that can be digitized and the process of converting information into digital format. Digitalization is the incorporation of digital technologies into daily life. Alternatively it is the use of digital technologies to move into a digital business undertanding. It is the management of business processes by transferring them to digital environments. Digitization is about the conversion of analogue information into digital information (Gartner, 2021a). Digitalization is defined (Gartner, 2021b) as the use of digital technologies to change a business model and provide value-creating opportunities or improve performance quantifiably.

Mainframe consultants (Accenture, 2017a, 2017b; BCG, 2021; CapGemeni, 2011; Deloitte, 2020a, 2020b; Gartner, 2021c; IBM Institute for Business Value, 2011; IDC, 2021; Markets and Markets, 2021; Mordor Intelligence, 2021; The World Economic Forum, 2020a, 2020b) and scientific resources (Bharadwaj et al, 2013, Kavadias et al, 2016; Morakanyane et al, 2017; Nwaiwu, 2018; Porter and Happelmann, 2014, 2015; Schmarzo, 2016; Kane et al, 2016; Tabrizi et al, 2019; Yablonksky, 2018; Westerman et al, 2014a; Westerman et al, 2014b) define digital transformation as the impact of changes on several dimensions of the organization driven by digital technology or other factors, such as the business models it enables. In these definitions, impact means stakeholder or shareholder that is created, captured and delivered. Early studies about digital transformation (CapGemeni, 2011; IBM Institute for Value Analysis, 2011) and later studies alike define digital transformation in terms of the what and the how. IDC (PWC, 2019a, 2019b) interviews about the state of digital strategy in 2019 shows that the most important digital strategies for the mainstream digital consultants are the cost agenda (the need to drive efficiency, increase profitability, and reduce costs) and the growth agenda (the need to increase revenue, strengthen cash flow, and build the organization's brand). The most important digital consultants are: Mc Kinsey, Accenture, BCG, EY, IBM, PWC, Publicis Sapient, Deloitte, KPMG, Globant, CapGemeni (PWC, 2019a, 2019b). A survey conducted by Harvard Business Review Analytics Services (2020a) has shown that digital transformation leaders enjoy clear business benefits, that may be classified as revenue growth and efficiency gains and include: revenue growth, operational efficiency, customer retention and loyalty, market position versus competitors, employee satisfaction, profitability, cultural change. Scientific literature review (Morakanyane et al, 2017) also defines the impact of digital transformation as value, which may take various forms. New frameworks to define value have emerged that will be discussed in the literature review at a dedicated point. Scientific literature reviews about digital transformation (Nwaiwu, 2018) show that the literature review follows the steps: assess current state of digitalization; what to transform; how to transform; origin of theoretical framework, which may be business or academia; whether the framework is scientifically validated or not. Digital transformation has been conceptualized in 2011 by Westerman, Bonnet and McAfee for CapGemeni and the MIT Institute for Technology. The study pinpoints the emergence of an important new topic, digital transformation. The three define digital transformation as the use of technology to radically improve performance or reach of enterprises (CapGemeni, 2011; Westerman et al, 2014a, 2014b). This study is recognized in the academic world as core to the Massachussets Institute of Technology. Westerman, Bonnet and McAfee explain executives in all industries are using digital advances such as analytics, mobility, social media and smart embedded devices as well as improving their use of traditional technologies such as enterprise resource planning to change customer relationships, internal processes and value propositions. Other important authors in digital transformation are Porter at Harvard Business School and Heppelmann at PTC, who argue a new wave of digital transformation will be incurred by intelligent connected devices across the internet of things. This wave of digital transformation will impact the competitive environment and organization both. According to Turchi from Roland Berger (2018). technology underpins business transformation; the business model is the highest form of business transformation; but before the business model is transformed, operating model, operations and go-to-market will also be transformed. Digital transformation is a perpetual process and a journey. In the academic world, Bharadwaj et al, 2013, Kavadias et al, 2016; Nwaiwu, 2018; Schmarzo, 2016; Yablonksky, 2018 address digital transformation. Works often involve definitions imported from management consultants. Industry 4.0 is the digital transformation from the automation pyramid to distributed networks or value networks (Alcacer and Macado, 2019; Kagermann et al, 2013; Lee et al, 2015; Zeid et al, 2019). It is refered to specifically as a change from pipeline business models to platform business models, made possible by innovative systems of systems of cyber-physical systems negotiating as peers across the Internet of Things (Kagermann et al, 2013). According to the proponents of the vision, Industry 4.0, value networks encompass the following processes: product lifecycle management, production system lifecycle management, supply chain management, service

(Plattform Industry 4.0, 2016). In manufacturing, digital transformation is a dual innovation strategy (Kagermann, 2015): explorative and exploitative both (Kagermann, 2015). This involves: optimizing the core, with existing technological capabilities and existing business models; reshaping the core, that is business transformation for the new normal; creating the new, that is new technology with new business model (Kagermann, 2015). Software AG (2018) has an integrated enterprise architecture approach to Industry 4.0, where new technologies: cloud, Internet of Things, digital twin, cyber-physical systems, additive manufacturing, augmented sales bots, blockchain, omnichannel intelligence work together in innovative business models with new end-to-end processes. The processes are direct: market to cash, demand to operate, source to pay or support processes: accounting to profitability and forecast to demand. These technologies, processes, competencies and business models work together in a new form of enterprise architecture.

Digital transformation is expected to progress to digital disruption (IDC, 2021a, 2021b). and impact several industries in a digital vortex (Global Center for Digital Business Transformation, 2015). Digital disruption (Capgemeni, 2016; Casadesus-Masanell and Ricart, 2011; Girotra and Netessine, 2014; Grossman, 2016; Kavadias et al, 2016; The Global Center for Digital Business Transformation, 2015; Ovans, 2015; Westerman et al, 2014a, 2014b) occurs when digital technology replaces incumbents' business models in industries with new business models. Digital disruption, especially the shift from pipelines to platforms, impacts all industries in a digital vortex (Blank, 2013; Bonchek and Choudary, 2013; Girotra and Netessine, 2014; Grossman, 2016; The Global Center for Digital Business Transformation, 2015; Van Alstyne et al, 2016; Westerman et al, 2014a, 2014b). According to the Global Center for Digital Business Transformation DBT (2019). digital disruption is the effect of digital technologies and business models on a company's current value proposition, and its resulting market position. Digital technology is marketed to all individual industries to a different degree. One of the main market consultants, Global Center for Digital Business Transformation (2017) expects digital technology will disrupt existing industries, in the following order: media and entertainment; technical products and services; retail; financial services; telecoms; consumer packaged goods; education; professional services; hospitality and tourism; manufacturing; transportation and logistics; real estate; healthcare and pharmaceuticals; energy and utilities.

Digital Maturity Indexes, An Overview Instrument For the What in Digital Transformation

In 1986, the capability maturity model was created by the US Department of Defense. In the capability maturity model, maturity levels are given by progressive capabilities that describe how the behaviors, practices and processes of an organization can reliably and sustainably produce required outcomes (Nayab, 2010). The maturity levels are: initial; repeatable; defined; capable; efficient. In digital transformation, maturity indexes refer to processes and other organizational dimensions and have several capability maturity levels. The goal tends to be value. According to Porter and Heppellmann (2014, 2015). smart connected products have several maturity stages given by their capabilities: monitoring, control, optimization, autonomy. They are to transform several organizational dimensions: business model, value chain, information technology architecture, corporate functions, relationships, processes, organizational structures, value. In Industry 4.0, maturity models are organizational capabilities, include a stream of objectives and sequential levels or stages (Sener and Gokalp, 2018). Maturity models function as improvement along with maturity progress (Sener and Gokalp, 2018). Maturity models are used to determine the current maturity model and generate a roadmap to move to the next maturity model (Sener and Gokalp, 2018). Maturity models represent a theory of staged based evolution and its basic purpose consists of describing stages and maturation paths through a scale of maturity (Bertolini et al, 2019). Mettler (2009, 2011) defined maturity as a development of a specific ability or reaching to a targeted success from an initial to an anticipated stage. In the view the most popular Industry 4.0 maturity model proponents, Schumacher et al (2016) maturity models are a tool for comparing current maturity level to the desired maturity level of an organization or

process, by conceptualizing and measuring. Schumacher et al, in 2016, relate maturity models to digital transformation and digital transformation in manufacturing, industry 4.0. Maturity systems increase their capabilities over time regarding the achievement of some future state. This definition is shared by other popular authors such as Proença and Borbinha (2016). Mittal et al (2018). According to Proença and Borbinha (2016). maturity models can be used as evaluation criteria and described as complete, perfect or ready. Maturity models may be used from progression from basic state to a more advanced final state. The role of maturity models is complex: audit; benchmark; process appraisal; organization appraisal; progress tracking; diagnostic (Proença and Borbinha, 2016). Maturity models are models that help an individual or entity to reach a more sophisticated maturity level, in people/ culture, processes/ structures, and or objects/ technologies following a step by step continuous improvement process (Mittal et al, 2018). Maturity models are questionnaires with several options to choose from for each question (Akdil et al, 2017). Nickkhou et al (2016) defined maturity as guidance to correct or prevent problems, evidence of an achievement or a perfect state to be reached. Maturity models enable organizations to audit and benchmark regarding to assessment results; to track process towards a desired level; to evaluate strengths, weaknesses, threats, opportunities; to sequence stages from basic to advanced. Duffy (2001) teach organizations which actions should be considered in order to reach an advanced maturity level, and when and why to decide these actions. Tarhan at al (2016) describe maturity models as desired logical path for processes in several business fields which include discrete levels of maturity. According to Backlund et al (2014). maturity models are extremely important tools to appraise organizations.

In the following, a literature review was performed on Industry 4.0 maturity scales as provided by scientific journals. The articles reviewed tend to be conceptual studies. Some are tested on cases, small and medium enterprises in different industries or national economies.

Authors also agree maturity maps are followed by roadmaps as tools for digital transformation, after the stage assessment of current digital maturity, that shape the transformation effort from one stage of maturity to the other (CapGemeni, 2011; Garcia and Bray, 1997; IBM, 2019, p. 33; Mittal et al, 2018; Schuh et al, 2017, p. 16; Schumacher et al, 2019).

The Digital Transformation Roadmap, An Instrument For the How in Digital Transformation

Management consultants (CapGemeni, 2011; IBM, 2019; Software AG, 2018) and scientific authors (Mittal et al, 2018; Schuh et al, 2017, p. 16; Schumacher et al, 2019) agree maturity maps are followed by roadmaps as instruments for digital transformation, after the stage assessment of current digital maturity, that shape the transformation effort from one stage of maturity to the other. Roadmaps are an overview instrument, tied directly to the strategy, which defines the goals and milestones (Project Management Institute, 2017). Since digital transformation, management consultants conceive roadmaps to include the maturity index. The gap between the actual and intended maturity stage is the digital transformation effort. A chart will be used with timelines on a horizontal axis and the dimensions of digital transformation on several vertical axes tied to maturity stages and timeline. This is the way management consultants Mc Kinsey (2018). EY (2020b). KPMG (2017). BCG (2020b, 2020c). CapGemeni (2014). Accenture (2018, 2019). Deloitte (2018) use roadmaps in digital transformation with specific impact on business value calculations. Scientific research authors also agree maturity maps are followed by roadmaps as instruments for digital transformation, after the stage assessment of current digital maturity, that shape the transformation effort from one stage of maturity to the other (Garcia & Bray, 1997; Mittal et al, 2018; Schuh et al, 2017, p. 16; Schumacher et al, 2017). According to project management standard setting bodies, roadmaps are used to oversee programs and projects (Project Management Institute, 2017). Project management bodies define basic concepts such as roadmaps, programs, projects, operations (Project Management Institute, 2017). A project roadmap is a graphical, high level overview of the project's goals and deliverables presented on a timeline. It specifies important milestones, deliverables and risks. Programs are defined as a

Table 1. Digital transformation maturity scales according to digital consultants

Year	Author	Maturity level	Dimension	Scale
2011	CapGemeni	the combination of digital intensity and transformation management intensity: both low for beginners; high and low respectively for fashionistas; low and high respectively for conservatives; both high for digirati	business model: digitally modified business, new digital business, and digital globalization; operational or process: process digitalization, worker enablement, and performance management; customer experience: customer understanding, top line growth, and customer touch points	
2014	IBM	ad hoc, foundational; competitive; differentiating; breakaway	business strategy; information; analytics; culture and execution; architecture; governance	
2015	IMPULS (Lichtblau, 2015)	beginner (new comer); intermediate (learner); experienced (expert); top performer (leader)	organizational strategy; smart factory; smart operation; smart products; data driven services; employees	beginner (newcomer); intermediate (learner); experienced; expert; top performer
2015	Roland Berger	digital data; automation; connectivity; digital customer access	technology; technology enablers; customer propositions	detailed scale for each maturity model
2016	PWC	beginner; vertical integrator; horizontal collaborator; digital specialist	digital business models and customer access; digitization of product and service offerings; digitization of vertical and horizontal value chains; data and analytics as core capability; agile IT architecture; compliance, security, legal and tax; organization, employees and digital culture	beginner; vertical integrator; horizontal collaboration; digital specialist
2016	KPMG	reactive participant; digital operator; ambitious transformer; smart digitalist	strategy; culture; monitoring; customer; organization and control; technology management; people and capabilities	transformation intensity; operational effectiveness
2016	Forrester Research	skeptics, adopters, collaborators, differentiators	cultural, organizational, technical, insights	score range based on scale
2017	Knowledge Exchange and Fraunhofer	the starting point, Industry 3.0; visibility, answering what happens?; transparency, answering what will happen?; predictability, answering what will happen?; adaptability, answering how can an autonomous reaction succeed?	smart solutions; smart innovation; smart networks; smart connected supply chains; smart production; data driven business models; digital strategy and vision; digital strategy and vision; information technologies; resources; culture and mindset	framework; visibility; transparency; predictability; adaptability
2017	Acatech	computerization; connectivity; visibility; transparency; predictive capacity; adaptability	resources; informational systems; organizational structure; culture	detailed for each dimension and scale level
2018	McKinsey & Company	capabilities: data driven insights; integrated customer experience; digital marketing; digitally-enabled operations; next-gen technology; digital enablers	strategy; culture; organization; capabilities	

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Table 1. Continued

Year	Author	Maturity level	Dimension	Scale
2018	CapGemeni	beginners, conservatives, digital masters, fashionistas	the how: digital strategy, organizational structure; competencies; culture; IT ecosystem; network and data; the what: operational processes	computerization and connectivity; visibility and transparency; predictive power; adaptability and self-learning
2018	Deloitte	early; developing; maturing	strategy; leadership; workforce development; user focus; culture	early; developing; maturing
2018	European Commission	EU survey	digital economy; digital technologies; digital strategy; digital adoption; digital skills; digital transformation; digital investments; impact	scale from 0 to 100
2019	Accenture	champions; contenders; cadets	alignment; infrastructure; skills; partnership; measurement; cultural	champions; contenders; cadets
2019	EDP Singapore, McKinsey & Company, Siemens, SAP and TÜV SÜD (2019)	readiness assessment	process: operations, supply chain, product lifecycle; technology: shopfloor, enterprise, facility; organization: talent readiness, structure and management	process: vertical integration; horizontal integration; integrated product lifecycle; technology: automation, connectivity, intelligence; workforce learning and development; leadership competency; inter and intracompany collaboration; strategy and governance
2020	BCG	innovate; incubate; scale and industrialize	strategy and aspiration; prioritized outcomes; people/ skills/ culture gap assessment; operating and governance principles; technology and data assets	
2020	Deloitte	low; medium; high	flexible, secure infrastructure; data mastery; digitally savvy, open talent networks; ecosystem engagement; intelligent workflows; unified customer experience; business model adaptability	
2021	EY	developing; established; leading	strategy, innovation and growth; customer experience; supply chain and operations; technology; risk and cyber security; finance, legal and tax; people and organization	

Table 2. Digital transformation maturity models in scholarly or scientific journals

Year	Author	Maturity level	Dimension	Scale
2011	Katsma et al	supply chain systems moving towards the Internet of Things	business; application; information; technical infrastructure	ERP; ERP 2.0; SOA/ SAAS; IoT
2014, 2015	Porter and Heppelmann	monitoring, control, optimization, autonomy	business model, value chain, information technology architecture, corporate functions, relationships, processes, organizational structures, value	
2014, 2015	Lee et al	smart connection level; data to information conversion level; cyber level; cognition level; configuration level	technology	
2016	Schumacher et al		strategy; leadership; customers; products; operations; culture; people; governance; technology	1 – not implemented to 5 – fully implemented
2016	Ganzarain and Errasti	initial; managed; defined; transform; detailed business model	vision/envision; business/enable; actions/enact	detailed scale for every maturity level and dimension
2016	Jæger and Halse	3.0 maturity, initial; maturity; connected; enhanced; innovating; integrated; extensive; 4.0 maturity	Internet of Things	
2016	Qin et al.	digitalization; communication; standardization; flexibility; customization; real time responsibility; predictive maintenance; decision making; early aware; self-optimization; self-configuration	factory; business; process; customers	transformation stages from initial technology to Industry 4.0
2016	Leyh et al (SIMMI)	basic; cross; horizontal; vertical; total	vertical integration; horizontal integration; digital development; technology crossing	
2016	Westerman et al	monitoring; communication and analysis; interpretation and services; adaption and optimization; cooperation	cyber-physical systems; information processing; communication system; human-machine-interface; data; services	
2017	Weber et al	non-existent IT integration; data and system integration; integration of cross-life-cycle data; service-orientation; digital twin; self-optimizing factory	technology	
2017	Dreamy (De Carolis et al, 2017)	initial; managed; defined; integrated and interoperated; digitally oriented	processes; control and monitoring; technology; organization	

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Table 2. Continued

Year	Author	Maturity level	Dimension	Scale
2017	Klötzer and Pflaum	digitalization awareness; smart networked products; the service-oriented enterprise; thinking in service systems; the data-driven enterprise	strategy development; customer offering; smart product or smart factory; complementary information technology; cooperation; structural organization; process organization; competencies; innovation culture	
2017	Gökalp et al	incomplete; performed; managed; established; predictable; optimizing	asset management; data governance; application management; process transformation; organizational alignment	
2017	Lee et al	analytic network process	leadership and strategy; product development; production planning; process control; quality control; facility management; logistics management; information system; facility automation; performance assessment	highly detailed assessment items
2018	Canetta et al	absence; beginner; intermediate; experienced	strategy; processes; products and services; technologies; human resources	
2018	Akdil et al.	absence; existence; survived; maturity	smart products and services; smart business processes (research and development, production, marketing and sales, supportive operations); strategy and organization (business models, strategic partnerships, technology investments, organizational structure and leadership)	
2018	Scremin et al		business strategy, technology strategy, networking and integration, infrastructure for Internet of Things, analytical skills, absorbative capacity, benefits of Industrie 4.0 adoption, impact on efficiency	detailed scale for each item
2018	Sjodin et al	connected technologies, structured data collection and sharing, real time process analysis and optimization, intelligent and predictive manufacturing	people, processes, technology	
2018	Sener and Gokalp	incomplete, performed, managed, established, predictable, optimized	asset management, data governance, application management, process transformation, organizational alignment	
2019	Modrák and Šoltysová	conventional; starting, moderate; advanced; optimized	organizational product model; knowledge management; business strategy; product related business models; innovation culture	additional requirements; product standardization; product modularity; process modularity; integration of product configurator into process planning; optimization of intelligent technologies and products
2019	Schumacher and Sihn		technology; products; customers and partners; value creation processes; data and information; corporate standards; employees; strategy; leadership	detailed scale for each dimension

group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually. Program offices are hierchically superior to projects and oversee project management. A project is a temporary endeavor undertaken to create a unique product, service, or result. Examples are product design, production planning, construction. Operations, on the other hand are the ongoing production of goods and/or services.

A different approach popular in the past decade in the lean start-up method (Blank, 2013; Osterwalder, 2011; Ries, 2010, 2011a, 2011b). Blank (2013) and Ries (2010, 2011a, 2011b) define start-ups as organizations that search for a repeatable and scalable business model. The first stage of a start-up's life is the search for a business model, and finalized by finding one. Start-ups will experiment, formulate, learn and test hypotheses via the minimum viable product. In the next stage, the minimum viable product is a pivot which needs to be tested for proof of concept and prototyping. At the stage when the business model is executed, a plan for cash flow will be devised. This is the customer development stage. Customer development involves customer discovery, customer validation, customer creation, scalability. The next stage is agile development. The approach is compared to McGrath's (McGrath and Mac Millan, 1995) discovery-driven planning, suitable for an uncertain environment and the initial stages of the product lifecycle. Roadmaps are intended to reflect agile decision systems (Pankaj et al, 2017).

As a Service Business Models, An Instrument For the Why in Digital Transformation

On business to business markets, consultants (Accenture, 2017a, 2017b; BCG, 2016; Deloitte, 2020a, 2020b; The World Economic Forum, 2020a, 2020b) indicate the purpose of digital transformation is return on investment. In 2020, the World Economic Forum launches an initiative to maximize return on digital investment in digital transformation. Digital transformation may be an investment decision made by existing companies in a brownfield approach (CIMdata, 2020a, 2020b, 2020c). According to Accenture (2017a, 2017b, 2020). smart connected products will first cooperate in eco-systems based on operational efficiency (asset utilization). and move to new products and services (new business models, pay per use). outcome based economy (pay per outcome platforms). and finally the autonomous pull economy. The Internet of Things is refered to as the outcome based economy (World Economic Forum, 2020a, 2020b) and defined as companies' ability to deliver customers value by quantifiable results. According to the World Economic Forum (2020a, 2020b). the Internet of Things will bring the outcome economy, now emerging, where companies will shift from competing through selling products and services, to competing on delivering measurable results important to the customer. Outcome based contracts are rated a business innovation due to which EY has been prized the most important digital consultant in 2020 (EY, 2020a). At BCG, one of the highlights of innovation in 2020 is disruption (BCG, 2020a). via orchestrating IoT ecosystems (BCG, 2020d) or as as service business models (BCG, 2019b). In scientific literature, the transition from products to product-service systems or solutions is called servitization (Visnjic et al, 2017). Servitization is defined as the trend via which manufacturers add services to existing products throughout the lifecycle, creating product-service systems (Li & Mischra, 2020). Scientific literature reviews (Raddats et al, 2019) note that, since 2010, products have evolved to product and service systems or solutions. Solutions are regarded in literature reviews (Raddats et al, 2019) as bundles of tangible goods, services, and software. There are several kinds of solutions: product-oriented product service solutions; use oriented product service solutions; result oriented product level solutions. In this view, product-service models focus on products and are regarded as a simple solution. The second category is use oriented product service solutions, which provide output as value via key performance indicators such as availability. The most complex form of product service solutions are provided by suppliers with profound knowledge of customers' needs, operations and processes. These are outcome based solutions, where suppliers pay for achieved performance outcomes and value in use.

EXPLORING DIGITALIZATION IN THE CASE OF SIEMENS

Empirical Data Analysis – An Instrumental Case Study on Oracle and Siemens

Methodology

The current research is a multiple instrumental case study on PWC advising Oracle and Siemens for digital transformation (PWC, 2018a, 2018b, 2018c). The case object is a new market and new management phenomenon, digital transformation, where literature review shows management consultants have been working with customers on a key strategic issue. The timing of the study, 2021, allows for empirical experience to be included in the literature review and empirical data analysis both. The case subjects are amongst the most important market players on the digital transformation market. On digital transformation market, Oracle and Siemens are digital transformation market players and consultants; both have integrated end-to-end solutions for their customers, guiding them through the digital transformation journey. PWC, Oracle and Siemens have digital transformation consulting methodologies in place that have been induced as a result of a wide body of empirical evidence systematic for Siemens years 2016-2020. The empirical evidence has been structured according to Siemens' overview provided in 2020 (Siemens, 2020c). The instrumental approach is intended to be theory-building for managing digital transformation. As a limitation, the general approach does not cover the details.

The Why in Digital Transformation Consulting: The Scoping Workshop

PWC's (2018b, 2018c) digital transformation consulting begins with business strategy and performance analysis. This uses PWC customer database knowledge and specific strategic management software. It allows analysis, benchmarking, a specific client digital transformation roadmap. In the next stage, PWC – Oracle customers are assisted to develop strategy.

Siemens defines digitalization as leveraging digital technology for concrete customer benefits (Siemens, 2016a, p. 16; Siemens, 2016b, p. 4; Siemens, 2016c, p. 5). Digital transformation is defined as a change in the way value is created in an organization, via changes in business models, business processes, or organizational set-up triggered by digital technology (Siemens, 2019h). At Siemens, an internal consultant, Advanta, is in charge of digital transformation consulting (Siemens, 2020k). The consulting process is called Digital Enterprise Transformation Consulting process. According to Siemens Digital Enterprise Consulting (Siemens, 2020a, 2020k). At the early stages in digital transformation consulting, the why in digital transformation is explored (Siemens, 2019c, p. 19). and a value-based digitalization roadmap is generated. Siemens develops a holistic strategy around the why (Siemens, 2019h). Understandig the why means understanding the value driver (Siemens, 2019c, p. 19). Siemens (2020a) claims the beginning is the scoping workshop, where Siemens works with all relevant stakeholders to define the results that need to be achieved: Why are you customers pursuing digitalization?; What are their business drivers and motivations behind your digital transformation journey?. The roadmap is a key instrument to guide through the digital transformation journey (Siemens, 2019a, 2019b). Advanta delivers end-to-end digital solutions, where the main types of digital transformation solutions are innovation and Product Lifecycle Management; operations and supply chain management (Siemens, 2020g).

The What in Digital Consulting: The Maturity Index

At PWC (2018b, 2018c). the diagnostic of business process maturity is next, as the third stage in the digital transformation journey. PWC focuses maturity on business process maturity, and uses an internal tool, LEAP, with reference target operating models for sectors in which PWC clients do business. These models are used for analysis and improvement guidance.

At Siemens (2020a, 2020c, 2020d). the next stage of the digital consulting process is the digital maturity check. The maturity analysis establishes where to start (Siemens, 2019e, p. 19). The Industry

4.0 potential activity is a one-day, fast-moving workshop where the full digitalization landscape is briefly investigated to determine potential key value areas and solution maturity levels (Siemens, 2020b). The maturity index is a fundamental instrument in digital transformation (Siemens, 2019a, 2019b). Evidence of digital consulting (Siemens, 2020a) has confirmed Siemens begins the consulting process with an assessment of the digitalization of the value chain. Identifying the digital maturity level shows where to start and what status to reach (Siemens, 2019c, p. 19). It may be seen as the answer to the question what to transform? (Siemens, 2019c, p. 19). The maturity index shows the potential of Industry 4.0 (Siemens, 2020c). The maturity workshop may be used as a benchmarking effort, to compare the technology and process maturity in Industry 4.0 to others in the industry (Siemens, 2020b). There are numerous starting possibilities (Siemens, 2019c, p. 4). Digital transformation consulting show the starting point may be greenfield or brownfield (Siemens, 2019c, p. 4). PWC (2018a) and Siemens have worked together for a coherent framework for digital transformation, that begins with the digital maturity assessment.

Most Siemens presentations (CIMdata, 2019; Siemens, 2019e, p. 21) show a digital maturity index based on technology, showing five progressive and accretitive levels of digital maturity. Level 1 of digital transformation maturity belongs to connectivity via the cloud. Level 2 of digital transformation capability maturity corresponds to analytics, levels descriptive, diagnostic and predictive in Internet of Things platform Mindsphere. Level 3 of digital transformation capability maturity belongs to closed loop manufacturing, augmented reality and virtual reality. Closed loop manufacturing is the integration of product digital twin, production digital twin from Product Lifecycle Management software and the Mindsphere Internet of Things platform predictive digital twin in a digital thread and a feed-back loop. At level 4, artificial intelligence enables peer-to-peer decisions across the Internet of Things and systems of systems. At level 5, self-optimizing systems based on intelligent expert systems act with autonomy. Siemens states digital transformation refers to technology, business processes and business models (Siemens, 2020b). The digital enterprise assessment covers organizational dimensions strategic planning; organization and administration; system integration; production and operation; data management; digital application (Siemens, 2020e). With Digitrain (Siemens, 2017a). the maturity scale takes artificial intelligence further, and progresses with additive manufacturing; disruption, new business models and the outcome economy; open innovation; blockchain. PWC (2018a) lists the following dimensions of digital transformation bottom to top: technological infrastructure and digital manufacturing processes; digital operating model, processes, structure and culture; digital strategy and business model. Digital transformation reimagines a company's structure, processes and business model (PWC, 2018a). At each stage of digital maturity, Siemens intends to create and deliver customers targeted value (Siemens, 2019e, p. 21). At these levels of digital maturity, the maturity index is used by Advanta as an integration instrument, where 8000 Internet of Things integration experts manage this issue. US market digital maturity surveys show that digital technology is about driving efficiency or reinventing the business (Siemens, 2020f, p. 6).

The How and When in Digital Transformation Consulting: The Digital Transformation Roadmap, Business Case and Predicted Value

At PWC (2018b, 2018c). the business case for change is the fourth stage in the digital transformation journey. Change refers to the difference between the current operational performance and the target operating model. PWC provides guidance for the understanding of current operational performance and the starting position. The target operating model involves PWC designing a strategy, which connects solutions to imperative issues, adaptable for any contingent future. The starting stage and the final stage will be connected by a business case for change. A roadmap of the digital transformation between the two stages will be provided. The value the business will realize at the end of its journey will be quantified and predicted (PWC, 2019).

Siemens' Digital Compass Trademark methodology involves using maturity maps and then value driven roadmaps, programs, projects to build a business case and predict customer business

value (PWC, 2018a; Siemens, 2017a, 2018d, 2020a, 2020b, 2020c, 2020d). The roadmap and most impactful projects answers questions how and when in digital consulting (Siemens, 2019c, p. 19). The roadmap takes the digital transformation from its starting state to its desired state (PWC, 2018a). Siemens' Digital Compass Trademark methodology involves using maturity maps and then roadmaps, programs, projects (Siemens, 2017b). The methodology belongs to Siemens Advanta and has been used in several businesses). According to Siemens (2020c) following the digital maturity analysis, which incorporates several discussions with employees on all levels, the Siemens team develops the digital roadmap. The roadmap (Siemens, 2020d) is defined as follows: a comprehensive plan that follows the company over a period of years, similar to a user manual that tells companies what measures they need to perform, when and in what order, how all the issues are interrelated, what they'll have to invest, and when these investments have paid off. Siemens may furthermore detail the roadmap into projects on request. In another definition (Siemens, 2020a), the roadmap is intended to help customers develop the digitalization strategy. The roadmap has the following compenents: Siemens industry best practice catalogs; opportunity and potential exploration via maturity analysis; value and solutions scope, via value maps; solution maps; scenarios; stakeholder prioritization; solutions review; solution specific benchmark; return on investment. Results are a value driven, phase solutions plan (Siemens, 2020a). Digital transformation will be the implementation of the digital transformation roadmap (Siemens, 2020a). This includes program management, change management, and key performance indicator tracking system (Siemens, 2020a). The identified financial key performance indicators offer the confidence to boost investment in the minimum time (Siemens, 2020a). Siemens supports customers with a digitalization roadmap that is innovative but executable and with realizable business value (Siemens, 2020c). Activities in the digitalization roadmap and transformation plan are: industry solution catalogs; benchmarking; solution reviews; stakehoder prioritization; plant clustering; process harmonization (Siemens, 2020c). The overview roadmap is value based and includes several stages, as follows. The consulting process begins with industry best practice catalogs, which includes technical solutions and associated value (PWC, 2018a; Siemens, 2020c). Siemens has a value and solution catalog, which includes pre-architected solutions and solution maps, value maps and scenarios (Siemens, 2020b). In several presentations, Siemens boasts Industry 4.0 use cases as basis for consulting (Siemens, 2017e, p. 14; Siemens, 2019a). Siemens has end-to-end solutions for all industries (Siemens, 2019c, p. 4).

At this stage, Siemens uses value maps, solutions maps and scenarios (Siemens, 2017e, p. 18). Siemens maps scenarios on value networks (Siemens, 2017e, p. 18). In manufacturing, examples of scenarios include: order-controlled production: describes dynamic composition of necessary production resources for an order; adaptable factory: focuses on a production resource with respect to an adaptable design and addresses the consequences for supplier and system integrator; self organizing and adaptive logistics: considers entire inter- and intra-logistics; value based services: describes the design of service value networks if product- and/or process information is provided based on an IT-platform; transparency and adaptability of delivered products: focuses on a product and describes design of transparency and adaptability of delivered products based on an IT-platform; operator support in the production: describes future support of operator in the production based on new technologies; smart product development for smart production: describes collaborative product engineering, starting with product requirements and designing seamless engineering workflows to deliver necessary information to production and service; innovative product development: describes new methods and processes in product development with focus on early phases; seamless and dynamic engineering of plants: addresses increasing dynamic in plant engineering and importance of validation of engineering decisions; circular economy: considers (delivered) products up to recirculation of its physical parts in an overall material cycle.

Digital transformation will be the implementation of the digital transformation roadmap (Siemens, 2020a). This includes program management, change management, and key performance indicator tracking system (Siemens, 2020a). The digital transformation journey takes the roadmap to programs

and projects (Siemens, 2017d, 2018d, 2020c). Roadmaps initiate, oversee and finalize programs. Programs initiate, oversee and finalize projects. Much of roadmap, program, project, solution architecture runs in parallel. Siemens (2020c) claims strategy and program management activities include: trusted advisory; lead architect guidance; design office across all projects; close linkage to Siemens research and development; risk mitigation and implementation hand-off; realization of solution services with agile practices. Programs oversee several projects from a hierarchical point of view (Siemens, 2020a).

Projects may plan and schedule the transformation journey (PWC, 2018a; Siemens, 2018d, 2020c). Digital transformation will involve one or several pilot projects and scaling (PWC, 2018a). Siemens has several use cases for digital transformation, inherent solutions and the activities to be performed in the digital transformation case (Siemens, 2017e, p. 14). Siemens explains the how in digital transformation involves identifying the most impactful projects in digital transformation (PWC, 2018a, 2018b, 2018c; Siemens, 2019c, p. 19). Siemens' presentations consent the projects are related to product design, production planning, production engineering, and foresee production execution (Siemens, 2019e, p. 24; Siemens, 2020b). The next stages (Siemens, 2020b) are: solution prioritization (based on stakeholder input and Siemens deployment advice), solution review (explore process and technology possibilities) and solution specific benchmark (baseline, set targets and compare to the industry using the maturity index). Solution reviews (Siemens, 2020b) help customers understand Siemens' best practice solutions, their capabilities from a process/scenario viewpoint, and the logic data model for solution elements to explain how the solution interfaces with other processes. The logic model includes the virtual simulation of activities, inputs, outputs, outcomes, impact (Siemens, 2020b).

The Why in Digital Transformation: The Business Case and Performance Contract

The initial maturity diagnostic will be followed by a roadmap, and investment calculation in the business case. The strategic roadmap consulting process culminates in a business case (PWC, 2018a, 2018b, 2018c; Siemens, 2020b). In Siemens' Digital Enterprise Consulting (Siemens, 2019c, p. 19; Siemens, 2020c). the business case culminates in the investment case. Siemens has a guideline for writing business cases (Siemens, 2020e). The business case is based on estimated changes of the indicators (Siemens, 2020e, p. 10) on the net present value of the incremental discounted cash flow. This enables a highly detailed computation of the business value for digital investment, which Siemens claims moves from predicted to proven for every contingency (Siemens, 2020e). Siemens has software tools to link the cash flow scenarios, and compute the net present value of discounted cash flow, internal rate of return and payback time (Siemens, 2020b). When the future is uncertain, discounted cash flow is not predictable. Siemens recommends using scenario planning and real options valuation, treating investment in Industry 4.0 as a call option (Siemens, 2020e). Siemens claims that two situations summarize their case experiece: efficiency increase and sales growth (Siemens, 2020e).

The end of the Digital Enterprise consulting process is the performance based contract between Siemens and customer (Siemens, 2019c, p. 19). In 2016, Siemens (2016b, 2016c) identifies three types of customer contracts: traditional contracts, performance based contracts, network platforms. Siemens' portfolio is centered on customer business value (Siemens, 2019i). Since 2014, Siemens has complemented technology with business intelligence and business models to create concrete quantifiable customer business value (Siemens, 2014). This procedure is used to approve development ideas internally. Since 2015, Siemens has made public the use of value-based contracts, which include performance based contracts and outcome based contracts (Siemens, 2015; Siemens, 2016b). They are financing performance contracts, where payments are predicated on the expected level of business benefit or outcome delivered to the business or government customer (Siemens, 2015). One form of value-based contracts are performance contracts (Siemens, 2016b, 2016c). These performance contracts enclose performance increase stipulations for identifiable solutions. Performance increase is predicted and guaranteed to the customer in this contract. In this type of contract, value is predicted and guaranteed to the customer (Siemens, 2016b, 2016c, 2017c). Siemens defines equipment and

technology finance as affordable payments where return on investment or other benefits accrue over the lifetime of the asset (Siemens, 2017c). In this form of arrangement, customer benefits are enclosed in the customer contract, as predicted and guaranteed to the customer (Siemens, 2017c). In 2016, an example of an outcome based contract was given by flexible service in any market condition (Siemens, 2016b). In 2017, Siemens explains outcome based business models to integrate technology and finance to deliver outcome-based solutions (Siemens, 2017c). The customer contract will enclose a value target agreed jointly between Siemens and customers, where the responsibility for the solution configuration lies primarily at Siemens. According to Siemens, outcome based business models are suitable for solutions rather than products (Siemens, 2017c).

The payment for the technology and its benefits is pay-per-use (Siemens, 2017c). The focus of this business model is on equipment and technology usage (Siemens, 2017c). Payment for this type of contract may involve what Siemens calls traditional financing or pay-per-se models (Siemens, 2017c). Siemens explains pay-per-use models are suitable mainly to supported a company's need to access the required technology in order to compete without requiring upfront capital (Siemens, 2017c). This allows the benefits of the equipment's use to be broadly matched to payments over time (Siemens, 2017c). In outcome based contracts, payment is based on return on investment (Siemens, 2017c). This means that investment the customer makes will be matched with the target return on investment which Siemens commits to.

The Solution Configuration, Development Implementation and Changes

In the following stage, PWC and Oracle work together to provide customers integrated solutions. At this stage of digital transformation, PWC offers pre-configured industry model solutions, which are configuration and integration ready. They involve repeatable playbooks or repeatable model systems. This is the strategy to execution stage, where PWC provides customers corporate and business strategy, finance, delivering deal value, technology consulting, people and organization, regulatory, risk and compliance, tax, assurance. Each Integrated Solution ties back to a value based strategic roadmap. At the end of the journey, business value is realized. At the sixth stage of digital transformation by PWC and Oracle, PWC has an agile framework that serves as the optimal foundation for incorporating Oracle Cloud Integrated Solutions. It is at this stage that the strategic roadmap is phased into programs and projects. Projects use minimum viable product and agile development practices.

Solution configuration is part of the project structure. In Digital Enterprise Consulting, Siemens also provides customers with pre-configured solution architecture. Siemens Digital Enterprise Consulting (2020c) provides customers solution reviews offers customer best practice solutions, and explains these solutions to customers. Siemens has end-to-end solutions for all industries (Siemens, 2019c, p. 4). Siemens' customers are presented the detailed solution architecture and proof of concept (Siemens, 2020c). At Siemens (2020c) solution architects assess, define and improve digital business process and solution architecture. They are in charge of: solution modeling and definition; proof of concept; gap mitigation; reference system topologies; plan network architecture; reference process alignment. Siemens supports customers by aligning, with technology openness, all solution components and constraints into a production viable architecture (Siemens, 2020c). Siemens calls this a use cased based approach to digital transformation, based on existing manufacturing experience since company foundation in 1847 and digital transformation experience already gained (Siemens, 2017e). The use case based approach involves an elaboration of problems and solution approaches for the heterogeneity of manufacturing industries. Siemens argues not every problem may be of interest to a particular customer, while a solution approach can address several problems. Siemens' use case based approach is rated by Siemens as crucial in its strategic priority to create solutions that generate customer benefits for Industry 4.0. Project management is supported by Siemens' and SAP's (SAP, 2020) joint solution for Product Lifecycle Management software and project management.

At Siemens (2020c) the final stage of the Digital Enterprise Consulting process is the implementation of the Digital Enterprise Consulting process. Professional engineers and subject matter

experts deliver application and optimization guidance services (Siemens, 2020c). The implementation stage involves activities: application guidance; co-development; method optimization; process/plant optimization; troubleshooting; laboratory services; productivity application development.

The Next Stage of the Digital Transformation Journey According to PWC's Predictable Value: Digital Innovation

In the seventh stage, PWC provides strategic advice and systems integration for Oracle's preconfigured industry model systems to allow clients to introduce emerging technologies such as blockchain, Internet of Things, artificial intelligence, robotic process automation, robotic processes. PWC boasts the capability to predict the outcomes for the solutions. This includes the benefits of PWC's integrated solutions that they solve complex challenges, prove assets, bring faster business outcomes, digital innovation. PWC's process of researching, prototyping, testing, and building solutions around the essential eight emerging technologies help to extend the value of our client's Oracle investments.

Siemens moves business models from managed service to software as a service, availability as a service, insights as a service, outcome as a service (Siemens, 2018c, p. 16). Business models are changed from transactional to outcome based partnerships (Siemens, 2018d, p. 16). Siemens also writes about two service models: pay-per-use a mature business model already described here, and pay-per-outcome business models (Siemens, 2017c). Siemens' value co-creation methodology is an additional methodology, suitable for innovative cases that do not match existing use cases (Siemens, 2018b, 2020h). Siemens' value co-creation framework enables Siemens to gain new business with the customer (Siemens, 2018b). It is intended to create new value-driving use cases (Siemens, 2018b). In 2020, the methodology is applicable on Siemens worldwide level (Siemens, 2020h). Advants supports co-creation (Siemens, 2020h). The co-creation method aims at the development of high-tech solutions and new digital business models (Siemens, 2020h). In a 2019 example of an outcome based contract, the Siemens CEO and the president of Nigeria have signed a contract based on a roadmap (Siemens, 2019g). The goal of the roadmap is to upgrade the electricity network to achieve operational capacity of 25,000 megawatts (MW) from the current average of around 4,500 MW, through a series of projects spanning three phases. Against this background, the Federal Government of Nigeria and Siemens have defined the Nigeria Electrification Roadmap in 2019 and signed the deal in 2019. The Roadmap is structured in three phases. Phase 1 is focusing on essential and quick-win measures to increase the system`s end-to-end operational capacity to 7,000 MW. Phase 2 is targeting remaining network bottleneck`s to enable full use of existing generation and distribution capacities, bringing the systems operational capacity to 11,000 MW. Phase 3 is developing the system up to 25,000 MW in the long-term. This includes upgrades and expansions in both generation, transmission and distribution. The resolution of the roadmap remains with Siemens. Atos (2021) and Siemens have partnered towards a common vision: co-creation with their customers and pay-per-outcome business models. The research is jointed towards artificial intelligence, edge computing, internet of things, cyber security. Siemens' deputy CEO and CTO, Busch (2017). promotes innovation and gives as example additive manufacturing co-created for customer Strata Manufacturing, an aircraft manufacturer. Busch also refers to co-creation in mobility (Busch, 2017, 2018). Co-creation was also used in smart city Hong Kong (Busch, 2019).

CONCLUSION

In literature review, digital transformation is defined as the impact of changes on several dimensions of the organization driven by digital technology or other factors, such as the business models it enables. At Siemens, digital transformation is defined as a change in the way value is created in an organization, via changes in business models, business processes, or organizational set-up triggered by digital technology. The definition of digital transformation reveals the essential role of digital transformation dimensions, which are also constituent of digital maturity indexes. Literature review,

citing management consultants and scientific literature review as references, and empirical data analysis, showing the consulting activities of PWC, Oracle and Siemens reveal an overview tool of digital transformation, the digital maturity index. The digital maturity index is a comprehensive overview tool that shows what is to be changed, that is the dimensions of digital transformation. Digital maturity indexes characterize the dimensions of digital transformation at each stage of digital transformation capability maturity. The practice of digital transformation consultants shows digital maturity indexes are the first instrument in digital transformation consulting, at PWC, Oracle and Siemens. These consultants use their own digital maturity indexes. With these consultants, digital maturity indexes are used to conduct market surveys, synthesize empirical knowledge for instance from use cases. Both Oracle and Siemens use this approach when solution architecture exists from use cases. The roles of the maturity index are: analysis, dianostic, benchmarking, shaping the digital transformation roadmap.

The digital transformation journey ties the starting point of digital transformation to the desired state of digital transformation. The digital maturity index is used to derive the digital transformation roadmap. Both literature review and the empirical cases of PWC with Oracle, Siemens show the roadmap uses the digital maturity index and is the next instrument in digital transformation. The roadmap may be graphically represented as a chart with the horizontal axis representing the time series, milestones which correspond to degrees of maturity. The vertical axes show the dimensions of digital transformation and the way the maturity levels impact each. Maturity analyzes are used to derive roadmaps, a project management tool. Roadmaps may be used to oversee programs and projects. Both literature review and Siemens' Product Lifecycle Management solution collaborating with SAP Project Management support digital transformation roadmaps, programs and projects for customers. A detailed approach is used in a predictible environment, for instance when use cases exist. When innovation is involved, the digital transformation decision may be made based on business models and roadmaps without further details. The use of the lean start-up methodology is consistent in literature review and the digital consulting experience of PWC, Oracle and Siemens alike as an alternative to classic project management in an uncertain environment.

Digital transformation is a market for digital technologies with key market players which address existing industries as customers. Literature review shows existing industries are expected to be disrupted in a digital vortex. The definition of digital transformation, digitalization and digital disruption share the value impact rationale of transforming from existing technology, automation, to future technology, digitalization. Digital transformation literature review shows market players and customers engage in as a service business models. These are focused on selling customer value rather than the product itself. As a service business models show scarce details in scientific literature review, which refer to cross-company transactions, contracts, know-how and capabilities. Digital transformation consulting by PWC for Oracle and Siemens shows two main situations: the predictable value approach and the innovation approach. When value is predictable, it is computed via business cases, stipulated and guaranteed in customer contracts for the marketed technology. When innovation is involved, Siemens co-creates value with customers, which means the customer value target begins the customer contract and that operational details are worked out afterwards. The customer contract will contain the value stipulation and not the inherent technology, which is developed subsequently. Siemens is explicit about using as a service business models to manage customer value this way. Literature review shows digital transformation is a brownfield approach to existing industries, which are motivated to transform existing businesses by investing in the new technologies in exchange for return on their investment. Concrete value is inherent to digital transformation and the rationale for the management decision.

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