Barbara Flügge *Editor*

Smart Mobility – Connecting Everyone

Trends, Concepts and Best Practices

Springer Vieweg

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Foreword

As we live in an ever more populated, urban and connected world, the need to better manage how we move people and goods around is apparent to many. Whether by moving less, or by moving more efficiently, shifts are evidently taking place across many regions and industries. From developments in public transportation in South America and high-speed trains in China to autonomous trucks and self-driving cars in California and Germany, we can see rapid change already occurring in some areas and appearing on the horizon in others. The principle of Smart Mobility as the overall encompassing concept for a more connected and efficient ecosystem is therefore both timely and relevant for many.

Whether a government, city, company or individual, understanding what new developments are taking place, where and how, as well as seeing the associated opportunities and challenges is fundamental to enabling the right decisions for the future to be made. This book is an important contribution to the discussion and helps to make sense of multiple different views in a coherent and accessible manner.

- By looking at the whole smart mobility ecosystem rather than prioritizing one facet or platform, it helps us see the bigger picture: seeing the interconnection between the digital and the physical worlds, addressing both people and cargo needs, and understanding the underlying building blocks for the new infrastructure, all provide this insight.
- Moreover, by exploring different usage scenarios, it also allows us to see the varied options that might play out: with no universal blueprint likely globally, many see that different mobility solutions will be applied in different locations to address different needs and, consequently, considering the varied possibilities from such shifts as car-sharing, mobile ticketing and dynamic pricing all helps to provide context for change.

With major trends such as on-demand mobility, driverless-vehicles and electric transport all now having an impact in leading locations around the world, having an objective and pragmatic view of how these may play out is important for all. Some countries' and cities' mobility solutions will advance quickly, others will take time. Some, especially in

fast-growing economies, will be able to leapfrog today's leaders, while others will struggle to catch up.

If you look 50 or so years into the future, many can see a world where mobility will be increasingly digital, clean, safe and efficient. The end destination is clear. What is uncertain is the journey that will, in some cases, be bumpy, lumpy and include a few wrong turns. In others, progress may be smooth. Seeing the possible and probable changes in context is a vital asset and books such as this make an important contribution to the mix.

Program Director, Future Agenda Tim Jones

Preface

Pragmatic optimism – this is how 2016's Pritzker prize winner Alejandro Aravena describes his approach to making holistic and innovative architectural concepts, deployable in economically disadvantaged areas or regions that have encountered natural catastrophes. Similar to an architect, the variety and complexity of ecosystems and their challenges drive my work. Ecosystems that make up our living and working spaces, either on-site or remote, compete for awareness, investment, project budgets and creative heads like that of Mr Aravena who resolves any disputes despite budgeting constraints and sheer hopeless conditions on-site!

Regardless of whether the ecosystems consist of 20 participants or several hundreds or thousands of organizations, each of them has legitimacy. And any of the ecosystems can be decoded via a method that has been researched over the past years. Technology is not the critical element necessarily. It is rather a synthesis of strategic, functional and technical elements flanked by innovation empowerment and the willingness to change that make the decoding happen.

Mobility is a basic need of human beings, one that seeks fulfillment on the one hand. On the other hand, mobility raises the expectation that designers and decision makers will treat mobility needs in a responsible manner. Locations without access are living spaces of the past, as everyone would certainly agree. But how far are we reaching out in our thinking and decision capabilities to connect everyone? Are holistic concepts realistically suitable for smaller ecosystems and medium-sized cities that have less budgeting and investment means and are faced with fading innovation capacity?

Throughout my work with decision makers, forward thinkers, public and private entities, non-profit organizations and start-ups the ecosystems' viewpoint has opened up the discourse and has been well received. Curiosity and interest do matter more than remote couch surfing. I am often questioned about which steps to take first. Hereby, I encounter the need for a procedure model and a roadmap that outlines these steps. Another aspect that is questioned by individual interest groups is the role of the many individual contributors: many acting in isolation or solely pursuing their vision of participatory mobility deployment. Who is supporting? How does competence building take place and who coaches? The extra mile is often up to single organizations, interest groups and employees. To those I dedicate this book!

I would like to sincerely thank all co-authors for their exciting insights and contributions that enrich, suggest and exemplify mobility matters and trends from various distinct viewpoints and levels of detail. I would like to thank Tim Jones for his introductory words and his contribution. Finally, my special thanks go to the Springer team for its support and help.

To all readers: I hope that you encounter new and exciting perspectives. Happy reading and I am looking forward to your feedback!

St. Gallen, 2017 Barbara Flügge

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About the Authors

Volker Alberts
Volker Alberts is Senior Expert in the field of urban mobility, in the past working for private and public authorities, always aiming to maximize the social benefits of new technologies and services in transportation and mobility. For more than a decade Volker Alberts has been engaged on issues relating to the next stages of the evolutionary history of the Austrian Mobility System. His current core activities tension on the guiding theme of Mobility-as-a-Service, ranging from shared mobility across urban freight logistics up to living lab concepts. Since the beginning of his career he advocates for the implementation and promotion of a modern, efficient and affordable mobility system at the national and international levels.

Hans Arby
Hans Arby is CEO of UbiGo Innovation and one of the key people driving the successful development and test of UbiGo in Gothenburg, a fully integrated mobility service for urban households and businesses. It offers a subscription to mobility instead of car ownership, combining modes such as public transport, car-sharing, car rental and taxis. He holds a degree in MScEE and has 25 years' experience in marketing, communication, sales and business development in different industries and organizations. The last 12 years he has focused on sustainable travel and ITS for the public and private sector.

Stefanie Baumann
Since 2015, Stefanie Baumann has been engaged as research consultant for the thematic area of "Connected and Autonomous Driving" at acatech – National Academy of Science and Engineering. Previously, she accompanied acatech projects relating to "Industrie 4.0" and "Smart Service Welt", worked at a Berlin-based start-up and within the field of renewable energy. Ms Baumann studied international business management and political economy with the main focus on innovation and technological change.

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Senta Belay is a senior solution specialist, focusing on the travel and transportation industry working at SAP. Working in the tech industry, his day-to-day job focuses on how to translate the tech industries' advances into tangible solutions in the business of running passenger rail, public transit and cruise line industries.

Senta has an MBA from CEIBS (China Europe International Business School), which is based in Shanghai, one of the Financial Times top 20 business schools to transition to the IT industry. He did his B.Sc. and a post-graduate diploma in the field of nautical sciences and holds a Class II/I Seagoing Marine Officer Certification.

Senta has travelled across the globe while working in the nautical profession as a sea going marine officer working for various companies globally before doing his MBA and transitioning to the IT industry.

Barbara Flügge

Dr Barbara Flügge is a recognized expert and thought leader in ecosystems thinking, innovations, and strategy deployment. To date Barbara heads the global initiatives Empowering Ecosystems. It concerns the next generation's apps and services for organizations and contextual ecosystems such as ports, airports, mega events, urbanizations and metropolitan areas. Barbara invented, managed and prepared the market entry for SAP Networked Logistics Hub, one of SAP's first Internet of Things offerings. As a core member of the SAP Business Web Initiative she counselled on strategic and operational elements of IoT and service offerings in digital marketplaces.

To date, analogous to the Smart Mobility Ecosystem, she designs Smart City and Ecosystems Blueprints. Her activities embrace Service Design including functional, operational and economic aspects of business services. Prior to her current role, Barbara Flügge held management positions within SAP Consulting, Ariba Inc. and Arthur Andersen Management Consulting. Her contributions and advisory reach out to local and international ecosystems and can be found in a number of activities around the globe for academia, businesses and start-ups. She chooses selectively where to present and publish. Barbara is also a recognized mentor within and outside SAP.

Barbara graduated in Information Management and Business Administration at the Otto Friedrich University Bamberg, Germany and holds a Ph.D. in Management and Economics from the University of Tilburg, The Netherlands.

Carsten Günther

Dr Carsten Günther joined Heidelberg mobil international GmbH as CTO in 2007 and has been acting as one of the Managing Directors since 2012. Prior to that he held different leading positions at IBM Germany. He co-ordinated the Europe-wide research and development activities of IBM in the area of telephony-related language technologies over many years. In 2011, Carsten Günther was elected onto the board of bwcon, the technology and innovation network of Baden-Württemberg (http://www.bwcon.de). There he is

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Ludwig Haas is a management consultant in the field of telecommunications and transport industries focusing on business-IT alignment.

After his graduation as an industrial engineer from the Munich University of Applied Sciences, he started his consulting career at Andersen Consulting in 1995 and joined Detecon in 2010 after a tenure at Ernst & Young Consulting in the USA and Western Europe, co-founding and building a niche consultancy for telecommunications enterprises. At Detecon, he consults clients in the travel and transport sector in Switzerland and Germany, designing and bringing to life solutions in pricing and service management, customer interfaces, digital transformation in public transport, and future mobility. Ludwig is a member of “Münchner Kreis” where engages in the expert group “Intelligent and Connected Mobility”, leading the group since 2016.

Ralf Helbig
Since 2002 Dr Ralf Helbig has consulted multinational and mid-size companies in their challenges of process and IT management and developing digital and IT strategies to foster the transformation into the Digital World. In 2007, he joined Detecon, first in Germany and is now responsible as Managing Partner for the sectors Travel, Transportation & Logistics at Detecon (Switzerland) Ltd. Before joining the consulting business Ralf was in Business Process Management and is still a member of the teaching board at the University of Bonn. In addition he is lecturing at ZHaW, the Swiss University of Applied Sciences based in Zürich, Winterthur and Wädenswil.

Tim Jones
Dr Tim Jones is a recognized expert in innovation, growth and futures. He is the author and editor of 10 books and a regular speaker on innovation leadership, growth platforms and future trends. For over 25 years he has worked with many leading multinationals, governments and universities identifying emerging opportunities. A leader in collaborative programmes, Tim has made his name in helping organizations to see the world through a different lens and so reveal new areas for potential growth.

Tim Jones is Programme Director of the Future Agenda – the world's largest open foresight programme. Initially supported by Vodafone Group in 2010, the research project is now in its fifth year. It is a major cross-discipline project that unites some of the best minds from around the globe to address the greatest challenges of the next decade. In 2015, the second Future Agenda programme looked at the world in 2025. In collaboration with 50 hosts worldwide, it explored 24 topics and included dialogue with experts from over 4000 organizations at 120 events in 45 cities globally. Complementary on-line and social media input has involved direct interaction with over 100,000 consumers and additional input from 180 countries.

The insights from the programme are freely shared via multiple platforms such as www.futureagenda.org, so that all can be better informed about what others think about the next decade and so make better decisions.

Matthias Jöst
Dr Matthias Jöst has worked on mobile, location-based services and geo informatics since 1998. Initially he worked as a researcher on pedestrian navigation in urban spaces at the European Media Laboratory GmbH and University Heidelberg. During this time he co-developed the Deep Map technology that was later transferred to the spin-off called Heidelberg mobil international GmbH. Matthias Jöst is one of the founding members and to date one of the managing directors.

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Dr Nicolas C. Liebau has a joint diploma in electrical engineering and business administration from the Technical University TU Darmstadt. He received a scholarship from Deutsche Forschungsgemeinschaft for doctoral studies at the Multimedia Communications Lab (KOM) of TU Darmstadt. In 2008, he obtained the doctoral degree (Dr-Ing.) in the field of accounting in peer-to-peer systems with distinction. He also received the KuVS dissertation award. Nicolas headed the Peer-to-Peer Networking research group of KOM from 2006 to 2009. Since then he has also been a member of the supervisory board of Montionet AG.

In 2010, Nicolas joined SAP Research, the research organization of SAP SE in the role of an intrapreneur in the area of the Internet of Things with the task of identifying new business opportunities for SAP in this area. In 2011, he took a strategic role in the SAP Business Web initiative that aimed at creating a new cloud platform for the Internet of Things and Mobile. He was involved, for example, in projects for SAP Networked Logistics Hub and SAP Asset Intelligence Network. In 2013, Nicolas transferred to SAP SE's Product and Innovations organization and joined the Internet of Things product management group. Since then as Chief Product Owner Nicolas is responsible for the new cloud solution SAP Predictive Maintenance and Service – Cloud edition.

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Heinrich Pfriemer serves globally as Global Head of Business Transformation Services Public Services. He guides his clients who come from higher education, defence and supranational organizations, on how to master chances and risks in the newly emerging digital age. In addition to the topic of mobility he focuses on UN Sustainable Development Goals implementations as well as on efficiency increases in the military supply chain.

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Michael Püschner is advisor at German Association of the Automotive Industry. Previously, he was head of the mobility focus area at acatech – National Academy of Science and Engineering and personal advisor to Henning Kagermann, president of acatech and

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Katrin Redmann worked in Marketing and Sales in different industries such as travel, retail, publishing and communication agencies and was marketing lead point of sales with Yves Rocher Germany. Working for SAP for over 18 years she has had several distinct positions, for example marketing lead financial services, senior alliance manager for strategic ecosystem partners, solution expert and design strategist in the co-innovation centre AppHaus in Heidelberg. In her current role as Country Manager DACH with University Alliance she acts as Innovation Lead, Design Thinking Coach and Business Model Innovation Coach. Currently, she is leading strategic digital transformation projects with customers, industry partners, students, start-ups and universities, such as the GESS Global Entrepreneurship Summer School and LifeScience Hackathon, and represents SAP in the Wissensfabrik–SAP collaboration as well as mentoring WECONOMY start-ups.

Introduction

1

Barbara Flügge

Abstract

How to address a trend that is overarching and embraces many distinct addressees and disciplines such as Smart Mobility? What is happening behind the scenes? Often labeled as Intelligent Mobility, Mobility-as-a-Service or Mobility 4.0, and understood as autonomous driving or intermodal traffic management, Smart Mobility has many faces and focus areas depending on local contexts and needs. Decision makers in cities, rural areas and federal institutions now have the opportunity to prepare the ground so that everyone and everybody benefits. Smart Mobility, therefore, should be seen as a visionary and feasible offering that influences our present and our future – regardless of our budgets, capabilities, competences, and needs, regardless of where the demand is being generated and where it is being fulfilled.

Mobility is all about freedom. Regardless of whether we are considering a person or an object, a group of people or a demand fulfilment process, mobility is all about being maneuverable in one or multiple geographies. How to make it real in the digital age is all about connectivity, taking chances, and transforming constraints into opportunities. The essential elements are all there.

Throughout numerous initiatives about intelligently connected cities – also referred to as smart cities or new cities – mobility has found a terminological home as one of the six design elements of a *Smart City* [1, p. 9]. The other five elements are Smart Governance, Smart People, Smart Living, Smart Economy, and Smart Environment. The fast-paced rise of mega cities make research and project undertakings focus on the design, feasibility, and challenges of urbanizations with 10 million or more inhabitants.

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It is nevertheless fascinating to devote design efforts to those urban settlements and reach new heights of digitally fostered architectural and planning excellence. However, existing and over-decades evolving small and medium-sized cities, large cities, and metropolitan regions as well as rural areas must not be neglected. No more than technological advancements, those aspects that foster the move into cities, such as medical care, employment, and shelter, should not be neglected.

Fostered through trend topics such as *car sharing, eMobility* and *autonomous driving*, the increasing scarcity of resources in relation to partly aged, outdated, and maintenance-demanding infrastructure in developed countries raises the question of who can rely on receiving a mobility offering at all.

Social allies that share communalities such as interest, a certain geography or travel targets count rather on the use of one vehicle and not the ownership. The *shared economy* is predicted to grow by 3000 %. Hence, who are the ones that going to share and what is being shared? Consequently, each of us turns into a service provider that is getting active in known and unknown territories. If we are not doing it, others will. Moreover, if we are not steering it, we get steered and our assets will be controlled by others.

Technological achievements and innovation with respect to sensor and navigation technologies, the connected environment through the *Internet of Things* (*IoT*), the advancing servitization towards an *Internet of Services* (*IoS*), enhanced with Augmented Reality and visualization techniques, make us think about a visionary, yet feasible, *mobility of the future* – hence *Smart Mobility*.

▶ Those considerations drive our definition of the term Smart Mobility: as visionary, yet feasible mobility of the future. It is applicable and capable of being used by anyone, independent of location or region, unbiased by utilization period and length, individual capabilities and budget.

From a *traffic management*' perspective looking at mobility in an isolated manner does not work. Isolated refers to scoping out, for example, a targeted geography or the city train network and its top 10 train connections between two cities, one which has an airport nearby and the other does not. Isolation does not work from a strategic and planning perspective either. The habitat and the exchange among consumers, as well as between consumers and service providers, influence the decisions as to what kind of mobility and to what degree should be and can be provisioned.

Especially in agglomerations that factor in a high percentage of construction sites and an unexpectedly high degree of commuters, one should seek a strategy that is adaptable. This could be because of a re-location of a company's site or the set-up of a training center. Support is out there in the shape of *predictive analytics*, simulation techniques to turn traffic information into a *smart traffic* offering and innovative concepts such as *Mobility-as-a-Service* [2].

We will not be able to address all our readers' questions in this practitioner oriented book. It is nevertheless our aim to present a practicable, deployable toolset that is beneficial to project managers, forward thinkers, and service and application designers.

Here we seek to break up the siloes of theme-by-theme discussions and give readers access to holistic concepts. Mobility cannot be divided any more into public transport and privately managed mobility pools or goods and people relevant mobility seen as being separate. Gated areas in agglomerations encounter an increase in construction measures and reduced infrastructure consumption. Those characteristics make us re-think what modernization and remodeling projects are really about: how can unused space in public transport be re-purposed to transport cargo? Wouldn't it be great to bundle grocery demands for entire villages and reduce the co-ordination effort?

This book introduces Smart Mobility from distinct perspectives leveraging organizational, functional, and collaborative themes and questions. We hereby structure the content along four main parts. Part I reflects upon the status quo of mobility and introduces a number of measurements. An introduction into *ecosystems* thinking sets the stage for a holistic view into the various stakeholders and elements of mobility. Following the introduction of further terms we focus on the evolvement of the digital economy and how it triggers the design of the *Smart Mobility Ecosystem*.

Therefore in Part II we dedicate an entire chapter to the art of the possible and where and how Smart Mobility can make a difference: these *Usage Scenarios* are being elaborated from distinct stakeholders' points of view. Digitization itself urges decision makers to cope with change in a constructive and future oriented manner. They are a result of our efforts from the past years and hopefully inspire you in your own efforts.

In Part III, we focus on the design and deployment of Smart Mobility in great detail. We introduce for the first time the *Building Blocks of Intelligent Mobility,* the accompanying *Reference Architecture* and we introduce the *Smart Mobility Procedure Model*. These three assets will evolve hopefully through your project insights, feedback, and updates you might want to share with us.

Part IV focuses on action items and recommendations. Being innovation management, an elaboration of governmental influence, or the gap analysis on your organization's and ecosystem's maturity, we fully packed this last part of the book with a number of hands-on tools and ideas.

The trends, concepts, and best practices we introduce address any region and context. If not stated otherwise, they are applicable to passengers, goods, as well as services. Our eye on the context ensures that a one-size-fits-all approach is carefully leveraged where feasible and applicable to serve an ecosystem's mobility strategy. Hereby, the vision is to connect everyone throughout an overarching mobility concept that deploys the right to mobility.

We are looking forward to hearing from you via our direct contacts or through the website featuring the work: http://www.digitizingecosystems.com!

Part I

Mobility is Everywhere

Reflecting the Status Quo

2

Barbara Flügge

Abstract

It is everybody's right to be mobile. The current status quo is in flux as a greater demand on mobility and transport driven resolutions have emerged through established and new actors on the scene. Insights into mobility provisioning, mobility preservation and safe travel and sustainable offerings will be given throughout this chapter. Today, public and private actors are confronted with decisions about investment and infrastructure efforts that define the maneuverable space for tomorrow. Therefore insights into key parameters and measurements are being introduced, too. Those concern both individual and cargo transport needs. You will also find insights into traffic management systems and technological trends such as the Internet of Things and Industry 4.0.

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Who decides upon future mobility offerings? How do infrastructure measures look like in detail and how do condition frameworks appear?

The challenges that are apparent for any location around the globe are based on the need to maintain a *healthy hub economy* and participation in global trade. The challenge for mobility consumers is the design of a perfect mobility offering based on the consumers' needs and receive an optimal mobility result based on the variables of time, budget and comfort. In today's world the calculation is mostly done by hand and we as consumers need to invest time in it. Those efforts mean extra time and additional costs. Based on our own research the investment in a 1 or 2-day business trip requires up to 1 hour per trip in planning! These opportunity costs could be better used. What do you think?

An increasing world trade volume leads to a higher turnover and more services needs in hubs such as ports, airports and cities. Despite stagnating numbers and an increase in world population it is expected that two to three times more container and tonnage turnover in ports and airports will affect infrastructure over the next 5–10 years. Today's apparent and observable infrastructure burden is, on the one hand, a result of an increased goods turnover. On the other hand, cities, ports and airports have limited space and infrastructure available to cope with the increasing turnover and handling demand. The increase of demand fulfillment goes hand in hand with infrastructure consumption, too. Infrastructure embraces manufacturing sites and machines, ground, soil, energy and water. Moreover, means of transport, packaging, storage, loading and unloading facilities count as infrastructure assets.

The effect on infrastructure burden increases through the rise and expansion of the mega cities. Landwise the world's cities occupy just 3 % of the World's land, but account for 60–80 % of energy consumption and 75 % of carbon emissions. It is an outcome of technical advancements as well that the rise of entire cities does not take more than a decade anymore. The speed of urban development accelerates. Subsequently, the speed of building leads to an enormous consumption of required water supplies, soil, energy and further natural resources. These resources do not have the luxury or the capability to mobilize themselves and speed up in their own nutrition and energy lifecycle. Nature is not able to catch up.

Regardless of the size of an urbanization, its competitiveness depends on efficient, internal, operational procedures and an inter-organizational choreography of infrastructure needs. Concerning the latter aspect, enterprises and authorities seek to connect in an intelligent manner with all participating units on-site and virtually. In the course of our project efforts we were encountering in particular the following two barriers:

1. Missing interaction capabilities among business partners and data source providers leading to manual efforts, process breaks, delays and error prone decisions.

2. The choreography of goods, means of transport and personnel often takes place in a bilateral, hence one-by-one, manner and without knowing about influencing factors such as geo positions, congestion issues, construction areas, weather and available space.

Many questions arise. How is mobility affecting us? How is mobility being affected by global trends and developments? How can we firstly measure the degree of mobility of an urbanization – whether it is a city, a hub or a country? In the following text we are getting deeper and deeper into the topic. First, an overall perspective is presented from the Future Agenda perspective. Next we introduce measurements, discuss those and then present the resulting conclusions, innovations and arising requirements that result from an overall interest in the new kind of mobility. In this chapter we focus on the common criteria, meaning traffic volume of passengers and freight, economic contribution of mobility, infrastructure provisioning, impact of traffic volume and role of traffic management systems.

2.1 Mobility – Change for the Good

Tim Jones

There is a Chinese proverb "if you want to be rich, you must first build roads". Car-based systems have brought much accessibility, connectivity and convenience but at the cost of introducing noise, pollution, significant land-use needs, urban sprawl, urban decay and, in some high-use areas, increased social isolation. Given the growth of alternative transport options, private cars are also an increasingly inefficient way to travel. So perhaps roads, or more specifically roads for traditional cars, may not make us rich for much longer?

The US Federal Highway Administration says that every 1 billion USD invested in highways supports 27,823 jobs [3]. Globally, many road-building strategies rest on that premise and the CIA Factbook estimates that in 2013 there were over 64 million kilometers of roads in the world [4]. Nations like the USA have become very car-dependent. This is compounded by under-investment in maintenance of other forms of transport. But not all countries are equally committed. According to the World Economic Forum Global Competitive Index, the United Arab Emirates (UAE) and Singapore top the rankings for all transport infrastructure, and in the European Union (EU), the Netherlands is the highest-ranking country and the fourth overall [5].

According to the OED mobility is "the ability to move or be moved freely and easily" [6]. Many would agree with this and see that it applies equally to the movement of people, goods and ideas. As we work to improve how people and things move across the globe, across countries and between and within cities, learning from others and adopting and adapting their successes is key.

Demographic and social change is fundamentally transforming where and how we live. At the same time globalization, digitization and significant shifts in geopolitical power are challenging the traditional movement of goods and services. Everything, it seems, is on the move and governments the world over are trying to adapt. In an increasingly connected

and populated society, many see the future of mobility to be a major focus for the next decade and beyond. There is a pressing requirement for greater capacity to manage the inevitable changes in global trade and the ongoing movement of humanity and, as a result, the basic transport infrastructure, our roads, rails, air and sea routes, must be transformed. This requires investment, co-ordination and a large dose of imagination.

A Prosperous Future? As we look ahead, 5, 10 or even 20 years, there are a number of mega trends that are having an impact on mobility. These include demographic changes such as population growth and urbanization; the proliferation of interconnected systems including smart cities and autonomous cars; and inequality of access including access to mobility both in urban and rural environments.

According to the London School of Economics' Urban Age project [7], in 2015 every hour over 40 people moved from rural areas into the likes of Mumbai, Karachi, Lagos and Dhaka – all one-way traffic. The United Nations (UN) estimates that around a third of the urban population currently live in unplanned areas – townships, slums, ghettos and favelas. What's more, by 2030, just under 9 % of the global population will be living in 41 megacities. This mass movement of people is having a huge impact on the look and feel of our cities and consequently the infrastructure needed to support them.

In a few countries where new cities are being created from scratch, the ability to embed intelligent mobility solutions from the very beginning is an obvious option which many are taking advantage of: from Songdo in Korea and Masdar in Abu Dhabi to multiple examples in China, technology and new design concepts are being used to realize the vision of the Smart City. However, it's not so easy for existing cities, where legacy infrastructure, sometimes over 100 years old, is difficult to upgrade. Roads and train lines cannot easily be re-routed and building new underground networks is extremely expensive, politically challenging and time-consuming. Indeed there are only a few examples of new infrastructure being built.

Sometimes the best examples of good practice come from unexpected places. Take Bogota in Colombia, which is widely praised for its TransMilenio bus rapid transit; one of the largest and fastest in the world, now moving 2.4 million people every day on dedicated lanes with fast access platforms. Far cheaper than installing a subway system, this has become a global reference for many. Medellín, also in Colombia, is where we find the Metrocable, a gondola lift system designed to reach some of the least developed suburban areas of the city. It is the first system in the world dedicated to public transport and, in comparison to alternatives, benefits from cost-effectiveness, low emissions and energy efficiency. This too has sparked imitators.

Some cities are now shifting their attention from keeping cars moving to making it easier to walk, cycle and play on their streets. Central roads are being converted into pedestrian promenades, cycle lanes added and speed limits slashed. As one of the first to close large parts of its center to vehicles during Sundays and bank holidays, Bogota again was ahead of the game and has set in train imitators from Sao Paulo to Paris. More well-known and building on lessons from Copenhagen's Bycykler program initiated in 1995, the Paris Vélib' public bicycle sharing system now has over 23,600 cycles across 1800 stations and has been copied by many other cities around the world including London,

Helsinki, Boston, New York, Montreal and Hangzhou. Elsewhere, we see other notable projects underway including introducing high-speed trains, faster subway networks and even moving pavements and escalators – all are being used to accelerate personal mobility between and within cities.

Future Agenda Views In all of the locations where Future Agenda ran workshops in 2015, from Mendoza, Singapore, Dubai and London to New York, Wellington, Shanghai or Mumbai, there was a widespread agreement around the need to bolster up the global transport infrastructure to provide for more in-built flexibility. Policy makers increasingly want to make bets on longer-term options designed to adapt to changing technologies and infrastructure use and most agreed that the adoption of multi-modal hubs was one way in which this could be achieved – not just in the mega cities, but also around the growth of more satellite cities and networks of midi-cities, particularly in Asia. Many of those in the West were also concerned about the funding challenge acknowledging that governments are increasingly unable to fund the maintenance of existing transport systems, let alone invest in new infrastructure irrespective of location. Who will take on the responsibility for future infrastructure investment was a widely debated issue.

The following considerations are a result of "Change for the Good" insights we gained throughout more than 125 workshops we conducted.

Multi-modal Public Transport The idea of multi-modal public transport is increasingly gaining traction and going forward EU research [8] sees that it "has the potential to contribute to a cleaner, smarter and more sustainable transport, shifting mobility of passenger and goods from road, making optimal use of infrastructure and reducing costs". Key examples of integrated and "low-friction" experiences include those in European cities like Mendez Alvaro in Madrid, Birmingham New Street Station, the new Wien Hauptbahnhof, Helsinki's Kamppi bus station as well as Asian examples such as the SMRT Sembawang Bus Interchange in Singapore and the KL Sentral hub in the heart of Kuala Lumpur.

Similarly for goods, multi-modal hubs are gaining attention whether they be integrated facilities, including those run by DHL in Leipzig or the UPS Worldport hub in Louisville, or new logistics hubs such as those being built in India in Gujarat, Punjab, Rajasthan, Uttar Pradesh and Maharashtra [9] and many in China including the Zhengzhou CGO multimodal logistics facility [10].

Beyond this, the benefits to be gained from bringing the same level of efficiency to the last mile as there is to the first 1000 are also attracting much attention and innovation focus. Whether the winners will be Amazon's proposals around drone delivery or the more pragmatic, locally pooled collection points remains to be seen; certainly many options are now being trialed.

Autonomy The much-hyped concept of autonomous and driverless trucks is starting to have an impact. The vision of long-distance truck platoons all running on intelligent highways without drivers has been a controversial topic over the years but now, as shown by the recent licensing of Daimler's self-driving trucks in Nevada, its reality is not far away.

There are also a number of simpler developments taking place which further facilitate the movement of goods in cities. In order to reduce congestion from goods deliveries, Stockholm is just one city experimenting with night-time access for trucks while elsewhere in Europe and the USA, the start-up, Starship [11], is using small, robotic, driverless delivery vehicles available to customers [12]. Taking all these together, much is already underway to enable free and easy movement.

What remains to be determined are the all-important issues that sit around the core platforms. Mobile operators are already sharing data, but key questions yet to be addressed include who owns the shared data required to make the whole system work, and how is it accessed? This is matter of trust, value and liability and, depending on where you are in the world, the balance between government, technology companies and vehicle manufacturers will shift significantly. By 2025, we will certainly see more assisted driving and autonomy on highways for both cars and trucks, where everyone is going in the same direction with controlled entry and exit, and maybe there will be full autonomy in cities for goods delivery pods. At the moment, though, it looks like full autonomy in cities for passenger vehicles is a few years away.

Integration Looking beyond city-based logistics, global mobility is being shaped by evolving geopolitical change. Since the onset of the global financial crisis many would argue that emerging markets are now the main drivers of growth providing a willing workforce and a growing middle class with money to spend. In 1987 these countries made up just 16 % of global GDP, but today they account for 31 %. The opportunity this presents for the movement of goods is enormous, not only due to new and growing domestic markets, but also because many emerging economies, in Africa and South America for example, are richly blessed with the raw materials needed for growth and development; these need to be transported around the world, in particular to China and India.

As a result of this, the next decade will see the post-war trade routes gradually being eclipsed by the power of the Indian Ocean region where new port construction and proposed railways stretching from China to Turkey are the shape of things to come. Adding in major activities in South America such as new coast to coast railways, China's influence is growing: it owns five of the world's top 10 biggest container ports and is making huge investments in other developing markets, rich in natural resources. Boasting about a quarter of the world's container trade and as the largest foreign investor in Brazil, Laos, Myanmar, Iran, Mongolia and Afghanistan, its commercial power is indisputable. How it will integrate alongside other new and important markets into the global trading system remains to be seen.

Investment With regard to funding, many people agreed that the development of the Public-Private Partnerships approach is one which is particularly suited for twenty-first century needs. The theory is that private involvement will improve the quality of projects. A politically expedient but financially dubious initiative is unlikely to generate enough money to interest private investors. Unnecessary enhancements, short cuts or careless construction are also less likely to be tolerated. However, bitter experience shows that cost-benefit

estimates can sometimes prove wildly optimistic, as shown by the still only half-completed Sea Bridge in Mumbai. When projects over-run or run out of budget, leaving half-built roads or bridges that go nowhere, they become a public problem. Another negative is that big, iconic, infrastructure projects in some cities also take money away from local improvements. Also private investment might well end up being recouped in higher user fees, road tariffs and the like.

Prosperous cities are most likely to be able to generate big contributions from the private sector and thus often enjoy better infrastructure investment. For the city of Chicago alone the American Society of Civil Engineers reckons that underinvestment will end up costing each family in the USA about 10,600 USD between 2010 and 2020 and lack of funding for Washington DC's comparatively young subway system has meant that more people are turning to street cars (or taxis) to get to and from work, which causes unnecessary congestion in the already crowded streets of the capital. Despite this, continued austerity drives in Europe and the USA, mean that public-sector investment is projected to fall; in the UK from 3.2 % of GDP in 2010 to just 1.4 % in 2020. On the bright side, lack of funds can often stimulate imaginative measures to make effective use of the money available and sometimes the little things really can make the difference: traffic lights, the repair of pot holes or removing the connecting doors between railway carriages.

A major step forward is the US Department of Transport's Smart City Challenge [13], a focused accelerator model for improving urban mobility. After an open competition between cities across the USA, Columbus Ohio is receiving over 140 million USD of focused funding and will work with multiple private and public partners to reshape its transportation system to become part of a fully integrated city harnessing the power and potential of data, technology and creativity to re-imagine how people and goods move about.

Combating Inequality Inequality of access to healthcare, education and the growing digital divide between communities was a common issue across many of the Future Agenda discussions. The lack of decent transport links has huge consequences. Examples abound: in Nigeria, for example, where only around 20 % of the country's roads are paved, the tomato-growing farms and factories which make tomato paste have pretty much stopped producing because, without roads to move it and a network of refrigerated warehouses to store it, about half the crop is lost on the way to market. As a result, a country that should be exporting this product on a large scale currently imports about half of what it needs and high transport costs mean that food is expensive. Moreover, with big cities such as the capital, Lagos, bursting at the seams, workers have to travel for hours to get to work, wasting time and money.

Transport poverty, isn't just a developing world issue – the charity Sustrans says that it's a daily reality for millions of people across the UK as well [14]. The less well-off typically suffer most from a lack of mobility options and are often exposed to greater pollution and unsafe conditions [15]. To counteract this, avoiding the spatial marginalization of areas inhabited by low-income populations, improving (heavily relied upon) informal transport options, facilitating bicycle ownership for poor and low-income groups and providing

an adequate infrastructure for pedestrians (safe walkways, seating, toilet facilities, etc.) [16] are all vital. Fortunately, there are, however, many good examples to learn from. For instance, Hammarby Sjöstad is an eco-friendly urban development in Stockholm, and its sustainable transport mix features a tramline, bicycle and pedestrian networks, car-pooling and a ferry. Infrastructure here was planned as "closed loop" systems for water, waste and energy – all feeding each other [17].

Access Some argue that there is a need to focus less on providing transport and more on providing access. In its Future Demand Scenarios, looking forward to 2042, the New Zealand Ministry of Transport states: "We should recognize we are trying to improve access not just mobility. There are three different ways we can achieve this: with good transport systems; with good spatial planning; or by improving digital access" [18]. Others referred to the introduction of more balanced triple-access solutions for transport where physical proximity and digital connectivity allocated an equal role to mobility options. An important feature for some is the opportunity to use dynamic pricing to help balance supply and demand.

Already seen in many road systems as well as on Japanese and German trains, the principle of more sophisticated approaches to charging variably, beyond just peak and off-peak, is being investigated in a growing number of wider mobility solutions. Uber's surge pricing is often highlighted as a potential way forward but others see the need for a more subtle approach. Especially when linked to more open data sharing on vehicle occupancy, emissions and purpose of journey, the ability to price mobility differently for different system users is turning towards more dynamic platforms.

As we enter the more integrated, multi-modal digital mobility era, much emphasis has been placed on the opportunity presented by personal mobility accounts; essentially a virtual wallet and information resource for all transport options. Many saw that this would be recognized and accepted by everyone in the transport eco-system. Most likely integrated into smart phones, and later potentially embedded into wearables, not only will these provide access to the full range of public transport options but also to all the add-ons such as car-pooling, car-sharing and on-demand services currently growing globally. Linked to multiple marketplaces they will allow us to make more informed mobility decisions, choosing options based not just on cost and speed but also on health, space and social criteria.

If mobility is indeed "the ability to move or be moved freely and easily" then there are clearly many ideas of how to better achieve this in the mix. No two cities are the same; each has its unique characteristics, so there is no global blueprint for the best place for us all to live.

2.2 How to Measure and Compare Mobility

Barbara Flügge

Getting into the driver seat, as urged in the introduction, requires an insight into mobility related criteria and the related issuing parties. A large number of measurements are being published: being federal and national statistical offices, federal and national road transport

authorities, or federal and national offices of economic and export control. Those bodies define, publish and keep mobility measurements up to date. In the following we selected a handful of references and parameters that are useful for national and regional, but also international comparisons and activities.

The German report called "Verkehr auf einen Blick" (Engl. Transport in Brief) outlines the key movement with respect to mobility development efforts in Germany [19, 20]. The Swiss report "Mobility and Transport Microcensus 2010" provides, in the multi-language report, insights into mobility consumption and a survey conducted among Swiss citizens about mobility and service requirements [21]. The Austrian institute called AustriaTech is acting as advisory body to the Austrian Ministry of Transport in research, deployable solutions and future trends in mobility [22].

Concerning freight and goods related measurements we encounter logistics associations and representatives of the transport industry. Furthermore, a comprehensive set of material, projects and assessment are being issued by European and internationally acting committees and foundations such as the International Transport Forum (ITF), the Intelligent Transport Systems (ITS) initiative, and CLECAT, the European Association for Forwarding, Transport, Logistics and Customs Services as well as the Smart Freight Leadership Forum. Automobile associations such as FIA (Federation Internationale de l'Automobile) [23] and UITP, the International Union of Public Transport [24], facilitate and drive the discussion about intelligent mobility.

Overall measurements are applied by the means of transport that have been chosen. In some studies we now encounter more measurements about cycling, the expansion of bike lanes and the usage of e-bikes. The trend of car-sharing continues to grow – once launched by ZipCar [25] and globally forced into the market through disruptive and in some geographies aggressive enforcement as conducted by Uber.

Throughout this book we will illustrate mobility measurements using text and graphics. A pure arrangement of data will not serve the purpose from our point of view and distract from the real message we want to communicate.

The figures and insights we present are based on publicly available material. Where applicable and sound we will provide insights into distinct countries. There will surely be a point in time that figures and data will be outdated or that are missing from an individual reader's point of view. To our utmost effort, updates will be handled in subsequent editions. Thanks for your understanding.

2.3 Traffic Volume in Passenger Traffic

Barbara Flügge

Traffic volume to date is being looked at from a passenger and goods / freight perspective. Volume in passenger traffic is distinguished by chosen means of transport and travel purpose, i.e. purpose of the journey. Examples of travel purposes are trips for leisure, shopping or to work. Another term that is in use is transport "motif". The following assessments for Germany exemplify the approach [19].

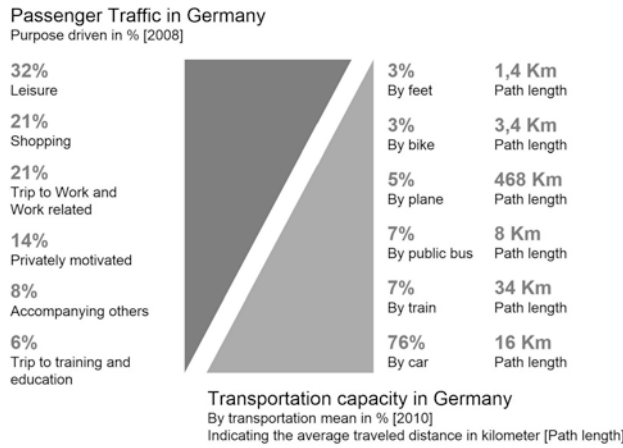

Fig. 2.1 Passenger traffic and capacity overview

From 2004 to 2008, on average each year 100 billion passengers chose transport services. The motives and the chosen means of transport are depicted in Fig. 2.1.

The referenced study does not reveal any detailing about *means of public transport* such as bus, taxi or car-sharing. Neither are distinctions made between publicly operated bus services or privately offered bus operators that emerge, for example, on municipality-to-municipality routes. An example is Flixbus [26] or the Postal Bus [27]. The latter operated until recently independently and has now been acquired by Flixbus. Compared to the German statistics detailing, the Swiss Federal Motor Transport Authority (ASTRA) [28] issues that level of detail for Switzerland.

Another means of transport that has being neglected in the referenced studies is the vessel. Same accounts for the relevance of vessel triggered mobility needs. A glance into the cruise business tells another story, a story of relevance. More than 50 % of cruise passengers reach the location of departure, the cruise terminal, by public transport (for example by train) – mostly in conjunction with further services such as city tours or an optimal use of the available transit time. It is highly recommended that you assess *cause-and-effect cycles* to depict the end-to-end mobility needs. It is also recommended to start engaging all relevant stakeholders in one mobility management effort. Only then decisions are made coherently. In the tourism segment, next to cruise travel, travel-by-bike is one of the largest-growing travel segments. And this effect is not only driven by the demands of the 50+ generation!

Another issue with the available level of detail concerning statistics is the following. With regard to car usage, knowledge about the volume of purchased and leased cars is mapped onto the measures of new vehicle registrations. Deriving decision criteria from those figures to distil further mobility management matters is not possible either with the currently available material.

An analysis by distance covered would reveal further insights. It is worth to compare the distance covered by a consumer in a familiar, known area with the distance he covers in an unknown area. This would disclose a different view on mobility consumption and required options of means of transportation. Known areas are those such as the working location, the training facility or the most visited city. In those comparisons of travels to known and

unknown territories, influencers make us change our focus on which mobility options to consider at all. Influencers are for example the acceptable radius of movement and the traveler's perceived comfort and safety level are made apparent. Furthermore, the assessment of a distance that is being covered in a public transport service portfolio signals the willingness of a mobility management office to invest in mobility. It can be generally said that short distances that are being covered by means of transport focus rather on city center or special interest areas. Medium distance that are being offered by public transport take into account the commuting needs and the regional spread of living, training and working locations and the urge to facilitate the commuters' efforts. Long distance offerings are mostly targeted to commuter communities as well as increasing the reach of service and education facilities for families and children.

When choosing a means of transport or deliberately walking, a traveler's fascination to explore the site could be another influencing factor. Another reason could be simply the available budget. The tourism sector introduced to the market some years ago new transport pass and exploring-the-neighborhood offers. Often those offerings are tradable via City Apps and navigation solutions to make exploring-by-feet consumable.

Coming back to the aspect of comfort that is being offered by means of transport we tend to opt for a taxi in an unknown area rather than taking a public bus or walking. The presence and guidance of a person that is familiar with the location is perceived as being safer, even for smaller distances. The perception of safety is not the only aspect that concerns travelers, also the targeted district and community. The Safe Cities Index issued by The Economist claims Mobility Security as one of the four criteria of a safe city [65].

2.4 Buying and Consumer Behavior of Individual Travelers

Barbara Flügge

The following figures and comparisons serve as a snapshot of a vast variety of statistical information at the municipal, regional and federal level. Any parameter could serve to compare one geography with another. However parameters need to be looked at from a contextual viewpoint and should not only take demographic, political and cultural habits into account. They should also look at external factors such as climate change, innovation movements and role shifts between governmental and private transport providers.

The average spend of households for mobility in Germany accounts for €346 per month [20, p. 5]. Minus vehicle tax and car related insurance the amount of €305 per month is the same amount that is for example being spent on average for food, beverages and tobacco [20, p. 26]. Car and fuel are the two dominant cost parameters according to Fig. 2.2. Thirty-five euros are spend on public transport. Car ownership therefore is the most investment related element in private mobility budgets. In contrast, the ownership of a bike is calculated at €6 per month and results in the most cost effective means of transport.

The utilization of cars in cities is typically expressed by the number of cars per 1000 of the population. In Europe, for example, Germany ranks in ninth place with 517 cars per

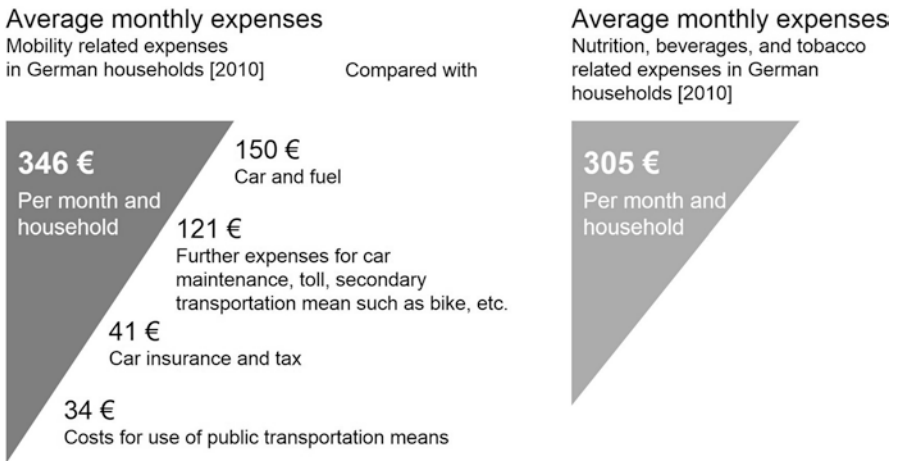

Fig. 2.2 Mobility spend in private households in Germany

1000 inhabitants in the year 2010, behind Luxembourg with 659 cars and Italy with 606 cars [20, p. 52]. In China about 69 cars per 1000 habitants has been counted.

With respect to car ownership in Germany, 78 % of all households owned a minimum of one car in the year 2011 Fig. 2.3 [20].

The share of bikes in German households is high with respect to households with children Fig. 2.4 [20].

It has become evident that the original trigger for mobility does not allow a reliable conclusion about the chosen means of transport. Geo-dependent purchase offers and commercials that are being disseminated via smart phones and tablets inspire, for example, those that are on the road for leisure. The travelers then leave the bus at the next stop to visit the department store and shop for the promoted item. As soon as the travelers (shoppers) finalize their purchases the decision is made to opt for car-sharing. The reason could be owing to the size of the bulky sports item that got purchased or because the happy customer likes to share the experience with others spontaneously and in an informal manner. Hopefully, in a car shared with other sport enthusiasts!

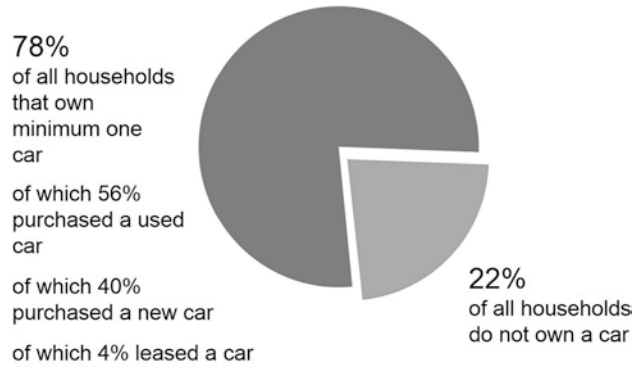

Fig. 2.3 Car ownership in German households

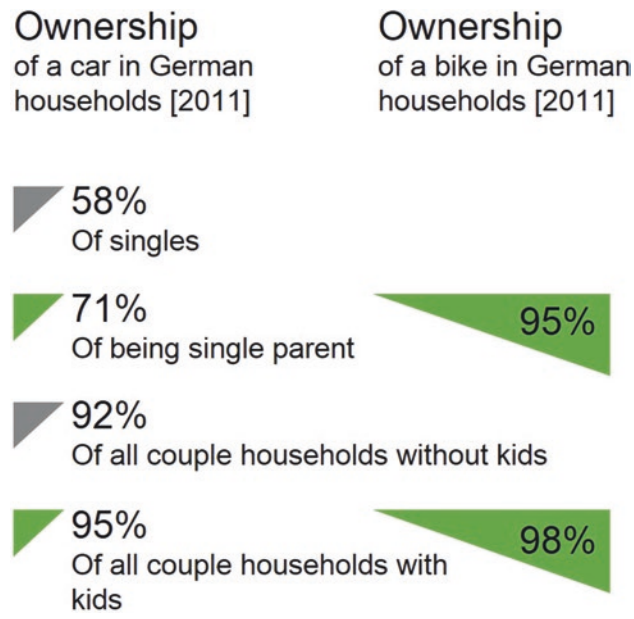

Fig. 2.4 Share of bike and car ownership in German households

Furthermore, external matters such as weather conditions, delays, congestions, cancelled bus or train services steer the last-minute, ad-hoc decision on which means of transport to choose. We refer to that phenomenon as a *situational mobility decision*. Predicting which means of transport is being chosen and which one not is then subject to the intelligent use of analytical tools and geo-referenced allocations. One of the key prerequisite is the consumers' willingness and openness to share a minimum set of their habits to do with their mobility processes.

How ready are we as mobility consumers to trade mobility in a digital sense? What does it take to open up our sharing habits and preferences? Looking into the percentage of on-line and digital consumer demand and demand fulfilment the numbers are still growing. As reported for 2014, 491 million of the 817 million people that live in Europe use the internet and 274 million of them are electronic shoppers [29]. A further effect that manifests digital competence and therefore expectations built among consumers is grounded in the enormous boost of product variances. Consumers' demand for more and more personalized products and services is made possible through technical advancements. Demand is being fulfilled in a much greater variety than we imagined a couple of years ago – for example, a high-value car assembled to meet our needs, the design of a pair of sneakers we want for a special sports event, our favorite burger composition or the coffee compilation we pick up before heading into the office. Personalized and preference driven offers give the physical touch back to online shoppers, allowing them to feel acquainted with the experience that they usually encounter when entering a shop. Information Technology (IT) even more brings back a 360° experience: being it the augmented interior car experience or the encountering of accessories that could pimp up a product, a delivery or provide further extra value to the consumer.

The evolvement of digital shopping behavior is not far away from considering arguments that the habits of travelers change. Change of habits come into play when deciding upon driving a car, sharing a car or taking advantage of a bus ride that offers a 10-minute podcast that is exactly meeting our interest and moreover fits exactly with the length of the ride. Being digitally trained to get any variance more or less on-line and in an electronic fashion, the ultimate mobility experience should meet our expectations, too. In the latter example the podcast accessorizes the mobility offer and aims to convert a product use (the car) into a service consumption (the bundle of bus, podcast and simplified consumption)!

Arguments about owning a car being the highest degree of accessibility and an expression of individual freedom and luxury do not add up anymore with car-sharing initiatives such as ZipCar [25], Uber [30] or the founders of the *Mobility-as-a-Service* (short *MaaS*) alliance. Founded in 2015, the MaaS alliance aims for a paradigm shift from owning to consuming, hence from owner to consumer.

To gather insights at first hand we conducted an interview with Hans Arby, CEO UbiGo Sweden, as one of the key promoter of MaaS. The interview can be found in Chap. 17, as well as a reflection upon the *sharing economy*.

2.5 Travel Business as a Key Contributor to Economic Growth

Barbara Flügge

The economic power of the travel sector has grown further over the past decades. Adjacent and post-travel related industries as well as cargo and individual transport rely on the economies of scale of the travel sector. Adjacent industries embrace hospitality and tourism services in a wider sense. Post-travel related businesses target location-based services. On a global scale a revenue of $7.17 billion was generated in 2015 in the travel and tourism segments as well as connected segments [31]. The underlying travel expenses relate to both, private and leisure motivated trips as well as business trips for individual travelers.

Some $2.23 billion, or 31 %, has directly benefitted market participants in the travel and tourism segments [31]. Expenses relate to incoming revenue from airlines, hotels, and the railway sectors. However the indirect segments are the ones that make a profit from the main body of the revenue, some 69 %. Let us elaborate on a number of examples of indirect segments that benefit from the travel industry: capital expenditure in the field of hotel and resort building, airline operations and marketing efforts, administering travel and tourism relevant processes and regulations by government institutions, implementing and operating public and personal safety, and many others, as for example cleaning and healthcare services. Moreover further revenue streams relate to the purchase of consumer products, food and catering, vehicle related resources such as fuel and oil, and cleaning while travelling.

In the broader sense and in addition to private transport, cargo transport is contributing to the economic development of the travel sector, too. Its contribution results from food and luggage logistics as well as infrastructure provisioning and asset operations with respect to

means of transport and stowage such as containers and boxes. Indirectly, information and IT service processors contribute to economic development of the travel sector, too.

With respect to the value chain, Germany's economic contribution measured by its Gross Domestic Product (GDP) ranked third in 2014 after China and the USA [32]. One of the key measurement criteria is the number of jobs that have been created through the travel and tourism sectors. Germany's travel and tourism sectors, according to the World Travel and Tourism Council (WTTC), will have a share of 12.7 % of jobs generated in the year 2025 [32].

Relying on Mobility In the same way as for those that travel for leisure or business, mobility is a key asset for all those that work in the tourism sector, whether the trip to work, the outward journey to reach the cruise ship, or the self-booked sightseeing trip while in transit at the airport waiting for the connecting flight. Seamlessly functioning mobility is especially demanded by any travelers with multiple destinations and transit segments compared to travelers without a transit segment. Transit travelers are, for example, cruise passengers that travel via train or airplane, via taxi or bus, to the final point of departure, the cruise terminal. For transit travelers it is not possible or easily manageable to arrive late risking to miss the vessel. Nor do cruise passengers expect to deal with the administrative and logistics burden nor with finding alternative routings themselves.

The prospect of travelling smoothly is, however, not in the hands of vessel operators and airlines. In reality it concerns the operators of a functioning public and regional infrastructure network onsite that mediates short-distance and on-time transit requests in an intermodal manner.

In the field of business travel, the demand is equally as high as in the transit business. The more seamless and unexciting the itinerary planning and booking process and the actual travel, the more relaxed and focused our appointments, meetings, and conference contributions will be. The same accounts for meeting the very own or employers' budget guidelines in the case of choosing a different means of transport or seeking alternatives that include additional overnight stays. Export oriented countries not only have a high share of sales and consulting personnel, but installation and maintenance staff travelling abroad. It is expected that profitability rises by enabling a frictionless dispatching of staff, machine, tools, and information. It is no wonder that the export power of a country is not just being statistically captured in mobility related statistics [33], the associated travel needs of staff are taken into account, too.

Market Forces in the Travel and Tourism Segments There are traditional travel agencies, *online travel agents* (*OTA*s), and meta layers that combine travel offerings or that act as aggregator for search sites. The last are mainly the type of companies that have intimate knowledge of the customers' needs and wants. By gaining insights into past customer behavior and projected future behavior and decisions, OTAs introduced the technical means to incorporate previous user numbers, click analysis, and comments that have been issued or tweeted in social media. Over the years nearly all related information and data pools have been brought together and issued to the customers through one single platform.

So-called Global Distribution Systems (GDS) as part of OTAs started in the 1970s rather humbly as former subsidiaries of the major airlines. Over the years, GDS spun off as independent companies and have spawned a large industry as a whole in the travel distribution sphere. Sabre [34] of American Airlines started in 1984, Travelport [35], brought to market by United Airlines in 1972, and the European organization Amadeus [36] was initiated by Air France, Lufthansa, and SAS in 1987.

The original mission was to systemize seat reservations, developing and operating an entire travel reservation system on behalf of the issuing airlines. Since then all named GDS have grown and have become independent publicly traded companies that obtain a major market share in the industry and dominate the market.

Over recent years know-how has been expanded and expertise built not only in the airlines industry but also in the mobility industry overall. More related sub-verticals, including cruise lines, railways, and the hospitality industry, were added. Furthermore, GDS trade travel data and customer profiles, and operate customer managements systems.

Further market forces proliferated over time, the so-called content companies. Some content companies interact with highly relevant advice on travel needs from the end user's perspective. Others are recognized in the travel sales distribution and mediation process. Yet others offer value-add services along the value chain.

Expedia Inc. [37] and TripAdvisor [38] are two well recognized representatives of content companies. Expedia focuses on online travel distribution and comparability. TripAdvisor, on the other hand, handles user-generated content that we as travelers and interested travelers are prepared to share and make use of: whether in the form of feedbacks to an offering, or shared experiences about hotel stays with respect to quality, or the service performance rating of an agent-issued itinerary. The presence of content providers is undoubtedly apparent in the daily travel planning process.

Further market forces disrupted the market through the rise of the so-called *Sharing Economy*. Back in 2010, mobility and travel providers encountered disruptive offerings from Airbnb [39] for overnight stays, Uber [30] as taxi replacements, or BlaBlaCar [40] with its focus on long-distance travel in private cars.

Those *app economy* representatives (i.e. *app economists*) conquered the market more than anyone else. Their prowess in analytical models and mathematical methods prove their capability to match demand and supply (i.e. *matchmaking*). The *matchmaking* functioning lifts things to new heights and introduces in essence a platform offering where suppliers, hence asset owners, can seek renters much more directly and without intermediaries. The direct encountering moreover resulted in a community built up of like-minded people that can adapt easily in a participation-like manner.

The impact of app economists on other market forces and the increasingly controversially discussed exchange about legality, intervention in the market, and displacement of long-serving providers would have been out of Rogers' imagination when elaborating on adoption theory and diffusion of innovation [41]! Moreover it should be noted that the sharing economy per se should force a balance between shared, sharing, and shareholders' interests beyond the interest of one dominant shareholder. Otherwise app economists transform into oligopolies.

Traditional and disruptive offerings as well as much closer, direct, and chained digital processing between providers and consumers will no longer pause in front of infrastructure providers. Consumers seek access to the entire portfolio of products and services, regardless of who is operating or owning an infrastructure and regardless of the point of a demand's origin and fulfillment. An example illustrates the expectation of seamless and end-to-end service fulfillment, so-called servitization: consumers do not care anymore who is operating a train or a railway track or who manages the commuting service that is being chosen alongside the train service. Even once the services are fulfilled in the promised and expected manner, the consumer expects properly managed aftersales service from one single entity, in an ideal world.

The variety of combining bilateral and multi-lateral goods and service provisioning goes hand in hand with an increasingly customized usage period of these goods and service. Usage driven payment and invoicing more than ever are part of the *Unique Selling Proposition* (USP) of a modern, hence usage oriented, value chain. Usage-based management moves into the spotlight of private, public, and commercial service providers to gain a share in the form of revenue share, loyalty points, credits, or other forms of remuneration.

Decision makers and mobility designers will encounter an increasing demand from consumers and paired with a growing variety of distinct sources of offerings, service providers, and bundling opportunities to establish a transparent, coherent, and deployable *End-to-End (E2E) mobility* process. Bundling opportunities are manifold and one can think of front row parking, car cleaning and maintenance, luggage logistics services up to VIP services including office facilitation and onsite assistance.

The same applies to the efforts in jurisdictions. In Europe, for example, there has been a gradual change of ownership structure of the railway companies. The Fourth Railway Package [42] in particular, which is the European Commission's proposal for the community members, advocates changes in three major areas: (1) promoting interoperability related to signaling, (2) separation of railway operators from infrastructure managers, and (3) liberalization and opening up of the rail operator market. The last two changes relate to the E2E mobility vision that is postulated in this book.

Those two areas postulate a structural shift in the governance nature of railways in Europe. They will have a profound effect on how the providers of the service, hence the carriers, will collaborate with each other and hopefully, under acceptable Public Sector Agreements (PSA) and in alignment with their respective jurisdictions. An analogy was introduced in the airline industry, the so-called *Open Skies* agreement [43]. The Open Skies agreement is a progressive arrangement amongst nations to liberalize their respective air space to a free market, thus allowing airlines from other states to fly not only direct from each other's countries but also if there is a multi-lateral arrangement in place. One airline can be domiciled in one country, but has routes in two other countries. A simple example would be an airline company which is based in the Middle East and has direct routes between a US and European city. Such a flight could happen if there is an agreement in place, the Open Skies agreement.

The above introduced examples of transforming markets and the growing kaleidoscope of participating entities illustrates the interweaving of "who profits from whom". Blurring

boundaries will not stop short of the travel and tourism sectors, which will seek new pathways and routes. In fact the share of IT originated companies and community designers is constantly occupying the space of the traditional players.

2.6 Freight Transport Stimulating Economic Growth

Barbara Flügge

The situation in the freight transport segment looks as follows. Trade volume is being measured to date in tonnage, route length, and allocation to individual means of transport. Compared to passenger traffic, cargo has a significant impact on the economic strength of a region or country. In 2010, for example, 87,500 enterprises operated in the transport business in Germany [20, p. 34]. Herein, a significant share of 60,100 enterprises operated in business processing for cargo and passenger traffic.

The cargo transport business and transport services are two pillars in constructing and deploying a continuous and increasingly national, but also export oriented economy. Germany is playing a key role in the pan-European trade flow and the trade services economy. The figures from 2010 look as follows [20, p. 48]:

- German roads are used for European wide transport with a share of 27 % of the overall European road transport network. With respect to railway transport, German railway tracks transport 28 % of the European wide railway cargo. German waterways take part in 42 % of the total European waterway related cargo transport. Also, the geographical positioning of German rivers and hubs with regard to the European layout has an effect.
- The value chain in the operations management area shows quite a different set-up: 16 % of German warehouse and transport services and 18 % of jobs that are allocated in Germany are sourced to manage European wide cargo flows.
- Tax privileges and re-allocation of transport and traffic related service providers from Germany to other countries fostered over the years and decades an exodus. The transport industry overall and the vacancies for truck drivers, cargo maintenance, and security personnel are a result of the struggle to find young talent and attract experienced personnel from other sectors. These challenges intensify the impetus to seek outside the country and hire on-demand personnel. Another effect relates to the fostering of technical advancements such as autonomous trucks and to operate a higher share of cargo volume via railway tracks and waterways.

A comparison of cargo related means of transport with respect to managed trade and volume is shown in Fig. 2.5.

Asian ports in the top 15 ports worldwide dominate the leaderboard in seaborne traffic. Hamburg, for example, is keeping its position next to Rotterdam and Antwerp as one of

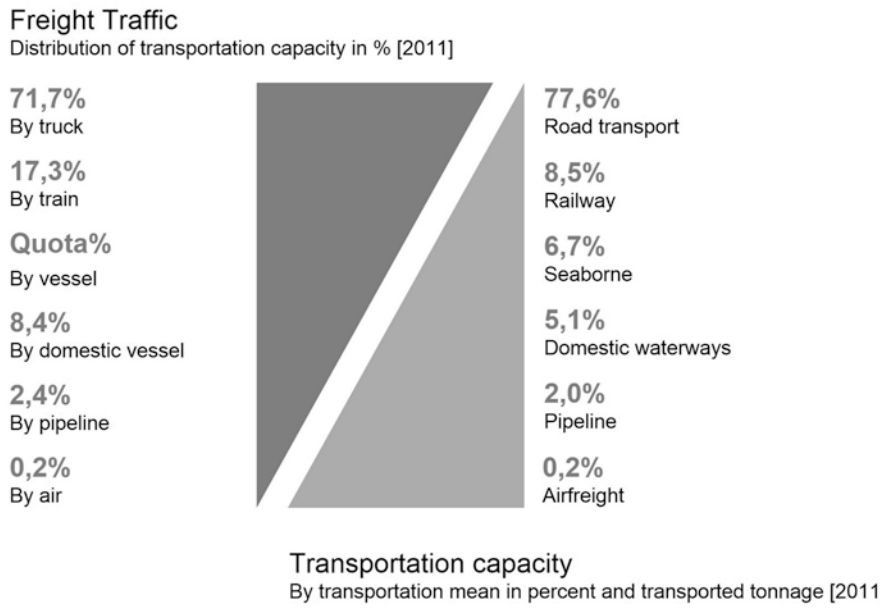

Fig. 2.5 Comparing distribution of transport capacity by means of transport and tonnage

the three European ports among those 15 [44, p. 4]. Positions however can change rapidly depending on managing not only container throughput but also leveraging a port's structural assets and capabilities. The latter aspect addresses the capabilities to operate a port's business efficiently and effectively concerning goods, containers and related equipment and tools, distinct and enlarging vessel sizes, industrial or goods related special requirements with respect to technology, on-site equipment and available on-site experts. Moreover, does a port's business steer the local and regional economy and influence it for the good or bad? The port operations business in Hamburg generates more than 150,000 jobs. An ecosystem wide analysis that we conducted revealed not only a direct effect with respect to job generation, but also indirect effects. Direct effects are, for example, traffic and transport related. Up to two million jobs in German apply to those two areas [20, p. 34]. Indirect effects emerge that are analogous to the individual travel and tourism sectors, with further mobility needs of personnel, equipment, and tools.

A successful port, as outlined above, and an integrated hub economy strengthen economic power overall and therefore the ranking of the location on a global scale and in the region. Figure 2.6 demonstrates the impact of efficient and effective operations for port operators and adjacent business segments. The outlined figures concerning export volume were diminished in the subsequent year (2012) caused by the Asian region. In 2013, Hamburg won back a trade volume of 9.3 million TEU compared to 2011 [45, p. 23].

To safeguard an active and profitable position in the international supply chain business mid- and long-term that requires predictable and timely acting. Hamburg Port, for example, initiated in collaboration with the authors of this book two of the six strategic

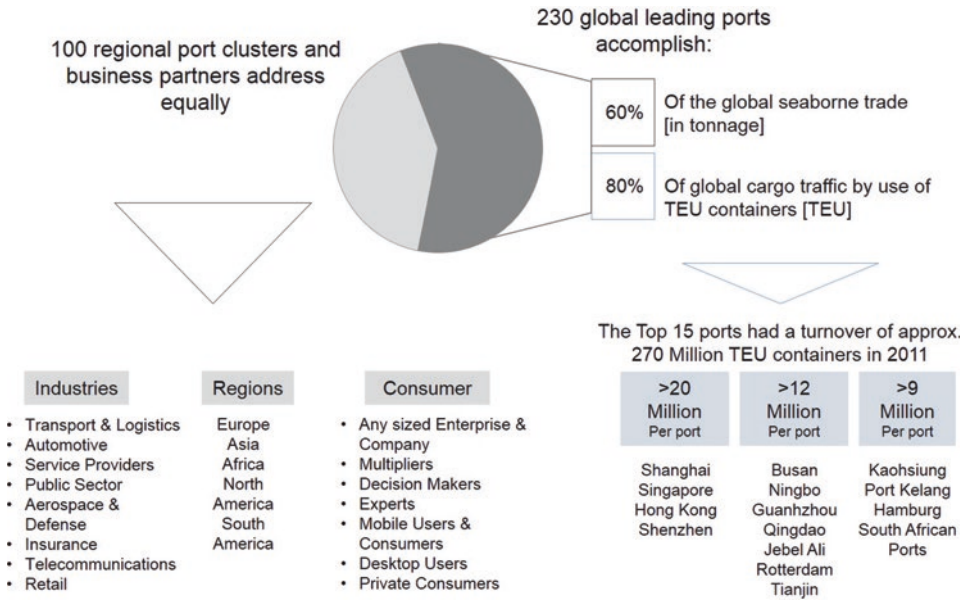

Fig. 2.6 Comparing cargo trade on a global scale

pillars of their smartPORT initiative [46]. Two key success factors facilitated the successful deployment of the first phases. Firstly, the decision to establish the projects as co-innovation projects and sticking to a collaborative and joint effort. Secondly, the project conduct in an inter-organizational, community driven manner with technology partners, economic entities, other government departments, institutes and mobility consumers, and facilitators such as dispatchers and truck drivers.

Projects in other locations underline the need to incorporate distinct interests and act in a highly integrative and collaborative manner – up to the point you forget about your own organizational assignment and put yourself in the shoes of your government or any other project partner and mobility consumer. Joining forces is the glue that fosters global competitiveness for all participating parties.

2.7 Mobility as a Guarantor for Successful Supply Chain Management

Barbara Flügge

Compared to passenger transport, individual actors in the cargo business optimize their intra-organizational business activities. Taking a look into the hinterland logistics, city logistics and near shore logistics look for actors who are watching out for cost-effective and simple-to-use business processing. International supply chains do not sustain without

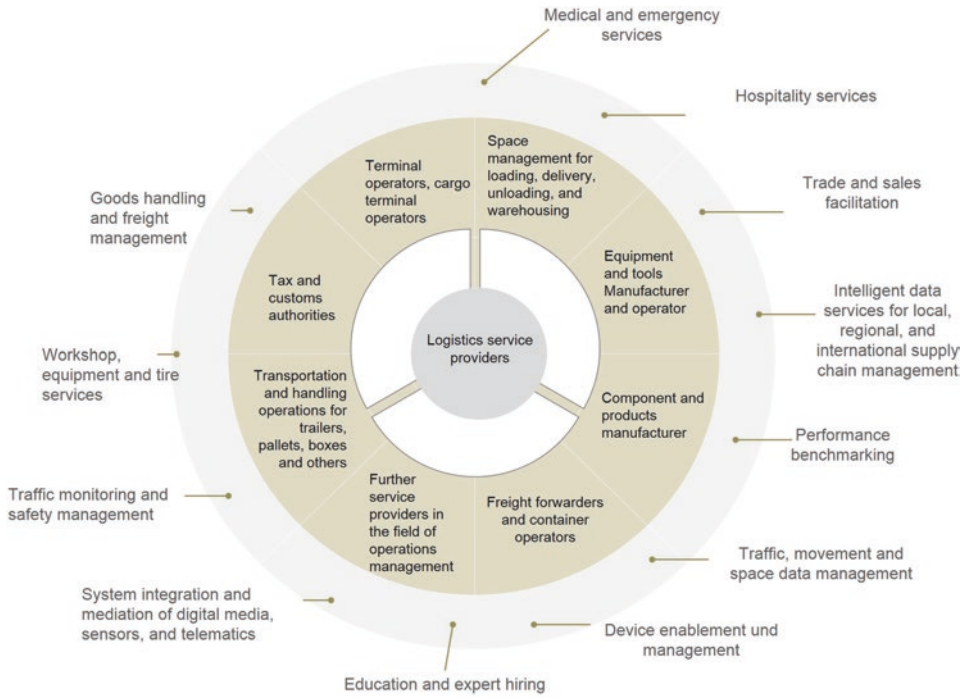

Fig. 2.7 Insights into the service world of logistics service providers

telematics applications and features, mobile dispatching, communications, and ticketing systems, or a digital transport management system. The connectedness among actors is not always an easy task to fulfill – not even in the digital age. However, connectedness is an essential criterion in a highly competitive market. An overview of logistics related services, hence a snapshot of the *service world*, is shown in Fig. 2.7. You might think of one service being peformed by one business actor. Another actor is then adding value to that primary service and starts promoting it in a bundle of services back to the originator! Getting to know who is out there and looking for the unknown business partners are one of the fundamental skills that companies need to look into now and the near future. And it is all about connectedness!

Positively speaking, a successful and therefore sustaining economy will be able to secure its local position and be facing international competition. The international trade business generates export-based revenues for individual companies in those locations that manage to take part in global trade chains. Maintaining its position locally needs a hub-driven management of economic growth, employment programs, competence building, training as well as innovation and creativity facilities.

Germany was leading the *Logistics Performance Index* (*LPI*) in 2014. It outperformed as number one followed by the Netherlands, Belgium, the UK, and Singapore [47, p. VIII]. The set of criteria that result in the LPI is the following:

- Customs operations
- Existing infrastructure
- Percentage of international shipments
- Logistics competence
- Timeliness of delivery
- Supply chain monitoring, cargo tracking and tracing.

Cargo and the successful management of a global supply chain ensure those actors that are, for example, responsible for a smooth handover of the cargo to the next actor. Another example are actors that manage the handover of paper and information to the relevant government institutions or those that secure freight or perform diligence in dealing with the assigned goods and material.

Especially in heavy goods transport, a wake-up call and therefore a focus on digitizing services are urgently needed! Based on an internal assessment, truck drivers have to deal with and browse through 20 or 30 pages of instructions to identify bridges to be used and intersections or crossings to be avoided with hazardous goods. The manual effort does not even stop with manual information. It continues with little insights about who to contact at the municipal level. Very often it is the driver's decision and therefore his risk (legally or for security reasons) to choose a certain route or not. Drivers will act outside the judicial areas very soon.

We as decision makers, innovation leaders, and forward thinkers lose sight of those challenges when passing by drivers who are encountering issues or discussions with delivery personnel and technicians. The LPI index does not include a criterion concerning competency development. We should amend the LPI and include competence building for both mobile personnel and the mobility front and mobility back offices! It is worth take that into account when managing smart mobility properly – as discussed later in Chap. 12.

Mobility consumers next to truck drivers are furthermore experts such as sales personnel, consultants, decision makers, security personnel, field staff, and auditors. Similarly to the driver community the expectations are to arrive relaxed and on time. Once a mobility process and the assignment requests are planned in a simplified and predictive manner, satisfaction on the job and identification with the task increase. Once travel and on-site operations are understood as one business processing effort, a future multi-media supply chain management eliminates efforts in travel booking and re-booking, dispatching, interim storage, cancellations, and planning renewals.

What has been missing until now is an optimization of the entire system of actors, mobile personnel, vehicles, and control towers.

Limited space and therefore infrastructure measures paired with extremely high waiting times are a result of missing transparency of infrastructure data and information along the transport chain. Furthermore, the limitations prohibit an increase in container throughput. Access to better and more reliable real-time information, whether infrastructure or traffic situation, will improve a dispatcher's planning capability. The mobile personnel encounter

a higher degree of accuracy and are prepared with on-site information before arriving at the targeted site.

Having conducted a series of interviews with drivers, dispatchers, and other mobile personnel, communication between the participating parties is not satisfactory. Employees that are on the road feel more and more isolated. Updates on the traditional traffic information channels or digital signs along the roads do not serve nonlocals. Another aspect of communication that is neglected concerns the interaction among those that are located onsite or transiting through one geo-fence and those who do not know each other yet. This crowd sourced information could turn into essential decision criteria once revealed and made public.

In addition, transport and accompanying personnel have little insights to the actual parking situation in conjunction with required storage space or requested special equipment to ensure the freight on-site. A location-based service discovery is dependent on the offering of geo-based apps and services. Those could turn into offerings about operation time slots, workshops, and hospitality services. Often the characteristics of the delivery profile as such are missing and this turns into yet another driver-based decision: (a) to gather an overview about the situation and (b) to judge the usefulness of the provided information.

One of the outcomes of our initiatives in conjunction with the world of services for cargo transport is the following list of ideas for location-based services:

1. Informing truck drivers about the import and export status of container movements
2. Informing company colleagues about position and job profile – the latter aspect facilitates switchboard needs once a driver has to be replaced by another one with a certain skillset
3. Tourist app with points of interest and highlights such as vessel types and flag information
4. Currywurst app for truck drivers to foster electronic orders and payment for food services
5. Informing dispatchers about current positions of approaching trucks and goods
6. Meet-at-parking-slot app for drivers
7. App for mobile service providers in the field of food services or truck and cargo related maintenance services
8. Informing dispatchers about arrival times whether container or means of transport such as vessels and trains
9. Special offers at truck stations that are located in the harbor area to serve the mobile personnel
10. (Just-)In-time-sequences to optimize the projected arrival at the container terminals
11. Resting time monitoring for truck drivers
12. Oil and other consumption monitoring at truck stations plus discounted offerings for recurring drivers
13. Healthcare app for drivers to observe, monitor, and improve health status

14. Fitness app for drivers when resting or waiting
15. Terminal operator related app to indicate the total container throughput
16. Real-time video channel to observe docks and parking areas
17. Reservation system for parking slots
18. Expected waiting time
19. Empty container marketplace for dispatchers and drivers
20. Equipment-to-go for workshops
21. Available loading space in trucks and car trunks
22. Monitoring app to monitor critical vehicle and equipment components and plan maintenance needs ahead of time
23. Provide interaction with packaging personnel
24. Enhance routing lifecycle back to the carrier home base
25. App that offers location-based services based on user's profile and preferences
26. Hub operator related app to monitor in real time as well as predict traffic flow and traffic situation
27. Apps that outline location-based events in the hub area such as meet-and-greet, those for lunch time and during waiting hours, cultural events, and language classes
28. App that oversees gas stations, their opening hours especially at night
29. App that instructs loading and unloading personnel
30. Equipment monitoring app for mission critical and/or high-value tools.

By categorizing the above introduced service ideas according to reachability and the trust they offer to ensure a smooth and enjoyable cargo transport business, the assortment looks like that shown in Fig. 2.8. The numbers in the graphic coincide with the above numbers.

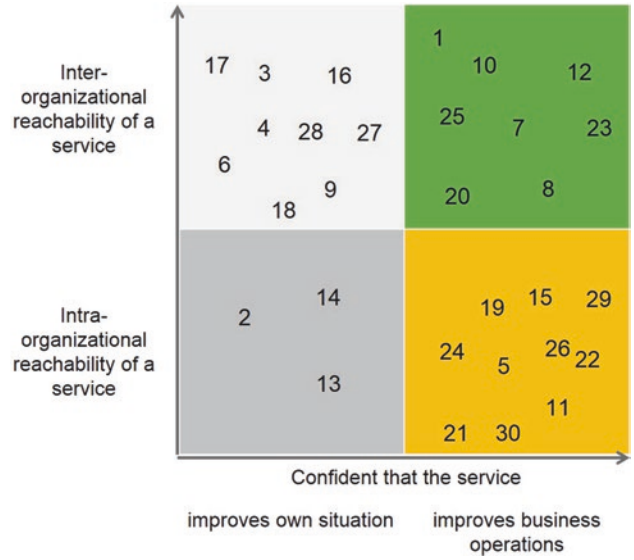

Fig. 2.8 Insights into the service world of cargo traffic

2.8 Mobility Creation and Preservation, Traffic Safety and Sustainability

Barbara Flügge

2.8.1 Mobility Creation

Who cares about our mobility? The entire theme of mobility and traffic infrastructure concerns a complex, multi-diverse entity of assets that are designed, developed, maintained, and renewed for the above introduced means of transport and route networks. New means of transport and routes are being introduced based on structural, economic, and behavior directed criteria. The closure of railway routes on the one hand, the introduction of new and maintenance of already installed high-speed railway routes on the other hand, re-open again and again a debate about purpose, roles, and responsibilities. The debate that has been on-going in Switzerland was caused by a change in the train schedules that caused a disadvantage to commuters who traveled 60 minutes into Zurich and had to accept a longer transit time. The outcome of decisions concerning infrastructure provisioning and preservation is hardly made transparent to mobility users. Furthermore, the often promoted participation of constituents is delayed until close to the deadline when it is viewed as interference.

Statistics that concern infrastructure assets in the field of construction [20] outline a 5 % usage of Germany's total surface area. That percentage is subdivided into motorways and routes, railway tracks, and space related measures:

- Streets
- Bridges
- Railway tracks
- Tramline tracks
- City train tracks
- Waterways
- Pipelines
- Hubs such as central stations, seaports, airports, and terminals that are essential for commuters and transshipment activities.

Germany's traffic infrastructure system has been valued in the year 2010 at €773 billion [20]. The evaluation of capital assets has been conducted by the German Institute for Economic Research. The main asset is the traffic route network as outlined in Fig. 2.9. Hubs are 10 % of the main assets' value. In many cases hubs are operated by private entities and not by public institutions.

Infrastructure related assets and provisioning efforts are evaluated differently when it comes to a country to country comparison. Reasons are based on legal and structural conditions, and varying matters. A global study of infrastructure measures undertaken by the World Bank [48] takes those differences into account. The study projects for 55

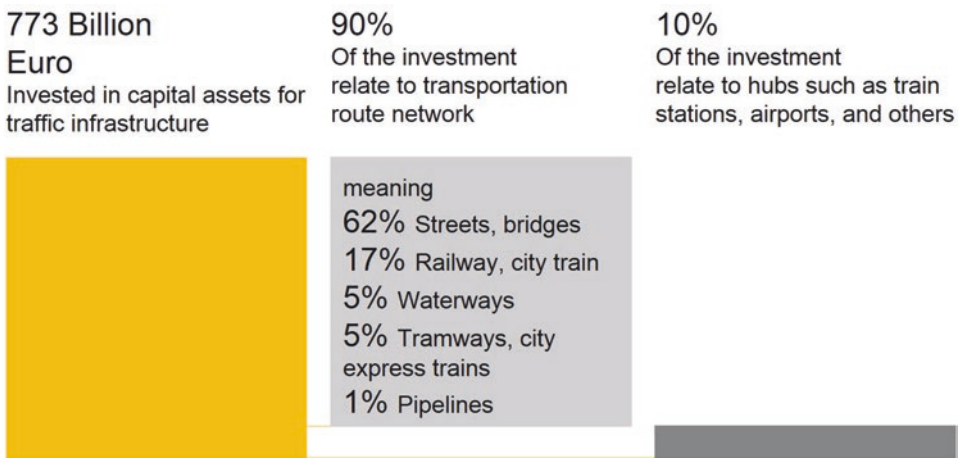

Fig. 2.9 Mobility provisioning in Germany

locations the right of all social classes to access mobility. All sites that have been investigated share the same balancing efforts to design space and infrastructure needs long term, and manage and steer short-term, annual, and/or incident relevant countermeasures and budgeting. With respect to long-term planning cycles we talk about 20–30 years. Infrastructure related concepts even take up to 50 years and more.

With respect to movable assets, 52 million vehicles were registered in the year 2012 in Germany. Those covered 34 million cars, 9 million trucks and tractors, 8 million motorcycles, and 1 million other vehicles [20, p. 21f]. The last category related to trains and locomotives mostly serves freight related mobility needs. The proportion of electric vehicles was insignificantly low and was therefore not measured or outlined.

Concerning infrastructure preservation, Germany introduced a German Investment Framework that manifests the preservation plan for the traffic infrastructure from 2011 to 2015. The investment sum of 2.6 % of the total asset value seems small [20, 49], see also Fig. 2.10. Next to the maintenance and expansion of the above introduced assets, a key focus is on streets and bridges. In addition, modern traffic management systems and IT are another element that is taken into account.

Judging the investment value as being low, acceptable, or high cannot be objectively assessed due to distinct publication periods and distinct definition of terms in statistics and studies. All that can be said is that the right to mobility is more and more focused at the political level. One way to measure the increasing interest and need are the number and subsidy amounts issued for funding and research projects. The European Commission for example announced in 2015 that it will provision a total sum of €13 billion for the traffic related program within the *Connecting Europe* program [50].

Connecting Europe overall is motivated to develop and expand a trans-European transport network, and expand infrastructure in the field of energy and telecommunications. Information technology is being recognized as one of the key building blocks as stated

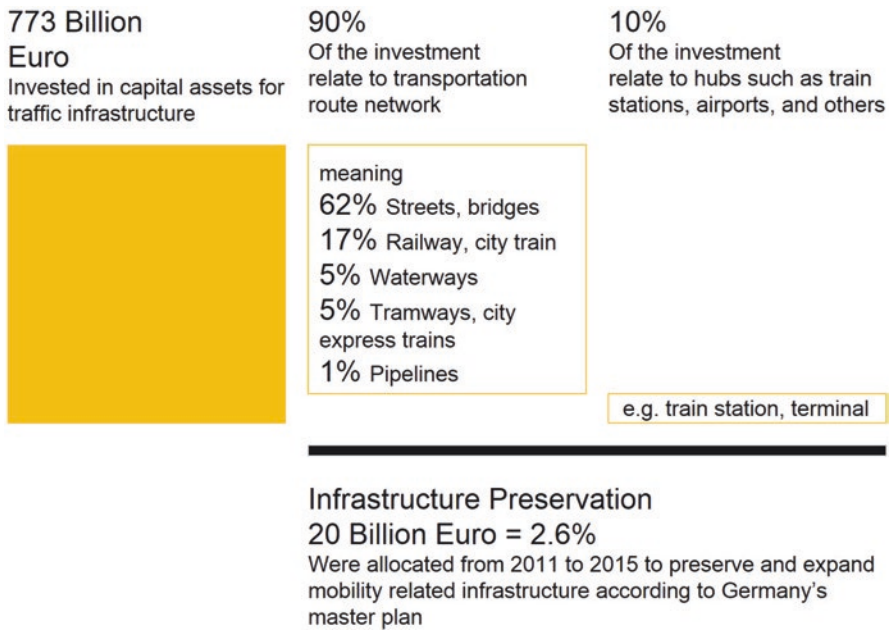

Fig. 2.10 Mobility and infrastructure creation in Germany

here: "[…] calls for the deployment of transport-related information and communication technology to ensure improved and integrated traffic management and to simplify administrative procedures through improved freight logistics, cargo tracking and tracing, and optimized schedules and traffic flows" [51, p. 1].

Comparing finance and cost parameters as outlined in Fig. 2.11 the financing of means of transport is realized by a mix of revenue streams, meaning ticketing revenue, tax money, subsidies from the public sector and contributions such as toll driven income from the transport sector.

Toll driven usage-based financing in Switzerland resulted in a revenue of €4.5 billion in 2010. Compared to the above outlined German infrastructure investment efforts of 2.5 %, the Swiss contribution resulted in 25 %. How Swiss citizens allocate income with respect to infrastructure was subject to a Swiss Bureau of Statistics survey in 2012 [21]. The result is shown in Fig. 2.12.

2.8.2 Mobility Preservation

Who are the actors behind the data we introduced in the section above? Looking at the reference list of the Germany Bureau of Statistics, an immense number of individual contributing actors, departments, institutes, commissioned auditors, and independent businesses are revealed [20, pp. 56–59]. Furthermore, surveys and observations that are conducted on

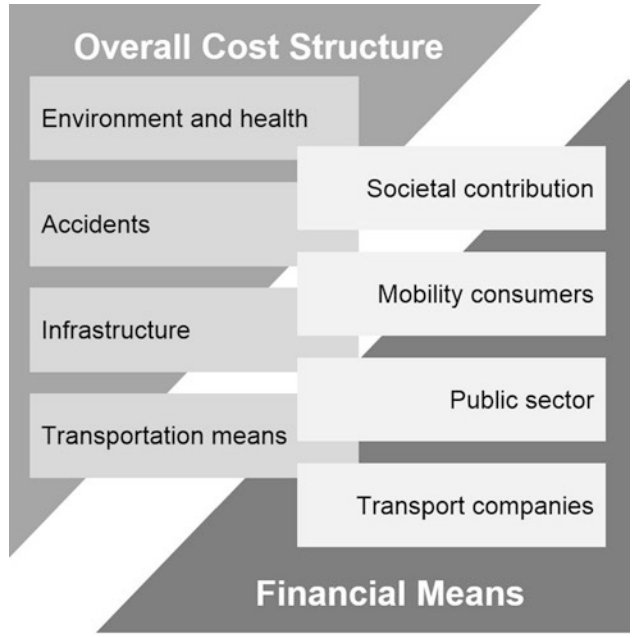

Fig. 2.11 Cost and financing parameters with respect to mobility creation

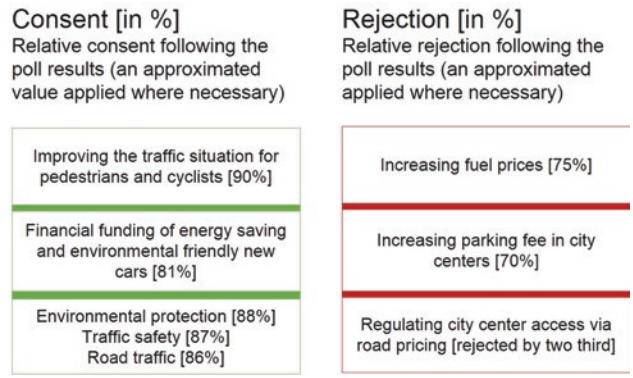

Fig. 2.12 Citizen survey measuring citizens' consent to or rejection of use of income and financial resources in Switzerland

a random basis reveal further actors and institutions that have been noticed as contributors and decision makers. Figure 2.13 gives an overview of today's understanding of roles and illustrates the demarcation between institutional and commercial actors and their offerings. The presentation is not country specific and can be applied to other regions and countries.

As already observed, the fundamental roles of who is owning and who is sharing has shifted. The movement in the *Sharing Economy* that provokes a usage instead of ownership role will be reinforced by increasingly more automation functions in vehicles. New players replace or complement traditional car manufacturers in the automotive industry.

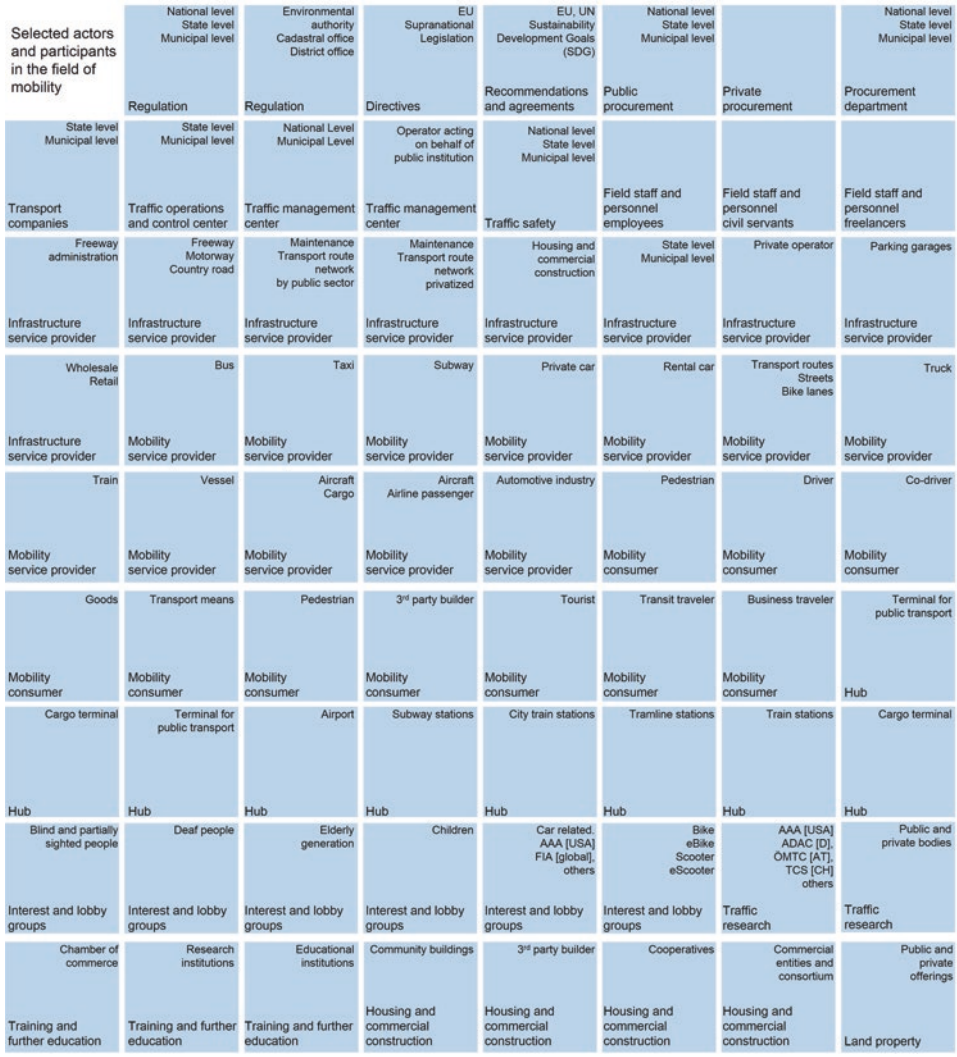

Fig. 2.13 Selected actors and participants in mobility

Alternative offerings span from vehicle offerings, components, to infrastructure management by offering vehicles, components, and infrastructure themselves. These providers are nowadays players that conquer the market with disruptive and innovative offerings as for example technology providers and location-targeting consortia focusing on mega cities and metropolitan areas. Furthermore, they offer usage-based services such as deliveries and pick-up services in rural areas. Other providers evolve as for example wholesale and retail chains that offer their fleets to customers or hub operators. Pricing might vary from mileage-based, distance-based, usage-based to the amount that has been spent.

2.8.3 Traffic Safety and Sustainability

An analysis of mobility without getting into the aspects of the negative outcomes of mobility would be fatal. In the field of personal safety, government institutions have registered a shrinking number of fatalities since 1970, for example in Germany [20, p. 36]. Nevertheless in the course of 2.4 million car accidents in 2010, 4009 people died. Accidents have been mainly caused, meaning up to 90 %, by human error. As reported in 2011, cyclists and motorcyclists caused most of the accidents.

The present assistance and warning systems – for example the lane departure warning system, the night optical systems, and distance driven adaptive cruise control – accompany and steer our behavior. Moreover, they increase our comfort zone and in correlation with the likelihood of accidents increase traffic safety, reduce the number of accidents, and even more importantly the number of fatalities [50, 51].

Despite the above-mentioned assistance and warning systems the groups that have been put at risk through car accidents are mainly pedestrians and cyclists. Elderly people walking are the most affected group. In that context there is an ongoing discourse and questioning about elderly people and their mental and physical fitness when using e-bikes. At this point in time there are no studies that prove a link between e-bike related accidents and the cyclists' age.

Driver misconduct is apparent at any age [20]. Misconduct is happening in the following situational contexts:

- Turning, diverting, backing-up and exiting maneuvers (16 %)
- Situational reaction time with regulations concerning right of way and precedence (15 %)
- Unadjusted speed (13 %), as well as
- Unadjusted distance (12 %).

Public transport by bus and rail as well as travel by plane are perceived as relatively safe.

One could only wish that innovative and creative undertakings continue to focus on safety measures independently of an individual's perceived safety or the relative safety that is being encountered in an actual traffic situation.

Residents are furthermore exposed to noise and air pollution. The increasing volume of transport and alternative routing due to traffic congestion on the main roads are also an outcome of a growing number of construction sites aimed at private and commercial needs. With respect to environmental protection measures, both decision makers and mobility consumers are not looking solely into the increase of air pollution in Asian mega cities. Fine dust pollution has reached other far regions, too. Another aspect to be reflected on is the fact that passenger traffic in Germany generates three times more carbon dioxide than cargo traffic [20, p. 42].

The pressing questioning about measurability, accuracy, and verifying carbon dioxide emissions from cars will not be discussed here. It is important to design, finance, and deploy intermodal traffic management offerings in the near future that include a desirable proportion of environmentally acceptable means of transport. An undertaking denoted as

the *Sustainable Urban Mobility Plan* (*SUMP*) aims to underpin sustainability-oriented and multi-modal targeted mobility management. Throughout our exchange with experts it has been claimed that only those urbanizations with an already comfortable budget will be able to deploy SUMP. If that turns out to be true it will be subject of further investigation. In this context, the *Circular Economy* movement postulates the following four deployable and relevant contributions for the near future [52, p. 56f]:

- Electrification and electro-mobility (short eMobility)
- Autonomous driving
- Materials evolution
- System-level integration of transport modes that from our point of view should embrace cargo transport next to individual transport.

Those contributions, according to the Ellen MacArthur Foundation, are achievable and deployable through joint efforts from governments and businesses around the globe.

2.9 Traffic Management Systems and IT Trends

Barbara Flügge

2.9.1 Intelligent Transport Systems

Intelligent Transport Systems (*ITS*) is the umbrella term for all traffic related technical and construction concepts. Here you will find traffic light control systems, telematics solutions, transport management and furthermore analytical tools that concern traffic and transport management. Applied as individual building blocks or in combination, ITS support traffic managers and operations personnel to safeguard and increase efficiency of traffic operations, infrastructure operators, and mobility providers. ITS encompass therefore also those information and control systems that are in use by stakeholders such as traffic managers, traffic operations managers, fleet managers and fleet control units, and transit and commuting specific traffic control units.

Concerning the taxonomy of ITS, we encounter distinct entries and listings depending on geography and interests. One example is the taxonomy of the US Ministry of Transport [53]. Figure 2.14 outlines the overall structure of the ITS content.

Another way to sort ITS related solutions and the innovation potential they might offer is by requirements. Here the ITS taxonomy serves as a baseline and is typically extended with customer specific or location individual offerings. A structure of ITS based on requirement profiles is illustrated in Fig. 2.15.

Through their dedicated focus on traffic management, ITS are reaching their boundaries as soon as traffic planning hits constructional, geographical, and building specific matters or seeks alignment with sustainability related regulations. It is recommended to define

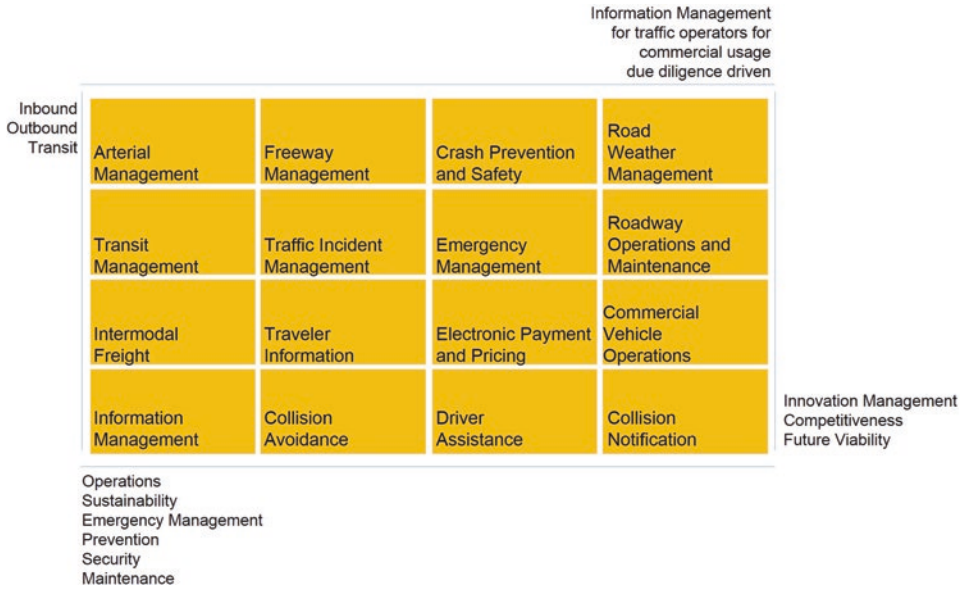

Fig. 2.14 Taxonomy of ITS

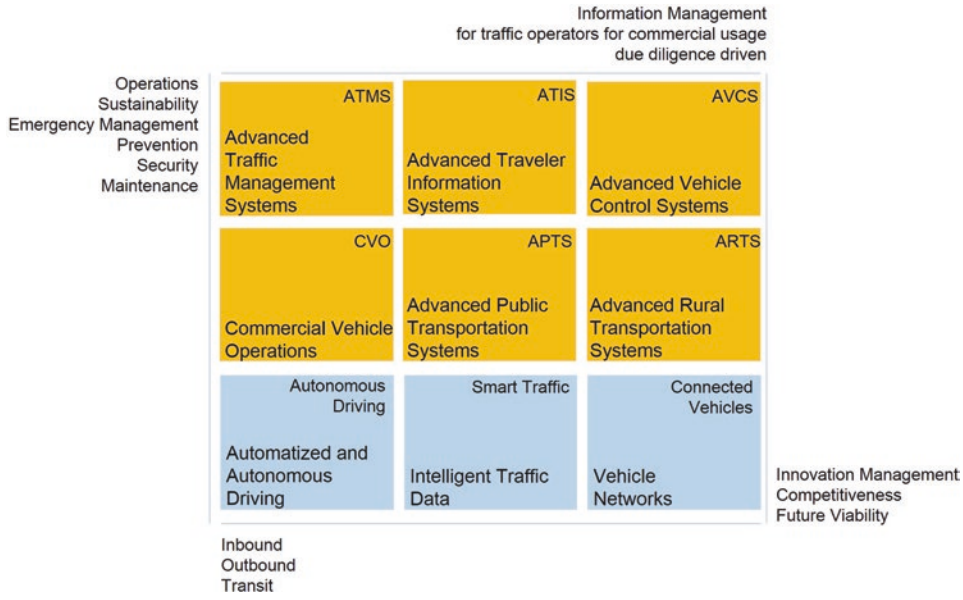

Fig. 2.15 Taxonomy of ITS based on requirement profiles

a requirements catalogue and a range of solution offerings that meet present and future requirements. Furthermore, the ITS framework needs to be adjusted.

2.9.1.1 Intelligent Traffic Management Systems in the Rural Area

To ensure a functioning and sustainable traffic infrastructure and serve households that are situated in rural, yet remote, areas the prediction capabilities of traffic management systems need to be much more in focus. Predicting traffic volume, travel and traffic behavior, and type and number of means of transport are subject to *Advanced Rural Transportation Systems* (*ARTS*). ARTS detect, collect, and evaluate those data. They cover routes, number of waiting passengers, pedestrians, punctuality, delays, and the cancellation of public transport services, as well as sustainability monitoring such as emissions.

Compared to cities, the infrastructure needs and budgets for rural areas ask for even more reliable results and protection. Moreover, reliability is expected to protect past investments and assure that those keep their promise for future demand. Another aspect of future demand is to keep the mobility rights of the supposedly shrinking population in the countryside and not target it only to mega cities and metropolitan areas. It is expected that interests and investment decisions will concentrate even further on cities. The right to mobility is in danger for those that live outside and have a less-influential voice to express their needs when it comes to public participation and decision making.

What are the key elements for ARTS? Innovations in the sensor area that ensure and manage the connectedness of assets and traffic related analytics will lead to more precise forecasts for the region itself as well as for the mobility needs from region a to city b and city c to region d. This approach of digital asset mapping requires however recommender and decision making parameters and a business process logic to ease the deployment. The simple “what we know” is not sufficient. The next and harder step is about acting such as convincing suppliers to target rural areas despite shrinking margins: being suppliers for food, pharmaceuticals, construction material and other kind of service providers. Moreover, they are faced with the decision to propose available space in their transportation means to other suppliers, even competitors.

In addition to digital asset mapping, the use of communications media, smart phones, or *OnBoardUnits* serves traffic participants once they agree on the usage of their movement patterns. In Canada, for example, a service is being envisioned for street cleaning in the winter season and the optimal use of snow plow trucks through temperature and surface sensors. As snow plow trucks by number are limited and distances are large, an optimal dispatching leads not only to a street-by-street but a meter-by-meter accurate dispatching and cleaning.

One other element that features ARTS are solution offerings that relate to *connected vehicles*. Those are vehicles that drive nearby and communicate with each other – independently from owner, driver, or operator of the vehicle.

With respect to project undertakings for rural areas we consider the use of *autonomous vehicles*. The idea is, in future, to bundle order fulfillment for individual constituents and optimize the usage of loading and driving capacities of vehicles to ensure remote delivery. It could be said that households get served digitally right up to their front doors! In fact carriers and online retailers ask themselves if they are able to afford remote deliveries that

make only x % of the overall consumer market while profit margins get tighter and tighter. Autonomous driving once intelligently used offers a real chance to get served wherever consumers are based.

2.9.1.2 Traffic Data Analytics

Regardless of whether the field of application is ARTS or the respective, preceding elements of ITS, functioning is based on the digital offering, usage, and reasoning of traffic data. Not only does traffic data encompass public transport related data but all traffic related data that private travelers and organizations generate and provision. Thus smart traffic decision management systems rely on data from other operators, such as taxi and bus operators, as well as behavioral and decision making data from passengers.

Traffic data categorizes by:

- Real-time data: data that is up-to-date by a maximum of 15 minutes. Real-time data are the oil of real-time monitoring, situation-based traffic management, and decision making. One example of real-time monitoring is the required time span that is needed to identify a car registry record triggered by a sensor that indicates car passed at 3.00 p.m. in city "A" and street "B". Another example relates to the identification and counting of cars that pass by a digital checkpoint within one minute. A third well known example is speed detection.
- Historical data: data history is the starting point for analytical and forecasting methods. Examples are data related to surface abrasion depending on climate zones and weather conditions.

The overall advantages of traffic data management are traffic monitoring and interactive steering – for example, to adjust the speed limit dynamically. Another benefit is related to road and traffic network planning, especially in the field of designing street crossings and critical intersections to balance incoming and leaving vehicle flow.

The so-called UK *London Congestion Charging* (*LCC*) scheme [54] was introduced in February 2003 with the objective of reducing and avoid congestion in central London. How does LCC function? Vehicles that are approaching London's city center and seek to enter a defined area were charged, in the beginning, £5. Exceptions were made at weekends and at night. A positive outcome led to a reduction of congestion in the city center, but caused an increase of congestion in the surrounding areas. To counter manage that effect, the fee increased over the time from £8 to £11.50 and the area that is liable to the charge was expanded. The registry of those vehicles that are allowed to enter the area takes place with *automatic number plate reading* (*ANPR*). A digital image is created that registers the number plate, the used street, and captures an entire geo-fence related image of the car and the used street. The registry is then counterchecked with the database entries. In cases of a missing entry of the captured vehicle, the system detects car owner and issues a traffic warrant. The LCC is still in use.

2.9.1.3 Intermodal Traffic Management

The means of transport that is provisioned or used is referred to as a *mode*. Intermodality refers to transport needs whereby "at least two different modes are used in an integrated manner in order to complete a door-to-door transport sequence" [55]. This referenced definition of the European Commission related originally to the transport of goods. It also refers to a minimum two different modes. Concerning the first condition, we hereby expand the addressees to the transport of persons. With respect to the second condition, the real challenges rely in the intermodal planning and deployment for three, four, and more distinct modes of transport – regardless of regional, country-wide, or international application.

Compared to intermodality, *multi-modality* looks into one means of transport as a closed system without integrating other means. As the theme of this book is the management and processing of distinct means and ownerships, multi-modal aspects are not in focus.

Most commonly used means of transport for intermodal transportation, are car, bus, train, e-bike, plane, motorcycle, city train, subway, and vessel. Depending on political, economic, and geographical conditions these are operated by private persons, or private or public institutions and organizations. Often transport modes are structured by road management, rail operations, sea traffic, and air traffic.

A typical intermodal travel sequence looks like the following:

- Taking the bus from home to get to the central station
- Travel by train from the central station to the train station nearby the event location
- Travel by taxi from the train station to the event location.

To identify travel plans and intermodal needs door-to-door we make use of customer journey mappings. Those are applicable to business travelers, event participants and families, and any other traveler profiles. The most common combinations of transport modes are bus-train, subway-walkway, and train-plane. Next to the technical transport modes, walkways are a transport mode, too. Especially in the digitization of intermodal routing and planning, walkways and efforts for pedestrians need to be considered. The optimal transport and transit efforts, adjustments, and re-calculations along a journey takes into account an individual's walking preference, how much, how long and under which conditions. The latter aspect depends on luggage to be carried or a hilly route to be taken. Next to walkways the e-bike as well as car sharing are added, too. Offerings next to train services already include bike and car rental options. Overall we observe an increasing number of transport mode operators – not forgetting the ones that offer their private cars!

In the *sharing economy,* operators such as DriveNow and car2go are two out of more than 150 car-sharing service providers solely in Germany at the beginning of 2016 with a total number of 1.26 million registered mobility consumers [56]. Latest figures as presented at the Fourth World Collaborative Mobility Congress [57] talk about nearly 300 car-sharing service providers in Germany only!

The worsening driving situation brought about by congestion and longer waiting and down times does not only harm the traffic system but also the economic situation of a hub or location. Supply and retail chains suffer because of a congested truck and a delayed or even canceled terminal check-in at the destination. The domino effect leads to physical as well as business processing issues driven by commercial agreements, agreed estimated time of arrivals, and shipment timetables. Furthermore, delays cause stress, waiting time, annoyance to participants and those nearby, and harm to the environment through noise and air pollution.

A sustainable concept for intermodal transport of persons and goods – such as SUMP – asks for intelligent dispatching systems, inter-organizational collaboration, and a settlement of interests to best utilize the existing assets and infrastructure.

2.9.2 A Global Study About Mobility in 20 Cities

We have been assessing the mobility offering of 20 cities as part of a global study. The analysis is based on publicly available material. Where relevant, accompanying interviews and surveys are being conducted. The study focuses on private transport. The key questions we have been asking are:

- What is the situation to date concerning private transport overall?
- Which offerings are available?
- How can the road transport network be described?
- What are the main reasons for traffic density and congestion?
- How does the traffic situation, especially congestion issues, influence the population?
- Which user groups are being affected by the traffic situation mostly and how?

To compare the analytical results and the research framework between the individual findings, a morphological box [58] has been designed. The applied attributes and units are shown in Table 2.1.

Table 2.1 Morphological box to derive mobility offerings for cities (source: own graphic)

Population[a]	0–5000	5000–10,000	10,000–15,000	15,000–20,000	20,000–25,000
Area [in m^2]	0–4000	4000–8000	8000–12,000	12,000–16,000	16,000–20,000
Density	0–4000	4000–8000	8000–12,000	12,000–16,000	16,000–20,000
Rail network [in km]	0–100	100–200	200–300	300–400	400–500
Number of rail stations	0–100	100–200	200–300	300–400	400–500
Size of public bus fleet	0–5000	5000–10,000	10,000–15,000	15,000–20,000	20,000–25,000

Table 2.1 (continued)

Daily rides[b] by train	0–2000	2000–4000	4000–6000	6000–8000	8000–10,000
Daily rides[b] by public bus	0–3000	3000–6000	6000–9000	9000–12,000	12,000–15,000
Road network [in km]	0–6000	6000–12,000	12,000–18,000	18,000–24,000	24,000–30,000
Road density	0–4	4–8	8–12	12–16	16–20
Number of motor vehicles[c]	0–1000	1000–2000	2000–3000	3000–4000	4000–5000
Number of private cars[c]	0–600	600–1200	1200–1800	1800–2400	2400–3000

[a] Population in '000, [b] Daily rides in '000, [c] Number of motor vehicles and private cars in '000.

The studied cities are Bangalore, Barcelona, Beijing, Berlin, Guangzhaou, Hong Kong, London, Madrid, Melbourne, New York, Seoul, Shanghai, Singapore, Stockholm, Sydney, Taipei, Tokyo, Warsaw, Washington DC, and Vienna.

To gain a detailed insight into the study, please contact Barbara Flügge through http://ch.linkedin.com/pub/barbara-fluegge/0/b1b/146.

2.9.3 Industry 4.0 and the Internet of Things

The fourth industrial revolution perceived as the evolvement in manufacturing and production planning, under the term *Industry 4.0,* predicts in the following years an increasing, stronger connectedness with traffic management and planning systems. What is Industry 4.0 about? What are the current developments?

The *Machine-to-Machine* (*M2M*) *communication* evolvement has been labeled as *Industry 3.0* and focuses on connected machines. A scenario as typically circumscribed by Industry 4.0 is the following. The aim is to enable connectedness amplified with the aim to gather information from any (connected) object, not only machines, and by measuring the object's conditions. Consequently, a building decides on its own about energy consumption, absorbing energy or releasing energy to another building nearby. The incorporated business processing resonates with the overall condition of the targeted building and informs the human stakeholders about changes, adjustments, or approvals to be made.

The embeddedness of machines into business relevant and business nearby activities is subject to *Cyber Physical Systems* (CPS). The functioning of CPS is as follows. A machine executes a maintenance service based on key performance indicators and conditional monitoring. In Formula 1, for example, a race car is already supervised during the race in real-time by its engine performance, the conditions of tires and brakes, and the driver's

behavior and reaction time. In the case of Smart Mobility, a CPS scenario looks like the following. The use of public transport is being measured by the occupied seats in a bus. Once all nearby seats are occupied and the demand for the next station has being predicted due to the number of people waiting at the station, another bus is being provisioned. The station related estimates will become more precise by the numbers walking towards the station, browsing for traffic information, and waiting at the station's geo-fence. Thus, the tedious look at bus schedules and estimated arrival times becomes obsolete.

Looking at CPS the term *Internet of Things* (*IoT*) relates to the entirety of all to-be-connected and connectable objects or things. Today, a true IoT scenario embraces monitoring and steering functionality via the Internet, mobile, and desktop apps. In the future, there will be sensing fabric and further device-like engagement modes. We all encounter IoT scenarios in our own environment: the remote use of the shutters at home, starting the coffee machine before getting home, or the remote monitoring of the elevator's operation to prevent dangerous situations or to countermeasure an incident as fast as possible. Through IoT advancements into consumers' households, namely the connected refrigerator that tells the supermarket to issue the delivery or the connected plants triggering fertilization, we can follow the digital movements more easily.

IoT as a subject of its own converges into mobility needs and efforts especially through the physical interaction and connectedness with infrastructure assets and devices. We recommend to take a look into an *IoT Role model* that has being investigated by the authors for quite some time.

Another IT advancement is the collection, capture, and re-use of data, massive volumes of data. The term *Big Data* refers to huge data pools, *data lakes,* and the consequent related data processing. Data lakes result from an information explosion through online, desktop, and mobile use of apps and services. Accelerated by the connectedness of things, goods, and services we expect an exponential increase of data volumes in the nearby future. From an operational perspective and to make as much purpose driven information available for further processing, organizations rely more and more on mobile apps and cloud offerings. Downsizing in-house operations and moving into the cloud is perceived as one way to keep data processing and data access manageable and affordable. Data processing itself takes place in cloud systems based on digital platforms.

The advancements in the manufacturing industry under the label Industry 4.0 create awareness in other segments, too. Among Industry 4.0, *Logistics 4.0, Workforce 4.0*, even *Information Technology 4.0* and *Infrastructure 4.0,* the term *Mobility 4.0* enters the stage. A vision of Mobility 4.0 has been shared by the Taiwanese Minister of Transportation and Communication, Mr. Tan Ho-Chen, at the 16th Germany–Taiwan Joint Business Council in Berlin [59]. Mobility 4.0, according to Minister Ho-Chen, is capable of deploying the following:

- People centered transport
- Mobile technology
- Seamless integration.

People centered transport offers personalized services, builds customer relationships, helps before passengers ask, and offers help to those in need. Mobile technology ensures an "always connected" momentum and feeds passengers and decision makers with real-time information where necessary and useful. A seamless integrated mobility offering can be looked at as an outcome of smart mobility, but also as helping to improve the service flow and find intelligent ways of new mobility offerings.

The plethora of players that are encountered with regard to the above outlined "4.0" movements influence and boost mobility initiatives. Everything and everyone connected will not stop in front of a governmental bulletin, a public transport bus, or a group of travelers that met "coincidentally" through a pop-up mailing that offered vacancies in a seminar that takes place "accidentally" nearby and matches with the travelers' business profile. Industry segments converge, and the same accounts even more for those that seek the optimum mobility offering.

The Mobility Ecosystem

3

Barbara Flügge

Abstract

It is our aim to approach intelligent, hence Smart Mobility as a design element for our habitat – and not as a necessary, investment intense effort. Addressing a habitat's needs opens up the mindset to identify the design criteria of ecosystems: societal and economic elements that make mobility capable of being consumed by everybody. This chapter elaborates on the elements of ecosystems, user groups, interactions amongst users and assets, and the advancements in service thinking. A role model for service-oriented functioning is being presented as well as the concept of usage scenarios that help to get started with Smart Mobility undertakings.

Contents

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3.1 Driving Mobility Through Smart Mobility Design

Mobility is a core element of freedom. The convergence that takes place in industry segments is even more apparent in our daily, private mobility enhanced lives. Once we are mobile, we decide upon joining a meeting, taking part in a soccer game in the village nearby, spontaneously deciding to have a coffee in town, or seeking medical advice at the pharmacy instead of feeling insecure and staying at home. Once we encounter un-mobility, decisions weigh more heavily and narrow our activity radius.

Judging the right to mobility should also be linked to the effort it takes to make mobility happen: time, costs, agreements, and alignments. One could argue that these four elements are the cornerstone of the DNA of the *Mobility Ecosystem*. Even when we are clear about the need to travel, we ask ourselves "being mobile yes, but how". Therefore it is not astonishing that even we as experienced business travelers consume on average between one to four hours in the planning and booking of a trip. For sure, the effort increases with distance and complexity in conjunction with other transport means, connecting flights and requirements with colleagues or business partners.

The increasing movement of being mobile we encounter beyond physical mobility. The extended mobility through digital means such as devices, smartphones, and tablets ease to a certain extent our travel management efforts. We are able to be heard in real-time, consulted in real-time and served in real-time. More than 100 travel management solutions ease travelers' lives in Europe to date.

Are there any white spaces remaining? Have we already arrived in the Smart Mobility age? And how can we explain Smart Mobility momentum to those that have not yet encountered digital devices or that do not have the budget or capability to apply them?

As outlined in the introduction, the path towards digitization has not yet come to an end: yes, sensors, induction guided traffic light systems, and connected assets are in use. The innovation force of *Smart Mobility* should be – from our understanding – then measured to be fully leveraged once Smart Mobility is applicable and available for everyone, regardless of location, region, and country, independent of length of usage and duration, and independent of individual skills and budget!

So let's get started!

Examining other work on mobility, you might encounter a discussion about "one whole with two parts" – consisting of a network of mobility providers on the one hand and a network of consumers on the other hand. We take a different path and approach mobility as how it emerged originally! Driven by contextual needs and dependent on the preferences of individuals and organizations that seek to achieving something great for their location and region – regardless of their formal roles and responsibilities. That contextual link is to be found in the ecosystems. We are all part of a minimum of one ecosystem. We live there and we work in one or many. We travel to them and we sell and consume in ecosystems. Ultimately, we are part of the whole.

We might not even perceive or like it, but we play a role in the considerations of those that plan and deploy mobility. In an ecosystems context we ask different questions, such as the following, about our own share and influence:

- In case we are not mobile or travelling, does our non-mobility moment trigger a digital event in a prediction system and translate our "not travelling" into "no intention to be mobile"? Do decision makers reason a smaller infrastructure effort based on our non-mobility moments? Could it be that the bus stop around the corner will be shut down because of that?
- In case we are not mobile at the moment and we are not travelling, how are decision makers deriving the real motives of our travel plans? It might be the shopping impulse that urges us to travel with a specific means of transport or it is the suitcase that hinders us in making use of public transport at all – owing to the lack of escalators or non-functioning elevators.

Let's take those distinct viewpoints into consideration in various guises throughout the course of this book!

3.2 Introducing Ecosystems

3.2.1 Habitats in Nature

The term "*ecosystem*" has its roots in ecology. Biologists and natural scientists speak of an ecosystem when referencing a system that consists of a habitat, all living organisms, and all non-living physical and chemical factors of the observed environment. Living organisms are plants, animals, and microbes. Non-living physical and chemical factors relate to those assets that ensure a sustainable nutrition and energy flow. The analogy to "system" is essential here as it ensures an over-arching functioning of an ecosystem driven by the following key characteristics:

- Interaction among living organisms
- Asset management covering stages of creation, operations, reuse, destruction, release, abolishment of assets and objects in the habitat
- Establishing energy and nutrition cycles to safeguard the living and survival as well as to preserve values and benefits for all members of the ecosystem. The latter aspects target guests and visitors to an ecosystem.

It can be concluded that the overall quality of an ecosystem correlates with the degree of collaboration and engagement, the ease of access to resources and assets, as well as the meaningful use and utilization of the existing environment.

In literature and science there are hundreds of variants of the term ecosystem. One of the most original definitions is the one from Arthur George Tansley from 1935 [60, p. 299]:

> But the more fundamental conception is […] the whole system (in the sense of physics), including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment of the biome – the habitat factors in the widest sense. […] but certainly the inorganic 'factors' are also parts – there could be no systems without

> them, and there is constant interchange of the most various kinds within each system, not only between the organisms but between the organic and inorganic. These ecosystems, as we may call them, are of the most various kinds and sizes. [60]

Examples of ecosystems in nature are lakes, the beach, the sea, a fenced landscape. In the example of the sea we notice the transition from sea to coastal ecosystem. In many cases the transition or crossing from one ecosystem to another one is floating and yet necessary for both ecosystems to keep functioning.

The critical reader might argue that the collaboration and habitat engagement are not the focus but the principle of the survival of the fittest where the strongest, but also the most interactive and active contributors, increase their chances of survival [61].

3.2.2 Economic Constructs and Other Ecosystems

In the past years the ecosystem as construct emerged in business terminology. The functioning of ecological habitats such as nature, forest, water, or landscapes, and the above outlined characteristics of interacting, asset management, and cycles of energy and nutrition critical cycles can be equally applied to *economic constructs* and *human habitats* and environments. They might be also referred to as *hub, business network, connected economy,* and even *social network*. Cities, ports, airports, university campuses, and locations that have been selected for mega events are examples of economic and societal driven ecosystems.

The overall objective to participate and gain a share in the global trade economy asks ecosystems to establish a healthy hub economy on-site. Cities and human settlements follow that principle, as do other systems. Firstly, they embrace a significant number of acting businesses and governmental institutions, citizens, and others. Secondly, cities are aiming to achieve something together without neglecting their individual and institutional objectives.

The challenges for the ones that steer the wheel of the ecosystem are manifold. Among those we noted the following two drawbacks as dominant growth limiting factors:

- Missing interaction capabilities among business partners and data source providers lead to manual efforts, process breaks, delays and mistakes in decision making and taking.
- The choreography of assets, goods, transportation means, and personnel often takes place in a bilateral one-by-one manner and without knowing about influencing factors such as geographical positions, congestion issues, construction areas, weather, and available space.

Hence, those that survive and generate local growth are capable of finding and interacting with the most innovative business and institutional partners within their business network. Not only governmental and business leaders are being asked to act, but also the overall population and the individual citizen. The multi-diversity of a business, economic, or other

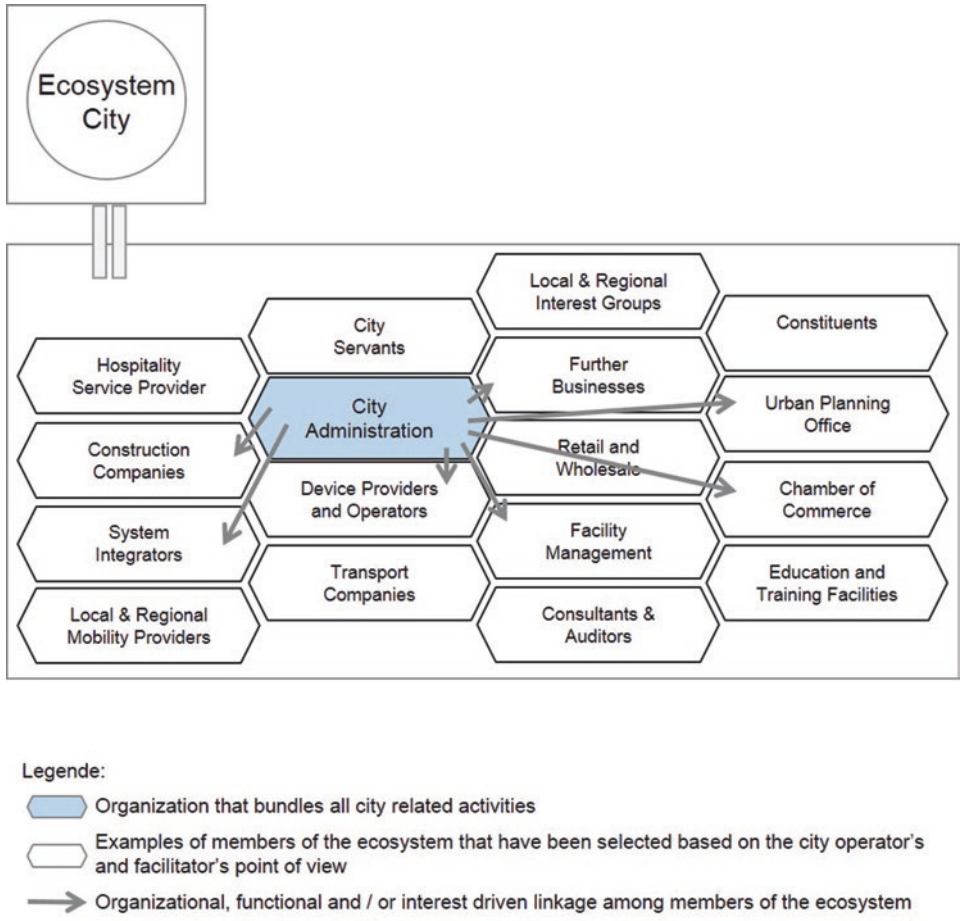

Fig. 3.1 The ecosystem "city" – an example

purpose driven ecosystems can be best captured in a schema we designed. One example of the schema depicts the ecosystems of a city, as shown in Fig. 3.1.

The predominant characteristic that helps to differentiate the needs of a city compared to a port for example is the element "*context*". In the same way as for the ecological ecosystem, the context addresses the adaptability of the living and non-living organisms with respect to an observed ecosystem. The contextual setting in a forest to move around is different than in a lake, for example. Another example relates to communities that grew over time in the nineteenth and twentieth centuries. They face their very own challenges by geographical boundaries, de-centralization of goods supply, and might be not competitive enough to cope with regional business trends. The impact results in investment drawbacks, a reduction in population, and a loss of brain and social capital.

It is not necessarily said that we expect different behavior and attitudes or that there is a predominance in one context compared to another. The context allows us to have a

focal point that guides and consults about potential changes and influencing factors. Initiative leaders that operate ecosystem-wide should take into account the efforts to (a) adapt their findings because of environmental changes on-site and (b) transfer them into other environments.

Kingsley references context with regard to the early urban settings [62]. Other ecosystems are contextualized by the business segment, for example supply chain management [63]. The contribution from Scharmer and Käufer relates to the socio-critical aspects of collaboration in handmade ecosystems [64]. The most common *contextual* objectives are the following five:

- Social bonding: having the mandate or urge to preserve the societal belonging of individual, institutional, and organizational entities
- Value driven bonding: maintaining a community of values prior, during, and after an incident or event
- Commercial bonding: service and/or product supply as well as service and/or product deployment imply further ecosystem relevant actions
- Purpose driven bonding: being an economic, political, or timing related purpose that leads to a multi-sided collaboration in an ecosystem
- Incident driven bonding: an incident raises the sense of urgency and asks for a resolution.

Can *ecosystems* be measured against the above outlined contextual objectives? The measures we propose are of an ecological, societal, political, and cultural nature. Their connectedness, yet interweaving aspect, asks for a multi-sided assessment: not only taking the cash cows and revenue generating participants into account, but also the ones with the most promising outlook and influence. What does it take for organizations to gain access to an ecosystem? And how is access managed anyhow? The ecosystem example in Fig. 3.2 illustrates those questions.

All members of a system should get the chance to participate and being heard. The way of addressing as many as possible participants is directly linked to the nature of the overall aim. If the perceived value gain is of an economic nature, the benefit in return should result in an economic outcome. Where the aim is to improve quality of belonging, livability, and safety within the ecosystem, the addressable entities within the ecosystem derive from an analysis of organizational mission and vision and the positions that are being obtained to date. The outcome is then measured against the rankings in the Safe Cities Index from the Economist [65] or other kind of ratings and rankings.

Next to the contextual assessment there are few publications that concern the least relevant number of participants to make an ecosystem function. Long-term studies [66] showed in one case that an industry-focused region consists of hundreds of participating micro-organisms that ensure stability and bring competences into the market. Even further, those hundreds of micro-contributors balance out the dependency of the region against one industry player. Small to medium-sized settlements such as urbanizations, villages, and small towns do function despite a small number of organizational bonded entities and because of a strong community spirit and strong interaction.

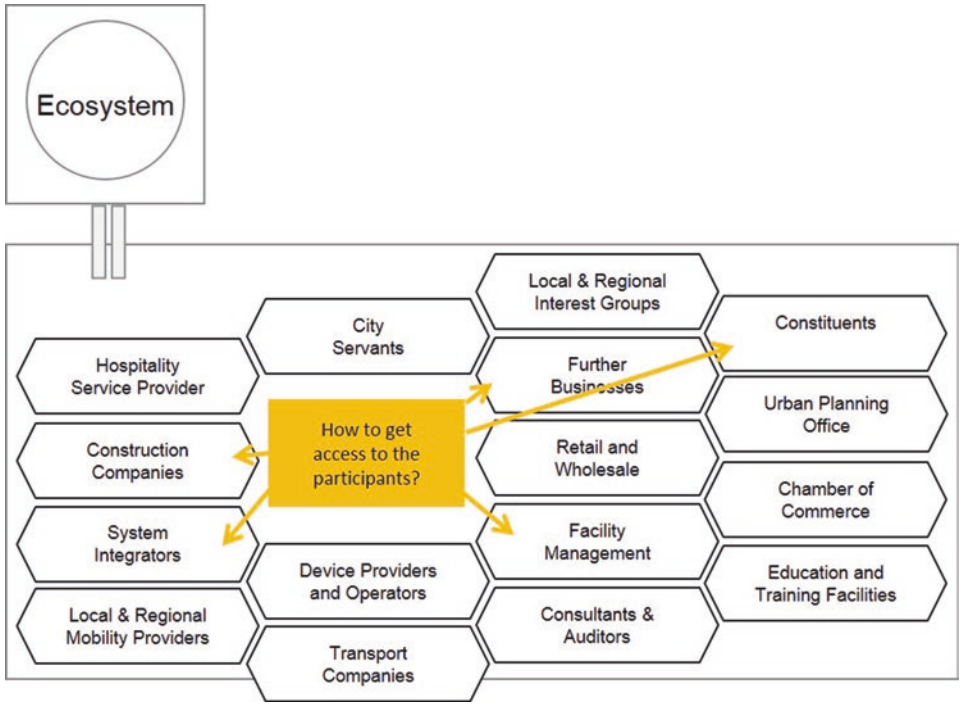

Fig. 3.2 Joining the ecosystem – managing the access

As rule of thumb, you find up to 10 functional clusters that contribute to the wealth of an economic driven ecosystem. In contrast, being dependent as an ecosystem on one to three clusters will diminish the further development of the ecosystem. Cluster-specific growth benefits from a positive synergetic effect, as for example in the shipping industry: the settlement of adjacent business activities such as pallet rental or a company that specializes on interior construction and fixtures draws in further functional business processing. Clusters are referred to as industry segments and industrial pillars.

A comparison of assets that are alike within an ecosystem and those that reveal a greater variety gives insights into the ability to connect one ecosystem with another. The illustration in Fig. 3.3 depicts the overall principle. Asset relevance could be the subject of an entire book. We hereby would like to emphasize that an asset is a critical element that influences, if not steers, the transformation capability of an ecosystem.

In that respect, an asset related analysis takes place ideally under the umbrella of an *ecosystem assessment*. That assessment takes place with representatives from distinct organizations, public and private, individual and institutional members. Different to traditional workshop settings, ecosystem assessments concern the following considerations:

- Should an ecosystem maintain a variety of distinct assets that ensures operations and growth to the population? Should a city ecosystem decide for a core industry that, for example, triggered the build and growth of the city in earlier times?

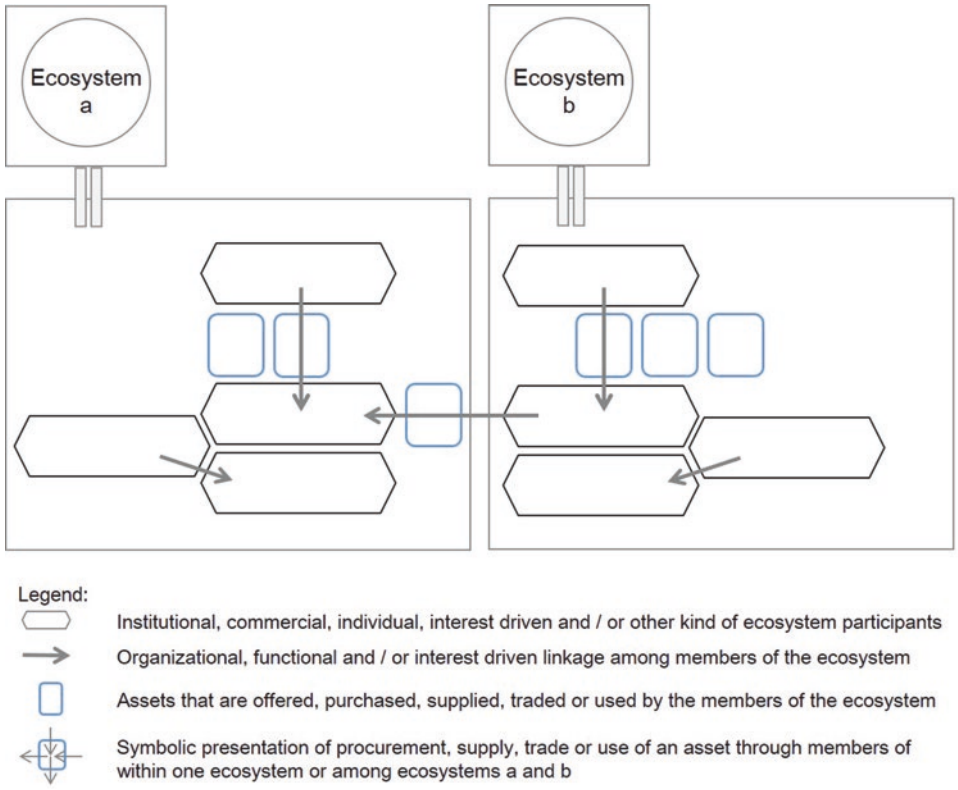

Fig. 3.3 Asset triggered connectivity

- What are the consequences in case an ecosystem decides to focus on one industry or functional segment? Taking a look at the targeted industry or business function are there already examples of other regions that decided to focus on that particular industry?
- How do business driven ecosystems sustain geopolitical influence, competition, and further risks like migration and incidents such as natural catastrophes?

3.3 The Digital Ecosystem

Taking Tansley's definition of ecological ecosystems into account and transferring it into our present and undoubtedly digitalized (or digitized) habitats, the digital ecosystem as a construct is born. Before getting into the definition the following examples illustrate its meaning.

Business networks rely on the commercial and Information Technology (IT) fostered partnerships with other enterprises and organizations. Speaking about the relevance of digital business networks in the course of the acquisition of Concur, SAP's CEO Bill McDermott

emphasized the global networked economies that benefit from a reduced business processing complexity without compromising on procedures and governance frameworks [67].

Next to economic driven functions and process optimization another focus area emerges in ecosystems: disrupting business functioning today with IT and new concepts for service providers to "get access to new markets" and ultimately get access to "new innovative business models" [67]. With respect to mobility we could envisage an analytical outcome of mobility profiles for business travelers that, for example, meet four times a year in the ecosystem "trade fair" and conduct business relevant and social activities.

Elaborating on the power of social networks, Christakis and Fowler define the network as an "over-organism" network that governs the thinking and acting of network members and their influence on outsiders [68, p. 15]. *Social networks,* consciously or otherwise, do influence at least, if not dominate, our acting and interactions through digital means. The authors apply examples along the lifeline of archetypes to picture the influence of social networks. Another contribution is made by the interest group Co:llaboratory e. V., which provides examples of technology oriented ecosystems adding the elements of architecture and platform [69].

Concluding our discourse on ecosystems we apply the ecosystem definition from Tansley and derive the following definition of a *digital ecosystem*. That definition is used throughout the course of this book.

▶ A digital ecosystem is a functional habitat that consists of individual and organizational entities, organisms, infrastructure, assets, and all non-living natural and anthropological environmental factors that all interact with each other and with the environment in energetic, value, and service oriented, textual, informative, and digital cycles.

3.4 About Users, Consumers and Personae

3.4.1 Targeting and Designing an Ecosystem Through Consumer Behavior

Targeting new apps and services from an end user's perspective asks us to consider user specific requirements and needs differently than what has been described under the traditional term "user". Users *per se* have been denoted as co-workers in IT departments, using tools and digital means for the daily business: this being communication and decision making processes, accounting or sales order management. With the rise of the Internet, private households and their members appeared on the scene as application users or app users. Those private individuals demonstrated, many years and almost decades ago, the untapped market in the business application business when transforming private asks into business asks in a creative manner.

With the lasting hype of the American *Design Thinking* method [70] the term user became outdated and the term persona (plural personae) emerged. The "user" appears too stereotypical and too focused on task processing, and restricted mostly to intra-organizational

duties. Design thinking aims for a persona driven design of products, services, and applications in a three-tier approach: an offering is capable of (a) meeting a user's needs, wishes and enthusiasm (desirability), (b) fulfilling the service provider's economic targets (economic viability), and (c) is deployable technically (technical feasibility).

Thus the "persona" describes an archetype of a user that comprises alike or similar behaviors of consumers. Examples of personae are "20 to 25 year old consumers", the persona "recurring cruise passenger", the persona "traffic management analyst", or the persona "business traveler". The description of archetype characteristics resonates as reproductions of alike acting consumers and their behavior driven acting, wishing, expectations, and needs. Service and product designers create a relation to reality and moreover provide a reflection space, so to speak, for project participants to step into the footprints of a persona. Once one has stepped into the role of a business traveler for example, the illustration of a business traveler's service expectation and mobility needs is made easier, more haptic, and more fun.

The vehicle to get much further into the consumer's way of acting and deciding is to gather consumer needs in a holistic manner from the first idea towards consumer accompanied product development up to its use. In addition, a persona driven assessment tackles economic and societal characteristics. Much has been discussed about the economic aspects of a persona's contribution to an organization's economic advancement. The same accounts for a persona's relevance to disseminate new offerings into his very own social network as a multiplier. Moreover, the societal aspects provide clarity about a persona's motivation to join, reside, transfer into, or leave an ecosystem! Those aspects are:

- Ensuring the interests of the persona
- Design a persona profile that is adaptable and expandable
- Gaining insights about the positioning of a persona within a network
- Fostering transfer of knowledge and insights
- Driving consensus driven collaboration
- Sharing common interests, and
- Forcing collaboration.

With regard to *social networks* those *business networks* are more successful than others once their offering and fulfillment of services is being facilitated ad hoc, meaning at just the right moment and at the exact location where the consumer is. Social network operators demonstrated that there is room left for opportunity! In the field of business networks those who will succeed are the ones feeding the appetite for services right away, at the very present location. Consequently, an individual receives instantly a service fulfillment notification right in the location where he is: this being the office, in the bus, or at the tourism office awaiting concert information at the desk and receiving a voucher for the nearby fashion mall via a smartphone.

Persona driven needs are best fulfilled before an incident occurs or emerges. One example is the pre-booking of a repair service for the electricity meter and the energy

efficient configuration of the new washing machine – based on the persona's profile and laundry habits. Furthermore, the digital service operator is aware of devices-in-use, checks them, and turns them off as a precautionary measure. An energy conscious tourist persona, for example, chooses a hotel with an intelligent control management systems that is able to reduce the energy consumption, dimming lights, informs the personnel on time in case of planned repair services and changes, and so forth.

A well-managed service provisioning is encountered in social networks where an optimal service mix is apparent: (a) user driven functionality and (b) unexpected, free of charge service offerings. An example of (b) is the upload of photos onto the hotel room's television, placement guidance for recently purchased media and hardware at home, or the offering of video snapshots on the user's device for a 20-minute ride on the urban metro. Thus consumers – driven by their behavior, reaction, and service asks – turn into the real designers of ecosystems.

3.4.2 The Digital Consumer

A new personae enters the scene as a result of Industry 4.0 and the Internet of Things (IoS): the *digital consumer* appearing in the shape of sensors, wearables, intelligent fabric, component and product suppliers, and the product itself. Seamlessly embedded in the working industry, the counterpart of the digital consumer encounters its new buddy in real-time time in preparatory, counselling, and aftersales instances.

The connectedness evolves from intra-organizational manufacturing and highly dependent supplier-manufacturing processing into lively, cross-industry and inter-organizational ecosystems: seaports, cities, rural areas, airports on site or as an ecosystem element in cross-regionally organized manufacturing and distribution chains.

The demand for individualized, "design-your-own" products and an increasingly growing seasonal trend caused by fashion trends, events, and celebrity targeted design seek solutions from the manufacturing industry. One of the prerequisites is sustainable and cost efficient manufacturing, obtaining supply and distribution related information and behavioral changes during and after production [71].

Industry 4.0 enables all participating parties to develop power offerings that foster digital growth. It is the mandate of companies and government institutions, as well as individual users, to promote innovations: from design via piloting up to the deployment. Thus, Industry 4.0 turns into a movement that targets all.

Industrial players have a unique opportunity to transform a business into a service business along the digital value chain for digital consumption. They are complementing existing and/or new products with service offerings. Another opportunity is to eliminate under-performing and paper-based activities in an organization's business network or transforming activities into re-usable and effective services. Service examples are maintenance and repair, and machine lifecycle and operational optimization. This phenomenon also accounts for IT related products: offerings such as Platform-as-a-Service

(PaaS), Infrastructure-as-a-Service (IaaS) and Software-as-a-Service (SaaS) are providing businesses with more flexibility in the demand fulfillment. And ownership of a physical platform, a computing center, is not necessary anymore.

Compared to Industry 4.0, the IoT targets digitization and connectedness of all items. Beyond and independent of manufacturing, supply and distribution processing "items" encompass items of daily use, assets, and any item from any other adjacent industry and segment. The IoT bridges the private consumer's demand with the business and governmental supply ultimately.

It is projected that to date 50–200 billion things, and tomorrow many more, experience digitization and connectedness. These items act amongst us, the users, and the operating units as information and data carriers. Information technology in the guise of sensors, wearables, and mobile devices acts as digital consumer. The above exemplified services turn into a critical element of the solution portfolio. The ratio of digital service trade and data trade to physical trade will increase over the following years on a global scale.

How is the Digital Consumer acting in an Industry 4.0 like attitude? Talking already about Mobility 4.0 as the complementary element next to Industry 4.0 and Infrastructure 4.0, among many other "4.0s", a seamless mobility offering enhances the integration of assets, goods, and other things in our daily lives. Once the digitally enhanced "everythings" know how to order, deploy, and report back on the service experience, the human counterpart is asked to prepare himself for a whole new demand and fulfillment experience.

3.5 Servitization and Interactions

3.5.1 Services, the Commodity for Intelligent Applications and Things

Innovative approaches such as the ecosystem-analytical assessment of emerging trends for cities, airports, and seaports stand out from the traditional approach when it comes to evolving a modern and future driven mobility, hence *Smart Mobility*. Attributes such as modern and future imply looking way beyond single instance ticketing, seat provisioning, and reservation systems in a city train or car supply and share.

The *service principle* comes into play. Take a look at the generation of Gross Domestic Product (GDP) in your country. You will encounter a growing attention to services, proven by their greater economic contribution compared to products. The services sector as such embraces multiple industries such as insurance, real estate, human resource and recruiting, consulting, and auditing. The growth areas are, to date, the retailing industry and those segments that benefit from a service-led packaged offering in the fields of healthcare, leisure, sports, well-being, and fashion consulting.

The term *service* by nature can be technical, business related, or craft related. In German we distinguish technical services (*Dienst*) and business services (*Dienstleistung*). In other languages you do not always find a clear distinction. It is helpful to gather the world of

services by the following examples: (1) technical services such as maintenance of an elevator or repair of a car, (2) technical data event that pings to the engineering organization of the machine manufacturer that one of the spare parts needs to be exchanged, (3) business services such as consulting gather market data and wrap them up in a certain format (a benchmark study for example), or (4) execution of a booking services to get the technical expert on-site for a machine repair. Ultimately, services turn into assets, being a perceived value for consumers or a competitive advantage as part of a product-based bundle. Regardless of the application area, consumers and buyers expect a coherent *service process* from the moment interest is generated via ordering and up to the point of delivery or fulfillment.

The *service principle* manifests itself in the following seven trends:

- Trend 1: Market growth by services will continue and influence a region's and a country's economic footprint.
- Trend 2: Anything-as-a-Service is yet to come in cross-industry, ecosystem spanning businesses.
- Trend 3: Geographical decoupling of service order and service deployment is needed to advance in the services sector.
- Trend 4: Electronification and Digitization of service ordering is advancing.
- Trend 5: Business transformations are required to leverage the services potential.
- Trend 6: Enterprises' and consumers' mobility increases further.
- Trend 7: Mature IT awaits intelligent content.

Through our work with forward thinkers and experts we started to investigate the anchoring of services in a digital manner. Digitization could encompass the use of web-based services, trading services via an online marketplace or service store. Why do digital services receive more and more attention? Despite the fact that traditional online services rise in number in the retail and tourism sectors and that they experience a greater conversion rate, through global promotion services, the benefits of digital services still got stuck in the tunnel: stuck in the tunnel of simplified online activities such as price comparison, hotel bookings, and train-to-airport services. Other industries than retail investigated and piloted in service digitization. Examples can be seen in the insurance, manufacturing, shipping, and operations industries. What is still missing?

In the process of deciding in favor of a bundle, product, or individual service the consumer applies a number of selection criteria, by intention or unconsciously. The four key criteria are:

- Expected value of a service that is being proposed
- Excitement that is generated to have and own the product
- Geographical reach concerning the quick and efficiently as possible access to the product or service
- Service competence concerning a provider's competence to deliver the service that has been offered, promised, or assumed.

Once the consumer concludes his selection the matchmaking between offer and demand takes place. Compared to products, service providers already made use of service variants, amendments, and re-work in the past. It is in his hands now of projecting consumer demand in an optimum and hopefully creative manner. The more efficiently and effectively the matchmaking process is being safeguarded by IT, the higher the probability that the original demand of the consumer is fulfilled by a product or service that is being delivered.

Excitement is more than ever the glue that binds consumers to providers. Thus, consumers expect the service to do better than expected. Personalized services are key to turn one-time consumers into long-term service customers and fans that sell forward the experience and excitement to others. With respect to "long-term", the targeted consumer relationship might last for one season, a business year, or for an event. Pop-up services that emerge for one specific event (e.g. the Olympics or the SuperBowl) have proved already by attendance numbers the dedication, investment, and planning efforts. The variety of offerings and bundling opportunities with products, gadgets, fan experiences, loyalty programs, and personae and interest matchmaking are far more than what we encounter and could think of today.

Service providers from private and public institutions and organizations will see a greater demand in the how-to of service deployment. Moreover, skills and competences that are being built from the product-oriented functioning of an enterprise will evolve further to get used in service orientation. Thus, customer-facing competences need to cope with an increasing number of interactions with business partners and prospects. Those interactions often go beyond an interest in selling towards an interest in collaborating and networking.

Consequently, customer experience techniques and the relevance of incorporating service feedback cycles need to be designed into the service offering. The virtual digital interaction goes hand in hand with the physical one where sales personnel are promoting services via direct contact through call centers and on-site visits and events. The service sales, on the other hand, should be efficiently provisioned with IT specific means. As a result of our work, for example as a member of the leadership team of one of the largest innovation programs from SAP, the TEXO program [72], a comprehensive analysis of services, their design elements and service characteristics took place in five living labs, covering insurance, banking, and healthcare service designs.

With respect to mobility related services, we recommend you apply the above outlined seven trends as depicted in Table 3.1.

Table 3.1 Converting Mobility into Mobility-as-a-Service

Service principles	Recommendation to proceed
Market growth by services will continue	Leverage existing enablers (devices, apps, physical ticketing booth, and service desks) and integrate them into a contextual digital network for mobility accounting
Anything-as-a-Service is yet to come in cross-industry, ecosystem spanning businesses	Define a data model that incorporates things, physical and digital assets, personae and contextual information from publicly available, publicly chargeable, privately made available, and privately chargeable points of view

Table 3.1 (continued)

Service principles	Recommendation to proceed
Geographical de-coupling of service order and service deployment	Design a door-to-door, ideally cross-regional or better international, mobility process as conducted in our Smart Mobility project. Thus, the opportunities for geographical de-coupling per se will be revealed much more easily than for one singular instance, a city for example
Electronification and Digitization of service ordering is advancing	Gather known and unknown digital touchpoints for service ordering Gather known and unknown physical touchpoints for service ordering
Business transformations are required to leverage the service potential	Implement a zone to win, to comfort change management needs
Enterprises' and consumers' mobility increases further	Think personal – despite the impressive number of connected devices, the user at the end determines if the adoption turns out to be recurring or not Insights into churn rates from the telecommunications and the utilities industries should be gathered to overcome similar design failures in, for example, flat rates, all-inclusive packages, and the minefield of roaming charges. Insights into the insurance industry ease the gathering of consumer-to-business demands
Mature IT awaits intelligent content	Content provisioning is one of the minefields of anything-as-a-service: the primary questions in business model designs are often "Who operates the service?" and "Who manages, aka sells, the content?". Skip those two questions! It is recommended to decouple content contextualization (local) from content operation (virtual) It is also recommended to allow existing players, on-site or elsewhere, to transform into multiple service roles The design circles should foster the inclusion of unassigned black boxes and white spaces throughout a minimum of five design iterations

3.5.2 The Internet of Services Role Model

The authors have been investigating and observing services and *service connectedness* in complex economic structures for quite some time – being ports, airports, cities, trade fairs, or mega events, whether local or virtual ecosystems.

The construct that is being used is the *Role Model* of the *Internet of Services* (*IoS*). Through the conduct of *ecosystem assessments* one area of investigation is the behavior among and between participating members, numbering 30, 100, or 1200 and more. The

behavior amongst further characteristics gives feedback on service personalization and service provisioning and sequence. Market entry opportunities are based on characteristics such as:

- Ecosystem members and participants
- Interactions and ties as part of the connectedness analysis
- Service design, development, and testing the market entry in a predefined environment.

3.5.2.1 Analyzing Stakeholders and Participants in the Ecosystem

A *stakeholder analysis* opens our eyes as to who is out there in the ecosystem. The full-end analysis is relevant regardless of the size and geographical reach of the ecosystem. Experience has shown that often the analysis is abandoned too early. If 20 or 100 participants are being listed and coincide with their own or sponsor-incorporated judgment, certainty might emerge that the analysis is complete. But the analysis might turn out to be wrong and the conclusion false. In particular, the ever-growing inclusion of further personae reveals mission critical insights into the probability of success and failure as well as the optimal service mix.

The analysis of personae and ties is intense. The *IoS role model* facilitates the categorization and clustering and directs the analysis of roles and responsibilities. We distinguish the following roles: *Service Provider, Service Hosting, Service Gateway, Service Broker, Service Aggregator*, and *Service Channel Maker*. Figure 3.4 illustrates these key six roles and their scope. Organizations, being public or private units, might perform one or multiple roles dependent on bias, business mission, and organizational outline.

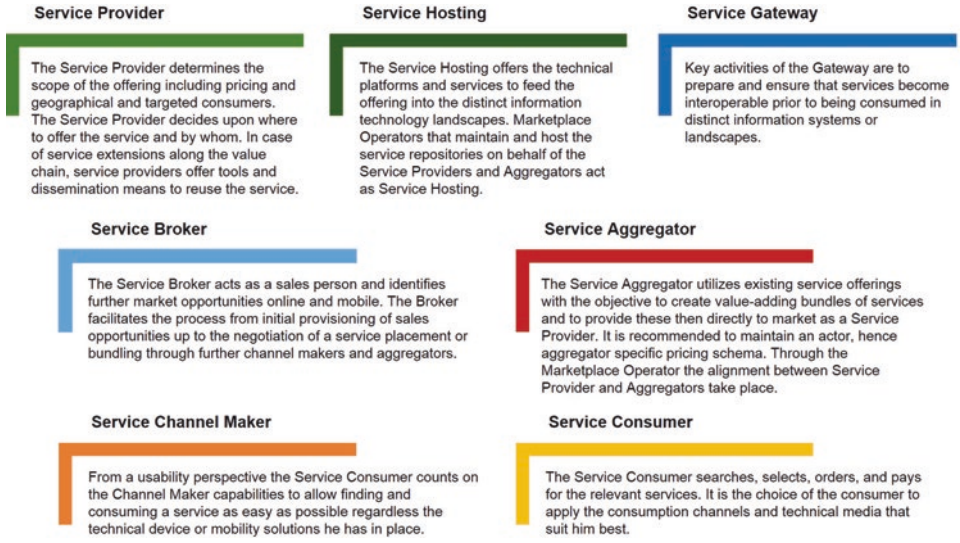

Fig. 3.4 The IoS role model – roles and responsibilities

The above introduced roles and their scope of responsibilities are understood as a schema that is being applied by service providers and those that seek to become part of the *digital service business*. The digital homes of these web-based service businesses are *service marketplaces* or so called *Service Stores*. Which organizations occupy which positions in digital trade is subject to the positioning of the organization within the IoS Role model. A key parameter that drives the positioning is the *context* in which the organization operates at present or seeks to act in future.

Organizations that seek to grow in the digital service business should check their compliance with a minimum of three of the following assumptions:

- Allowing the co-existence of other providers out there
- Prospecting the unlimited reach of the offering
- Grounding the project in network design
- Being prepared to encounter digital business opportunities, hence encountering opportunities by coincidence
- Selling forward by including those that should not be forgotten – ad-hoc user groups, welfare organizations, and other interest groups.

Further parameters relate to the questions about future roles and the condition framework to be able to take over a role from another actor or to release a role and make it available for others. An eye need to be kept on the value proposition of services. The depiction is conducted ideally in segments. Segments follow the roles. Further possibilities are the bundling of services into one sales offering and the rollout of tasks by another actor.

The increased interest in an ecosystem-wide spanning elaboration supports governmental institutions and the private economy alike along analysis, planning, and deployment processes. The holistic view fosters role change and requires a coherent project approach. It asks for cross-stakeholder communication and an interest in engaging along the respective project phases. The proposed *project phases* are illustrated in Fig. 3.5 and detailed in Part III.

Once an organization is in favor of a distinct IoS role and task area, the next steps concern the detailing of the expected value propositions, competences, impact on operational and

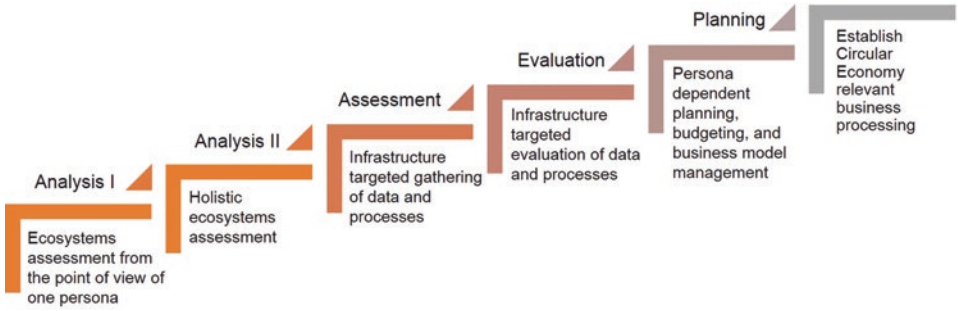

Fig. 3.5 Smart Mobility – ideal project phases

organizational set-ups, as well as the newly resulting competitive situation. The evaluation should be counterchecked against expected efforts to obtain the preferred position. Thus the efforts to transform from status quo to the preferred position are identified, too. A list of *effort categories* is useful to identify pros and cons as well as the status quo and future state.

Not necessarily all roles are assigned to distinct organizations. In our discussions with service providers, one organization considered occupying all of the roles excluding the marketplace operational part. Another organization, a North American-based solution and service development organization, focuses for example on the service provider and service aggregator activities. That organization does not seek to take over brokerage or gateway specific tasks. These are performed by the organization's business partners.

The reconciliation of present and future state implies an assessment of technical impacts and potential resulting barriers caused by unfinished, but essential developments. Technical implications result, for example, out of security, performance relevant, and data security based requirements. Earlier project work from own and third party stakeholders might contribute assets, achievements, and deliverables. Stakeholders are, for example, industry leaders, research projects, and others.

We recommend to design a *business development graph* that illustrates the analytical results of preferred and future state of your organization. Furthermore, those feed the decision making process that signs off or rejects the preferred position in the targeted area and geography. Once the decision is made in favor of the preferred position, the earlier introduced effort categories form the basis for deployment planning and execution.

3.5.2.2 Interacting as a Member and Participant in an Ecosystem

Service oriented acting is, in the view of the authors, the only realistic response to fulfill the demand of market participants and consumers and to keep the habitat and/or the economic functioning onsite alive. An ecosystem that is capable of this we refer to as s*elf-sustaining*. Envisioning an optimal service offering and the ideal sequence of launching it in an ecosystem goes hand in hand with the degree to which services are made tradable. Service trade should be facilitated by physical and digital means as well as the underlying interactions. Interactions are the ties that market participants have between each other. The service itself functions as a motivator to drive the analysis of relevant interactions.

It would be naive to assume that a thought-out interaction design is the cure of all ills. Planning, empathy, and openness to interact with ecosystem wide needs are equally as important. The discipline of *interaction design* thus emerged from a mix of activities within market research, marketing, and network theoretical considerations. The fresh, open, but still structured approach eases the distilling of relevant, useful, and influencing ties among customers and suppliers, service personnel and dispatchers, technicians and sales executives on-site.

Because of *design thinking*'s role in product and idea modelling, established methods and approaches that concern the analysis and definition of interactions evolved. Interaction design is being commercialized in these days extensively. It also entered academia.

The Copenhagen Institute of Interaction Design (CIID) [73] is one of the key contributors here.

Methods such as the one from the author concern the evolvement of the dialogue among distinct parties. Thus intra- and inter-operational and organizational service processing is being observed. The method itself we refer to as *Service Dialogue Process*. Another method uses *Ecosystem Assessments*. Here a four-stage approach guides the participants through projected target area:

- Assessing innovation potential and challenging current role(s) and planned role(s)
- Identifying service opportunities
- Investigating the business models for the future
- Identifying collaboration and innovation synergies.

One to two days of conduct are sufficient once sponsorship, focus, openness, and drive for creativity and dedication are given. In addition the use of *Strategy Maps* from Kaplan and Norton [74] is recommended, too.

Among the various methods and approaches the following are of utmost benefit:

- Ecosystems Assessment
- Service Dialogue Process
- Customer Journeys
- Design Thinking
- Usability Testing.

Further techniques are introduced in Part III (Chap. 12).

3.5.2.3 Service Design

The view of services is different where a user is looking for help or support compared to a consultancy that offers assessment services or business process analysis services. All services consist of a number of elements or categories that differentiate based on the service type and user's/consumer's service quality perceptions. They can be further grouped into, so-called, service layers.

Service design starts with a status registry of existing, and a list of envisioned, services. The recommended *service definition schema* is depicted in Fig. 3.6. It eases the identification, the systematic approach, and the revelation of new services.

The mapping of service elements as outlined in Fig. 3.6 is an interplay between analyzing digital services consumption in web-based, mobile, or other formats and determining the digitization capability of the analyzed services. Thus the analysis of the services follows the overall assessment of the digitization capability. The reason is that service designers tend to focus on specific technical means and consumption channels. If an organization is targeting the digital market purely then the assessment of physical services becomes obsolete. In addition, some services can only be fulfilled through digital means.

Fig. 3.6 Service definition schema

Once the digitization capability of a service is determined, *usage scenarios* are identified and services are described in a unified description language to ensure their applicability in local, regional, and international contexts.

In our work we focus on the following key elements of service design:

(a) Single-sentence statement about the value proposition of the service
(b) Asking for the interest of the user via interviews, observations, and customer journeys
(c) Briefing about the scope of the service in a technical, functional, creative, design, and interaction manner
(d) Defining an understandable pricing schema(s)
(e) Formatting the service to offer it in distinct digital ways
(f) Making use of recommended engines and other mechanisms to gather consumer interests and feedback
(g) Allowing the user to express his interests by identifying what he is looking for to get to the right service
(h) Deciding upon service offering features
(i) Defining the publication mode(s) of the service offering following the decisions in (c)
(j) Deciding upon the reach of the service offering.

These elements will help to distinguish a good service offering from an average one. The elaboration of service variances usually takes place in a matrix like approach along all possible personae-to-personae combinations.

3.6 Depicting Reality in Scenarios and Use Cases

How is it possible for outsiders and non-technical, functional, or strategic experts to understand the ecosystem approach? How are objectives and boundaries revealed once actors are placed in other ecosystems and seek market entry opportunities in yet others? In the already multi-layered addressing of entire ecosystems, the role of usage scenarios is undoubtedly a well-conceived design element to investigate, develop, and test throughout an ecosystem. The starting point is the agreed upon target: being the test of a new service offering, the assessment of means of participation for community members, or the envisioned project launch to optimize the urban mobility offerings for students, commuters, and tourists.

A *usage scenario* describes in detail "how the technologies featuring in the target scenario can be used to good effect in different contexts of users' daily lives" [75, p. 17]. More than ever, project sponsors and teams are being asked to demonstrate the transferability of recommendations and subsequent action items into concrete usage scenarios. Thus the benefits are not only related to testability of the observed topic. Transferability stands as well for mapping users' expectations to the ultimate goal of deploying viable and relevant technologies. The execution takes place then in various test cycles and field trials.

The term *use case* is synonymously used for usage scenario. Originally introduced by Ivar Jacobson in 1992 [76], the term use case referred to the act of documenting software requirements in the Unified Modeling Language (UML).

In the context of ecosystems and Smart Mobility we are thus combining the two viewpoints of use cases and scenarios. A *usage scenario* contains at least the following key elements:

- Motives to engage in Smart Mobility
- Value Drivers
- Owner of the scenario and/or of the overall initiative
- Personae that are being addressed with the usage scenario
- Market Offerings that have full or limited functionality
- Solution(s) that are available, in progress or planned
- Degree of deployment, hence readability
- Roadmap to deploy the preferred usage scenario in a real-life environment; this being a field test, a trial, or a productive environment (referred to as "deployment").

Once the structure is filled in with content, two evaluation cycles are conducted:

- Cycle 1: Evaluation of the expected benefit with regard to qualitative and quantitative measures
- Cycle 2: Evaluation of the technical feasibility.

Being in charge, the owner of the field test ensures that the conduct of the deployment and field trial in an utmost organized and responsible manner: ensuring the availability of the selected personae and the assets at the chosen site(s), co-leading the deployment in

a beneficial and entrepreneurial manner in close alignment with the project and scenario sponsor(s).

Stressing the analysis of the participating entities and end users, their needs and requirements is a critical success factor in field tests and scenario deployments. A deployment in the context of the public sector can be rated as successful and feasible once companies and local government with tight budgets and few resources are able to deploy it in "small spaces". Innovation deployment is deployable despite structural barriers. The "small space" might be a physical room in an ecosystem "road", "event", or a digital space using apps and an online and service marketplace triggered offering.

Bearing in mind the efforts to re-model the demolished, low-end, city district of Constitucion in Chile after the earthquake, the affected space was not only re-established. It was entirely re-set and re-purposed, driven by the ultimate necessity to give back a livable infrastructure to the population, but even more by the architect's foresight. He targeted a tsunami threatened section and he introduced space for community gatherings, a concert hall, and museums. The architect insisted on spending the first couple of weeks intensively with citizens and on-site businesses were well investigated – despite a tight budget and a high degree of skepticism from sponsors and government investors about the chosen approach. Active listening and insight gathering revealed structural, architectural, economic, societal, construction relevant, and safeguarding criteria. What also counted was organizational preparedness, as well as clarity about the undertaking:

- Depiction of the undertaking and the observed subject being a service, product, or a bundle of service and product
- Determination of the addressees, hence personae, employees, and organizations
- Timely information about addressees and the general public and their respective inclusion. The latter aspect often gets neglected despite its importance and relationship to the entire ecosystem
- Chosen media and technical means, questionnaires, observations, participatory and community related engagements
- Geographical determination in the sense of the real-life situation, laboratory environment, and geographical fencing
- Duration of the undertaking and deadlines, resourcing and participatory engagements
- Roles and responsibilities of participating individuals and organizations as well as necessary legal and insurance relevant premises
- Engaging with participating and relevant stakeholders and individuals independent from individual and organizational contributions, roles and durations
- Giving feedback and sharing of results, deliverables, and insights regarding all participating individuals and organizations. Feedback loops in general are tremendously useful in public and citizenship targeted projects and initiatives.

The usage scenarios that are introduced later in Chap. 8 will apply the above introduced recommendations and structure.

The Digital Economy and the Promise of a New Mobility

4

Heinrich Pfriemer

Abstract

The digital economy as a term was already established in the early 1990s. Despite its early introduction real application was only recent owing to recent, rapid technical advances. Technology as a basis allowed us to re-think entire new business models and pursue paradigm shifts such as the relationship between manufacturer and customer or government and constituent. The digital economy embraces all industry sectors but with distinct start-up periods because of an industry's complexity, competitive situation, and beliefs.

Contents

The *Digital Economy* as a new buzzword is nowadays widely used. This chapter introduces the term and gives background on its usage. Its tremendous reach and impact on our society is illustrated, starting from its historic origin and development of the terms "information age" and "digital economy", focusing on the dimensions and risks.

The inherent innovation potential based on strategic re-focusing and re-imaging of traditional paradigms, like the current customer-vendor relationship, requires a very profound strategy and innovation understanding, explained in an example.

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4.1 The Term Digital Economy

The Canadian author Don Tapscott first mentions the term "digital economy" in his book *The Digital Economy* published in 1994 [77]. As with many new terms there is a magnitude of existing definitions, but he describes its main characteristic as follows, by focusing on the potential:

> "It is fairly widely accepted that the developed world is changing from an industrial economy based on automobiles, and roads to a new economy built on silicon, computers and networks. … The new economy is all about competing for the future, the capacity to create new products or services, and the ability to transform business into new entities that yesterday couldn't be imagined and that the day after tomorrow may be obsolete. [77]

Tapscott anticipates the rapidly growing "networked world" and is asking us all to assess the potentials and risks of the embarking digital change, not only from an economic, but also from a social, perspective. The theoretical foundations of the term were provided by the futurists Heidi and Alvin Toffler. They already postulated, in their early 1980s published book *The Third Wave* the forthcoming information age revolution and the related formation of a new society [78]. The mantra of a new information age is implied in both publications, which can be not better described as by the credo of thinkers50:

> Ideas have the power to change the world. Management is essential to human affairs. New thinking can create a better future. [79]

That very paradigm change from an industrial age to the information age derived from the credo can be illustrated like this: Mass production, economy of scale, standardization, and passive consumers are moved into a new age of participation and sharing enabled by a global network. That network (of networks) allows dramatic and incremental re-design and re-imagination of the current orthodoxies, like vendor and consumer, government and citizen, family and society relationships. There is a risk that our understanding of society, community, will become obsolete or heavily questioned. Tapscott, in the meantime nominated as the fourth most influential thinker, illustrates again in the 20-year jubilee edition of his book, the main areas of change impact [80]. Labor market, wealth distribution, public administration, privacy, and family and learning, according to Tapscott, are providing the most challenges but also significant changes.

The already existing impact of the digital economy is nicely explained in Tom Goodwin's observation:

> "Uber, the world's largest taxi company, owns no vehicles. Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world's largest accommodation provider, owns no real estate. Something interesting is happening. [81]

In contradiction to the widespread misunderstanding that the digital economy is the "revenge of the nerds" and therefore only related to the information and technology sector,

its impact is seen in all sectors. The digital economy is not solely based on Internet service providers, even the traditional sectors have to understand, learn, and strategically adapt their Business Models in a digital world.

To approach the term and develop an understanding of the digital economy, traditional innovation approaches have to be questioned. The digital economy is basically supported by the newly available tremendous computing power in the cloud. That is the very technological reason why entire value chains are nowadays doomed to be re-imagined as digital services. As pointed out above in Tom Goodwin's quote, there is a re-focusing happening away from product innovation (faster, cheaper as typical industrial age dimensions) to customer interaction and experience, to new profit models and value chains. The result is new and clear; the currently prominent positions can be easily re-imagined and newly shaped relationships are emerging (e.g. active consumers).

That fact provides start-ups or small agile enterprises with a good position to close offering gaps with smart products and smart services, and a seamless user experience and associated high service levels, and to differentiate themselves extraordinarily. That is what we realize as "disruption" or as being of a disruptive nature.

4.2 Strategic Innovation as a Key Enabler in the Digital Economy

To disrupt successfully it is recommended you regard the Business Model as an innovation foundation. The impact of such an approach is proven in a Doblin Group study. The Chicago-based consulting firm examined 5000 innovation project over the last 15 years, trying to understand success and failure [82, p. 2]. The maybe initially shocking finding was that only 4.5 % of them were successful. But the real insight was that just 2 % of them were responsible for 90 % of the economic value added of all 5000 projects. So what was the reason for that? As the major finding indicates, while most innovators and enterprises consume their innovation budgets in improving existing products and services, the outstanding 2 % are not solely focusing on the product and service innovations, they focus hard on business model innovation and user experience.

User experience (commonly abbreviated to UX) is not only a nice looking user interface, it is the combination, the taste, of using such a digital service [83]. It includes all aspects of a user's experience during his interaction with a product, service, and context, with context being the most important one. A maintenance crew member on a ladder with only one arm free to enter data has different contextual requirements than an operator behind a desktop.

Improved UX can be achieved in the following areas:

- Accessibility of digital services
- Simple and intuitive usability
- Configurability and bundling of offerings
- Clearly structured and designed interfaces
- Simplicity of interaction with virtual and real partners and experts.

Modular Innovation Categories To achieve outstanding innovations it is necessary to categorize one's own innovation potential. Doblin [82] differentiates 10 types of innovation. In a simplified view, product and service are in the center and on the flanks are configurability (profit model, value chain) and the user experience (see Fig. 4.1).

So even without a revolutionary new product or service, the combination of several innovation categories paired with a good understanding of existing gaps in one or several

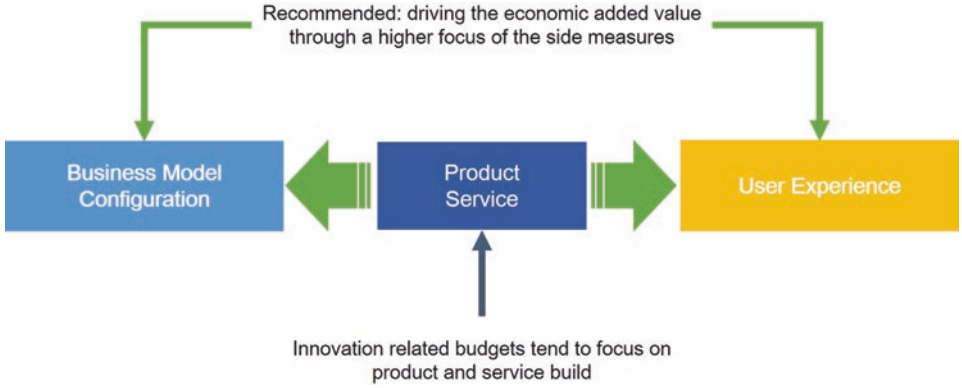

Fig. 4.1 On the innovation track

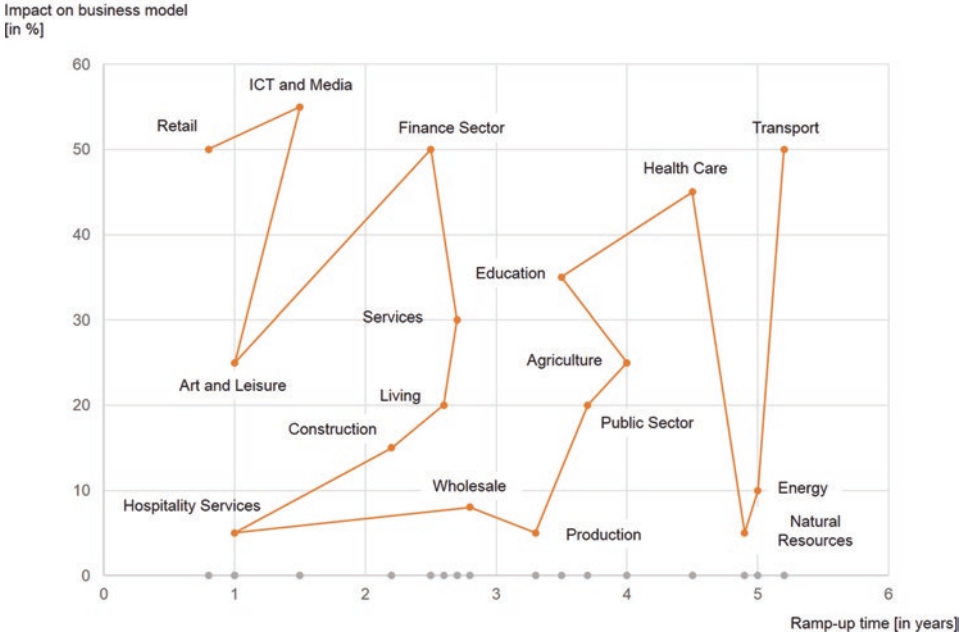

Fig. 4.2 Succeeding with innovation – Insights into industry segments

of the categories, enables a disruptive digital service package to emerge in the digital economy.

As a further and important amendment to better understand the digital economy, almost all sectors/branches or our entire society are affected by its changes, but with different lead times and impacts. A highly illustrative study named "Digital disruption – Short fuse, big bang" by Deloitte Australia regarding the digital transformation impact on the Australian macroeconomic situation is a good example to illustrate this point [84]. It positions sectors according to time (length of the fuse) and to the potential impact (bang) in four quadrants (see Fig. 4.2).

The digital age is already a reality. A further indicator of our digital society is shown by the widespread use of smartphones. Especially in developing countries their use allows us to use networks to find simple, handy and cheap solutions, which can disrupt the post-colonial society and business model. Fishermen on Lake Victoria in Africa are checking the current fish market prices while still catching them. Even that simple and free access and insight to the market price provides them with a better bargaining position.

The Smart Mobility Ecosystem

5

Barbara Flügge

Abstract

The Smart Mobility Ecosystem is the entry point into the overall mobility complex from a strategic level down to an individual task level, for all participating and future actors, whether these are a car-sharing user, a project manager that heads the conceptual depiction of mobility management, or an operator of a public transport management unit. By intention, the presentation of the Smart Mobility Ecosystem is design-oriented and structured by personae, roles, and responsibilities. The initial results of a study that was conducted in 20 cities are leveraged. The Smart Mobility quadrants – the Mobility Consumers, the Physical Mobility Front Office, the Digital Mobility Front Office, and the Mobility Back Office – conclude the chapter.

Contents

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Fostering the right to a Mobility-as-a-Service offering, hence a *Mobility-as-a-Service* (*MaaS*) construct, thoughts and considerations arise. Taking a look into the next centuries we ask ourselves if there are further, far-reaching means to work from home. We ask if drones do indeed substitute for the delivery person to reach us wherever we are. To what extent are mega trends such as urbanization, on the one hand, and aging, on the other hand, demand other mobility services than those to date? How do modern urbanizations look like or will they turn into zones and fragments based on personae's needs and life styles?

Furthermore, we ask if MaaS should turn into a personalized on-demand service, similar to the personalized pair of sneakers that gets produced with our individual style and color coding, so that mobility offerings can adapt to our needs and preferences instantly.

To make this happen all personae need to get connected in a more fashionable, yet ubiquitous, manner. This includes vehicles, infrastructure, and assets as well as travelers. Personalized and dynamic pricing models offer a pervasive stream of offerings with respect to means of transport, timing, and further services. Tailored information, commercial, and entertainment packages enrich the offerings and lead to new business segments. The biggest challenges we see are in the design and deployment of governance frameworks and in the interplay among public, private, and non-profit making actors and institutions.

5.1 The Role Play

Barbara Flügge

To identify the role play for the *Smart Mobility Ecosystem* we now gather all the design elements about personae, roles, and responsibilities which we introduced in Sect. 3.4. The richness and variety of Smart Mobility *personae* has been gathered through the above mentioned global study of 20 cities. Fifty personae have been identified so far. The large number, however, demonstrates not only the connectedness of mobility. Taking a greater look into the benefits of Smart Mobility for roles and responsibilities of the personae, the variety of personae emphasizes the importance of public, government, private, and institutional interests. The perceived benefit of Smart Mobility with respect to the denoted personae and their occurrence in one or more of the 20 cities is now introduced in Tables 5.1and 5.2. With these first analytical results the reader might deduce which of the following personae relate to which city and geography. The assessed cities are Bangalore, Barcelona, Beijing, Berlin, Guangzhaou, Hong Kong, London, Madrid, Melbourne, New York, Seoul, Shanghai, Singapore, Stockholm, Sydney, Taipei, Tokyo, Warsaw, Washington DC, and Vienna. The cities are numbered in alphabetical order, meaning Bangalore is designated "1", Beijing "2", and so forth.

In Table 5.1 those personae that encounter a benefit throughout Smart Mobility offerings for the listed city are marked with an "x"; "X" relates to the perceived, not necessarily realized, benefit of Smart Mobility in the listed city. Table 5.2 continues the assessment for cities labeled "11" to "20". The assessment took place by analyzing the mobility offerings of any of the 20 cities and the identification of the addressable personae.

Table 5.1 Personae in the context of mobility in cities 1–10

Identified persona	1	2	3	4	5	6	7	8	9	10
Academic researcher		x	x	X	x	X				
Automotive company				X						
Building inspection officer	x								x	
Bus driver		x	x	X			x	x		
Bus operator										
Business traveler		x	x		x	x				
Citizen	x	x	x	X	x	x			x	
City planner	x			X	x	x	x	x	x	x
Civil servant	x	x	x	X	x	x	x			x
Corporate company	x				x	x	x		x	x
Data scientist					x	x				x
Disabled person							x			
Driving school										
Educational service provider	x			x		x				
Event manager		x	x		x		x			
Firefighter				x						
Freight authority										x
Freight manager		x	x				x			
Government (local, national)										
Healthcare provider				x	x	x				
Local authority	x						x	x	x	x
Logistics service provider										
Major				x		x	x			
Parking authority									x	
Pedestrian					x			x		
Policeman	x			x		x	x	x	x	x
Private driver		x	x	x						
Professional employee		x	x			x				
Public transport authority				x	x		x			
Road infrastructure authority										

Table 5.1 (continued)

Identified persona	1	2	3	4	5	6	7	8	9	10
Scholar		x	x		x	x				
School authority		x	x							
Social welfare office	x			x	x					
Student	x	x	x			x				
Taxi driver	x	x	x						x	
Toll authority										
Toll collection units (private, government)										
Tourist		x	x		x	x				
Tourist office (private)	x				x					
Tourist office (public)										
Traffic authority		x	x					x	x	x
Traffic police							x	x	x	x
Traffic scientist						x				x
Traffic signal controlling unit								x		x
Transport manager (private)	x			x	x		x	x	x	x
Transport authority	x	x	x				x	x	x	x
Travel agency					x					
University staff member						x				
Waste disposal company				x						
Water authority		x	x	x						

Table 5.2 Personae in the context of mobility in cities 11–20

Identified persona	11	12	13	14	15	16	17	18	19	20
Academic researcher							x		x	
Automotive company	x	x					x	x		
Building inspection officer										
Bus driver		x								
Bus operator					x	x	x	x		

Table 5.2 (continued)

Identified persona	11	12	13	14	15	16	17	18	19	20
Business traveler										
Citizen				x		x				x
City planner	x		x	x	x				x	x
Civil servant			x			x		x	x	
Corporate company	x			x	x		x		x	x
Data scientist							x			
Disabled person										
Driving school										x
Educational service provider	x									x
Event manager										
Firefighter										
Freight authority	x	x								
Freight manager								x	x	
Government (local, national)	x		x		x	x	x	x	x	
Healthcare provider										
Local authority	x	x	x	x		x	x	x	x	
Logistics service provider									x	
Major					x					
Parking authority	x	x	x	x		x				x
Pedestrian										
Policeman	x	x		x						
Private driver										
Professional employee			x		x					x
Public transport authority						x				
Road infrastructure authority				x						
Scholar										
School authority										x
Social welfare office							x	x		
Student										
Taxi driver										
Toll authority			x							

Table 5.2 (continued)

Identified persona	11	12	13	14	15	16	17	18	19	20
Toll collection units (private, government)					x					
Tourist										
Tourist office (private)					x	x				
Tourist office (public)				x	x					
Traffic authority	X	x	x		x	x	x	x	x	
Traffic police	X	x	x	x						
Traffic scientist	X		x	x			x	x	x	
Traffic signal controlling unit	X	x								
Transport manager (private)	X	x		x	x	x	x	x	x	x
Transport authority	X	x		x	x		x	x	x	x
Travel agency					x					
University staff member										
Waste disposal company										
Water authority										x

Mobility Consumers The above introduced personae are now clustered along their motives for consuming mobility (see Fig. 5.1):

- Commuting to work location or other destination
- Business triggered travel
- Private travel need for shopping, vacation, or visiting
- Travel in transit in conjunction with connecting trips via a central station or an airport to reach the cruise ship for example
- Distribution and supply of goods and/or services
- Event and/or purpose motivated travel
- Incident or inception driven counter measures caused, for example, by evacuation scenarios or natural catastrophes.

Employees and service consumers of mobility service providers themselves are private users of their own and third party mobility offerings. The illustration in Fig. 5.2

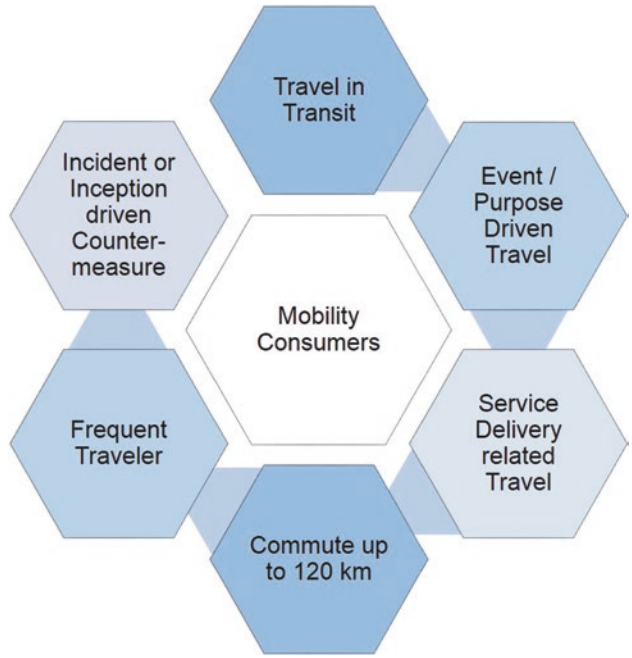

Fig. 5.1 Motives for mobility consumers to travel

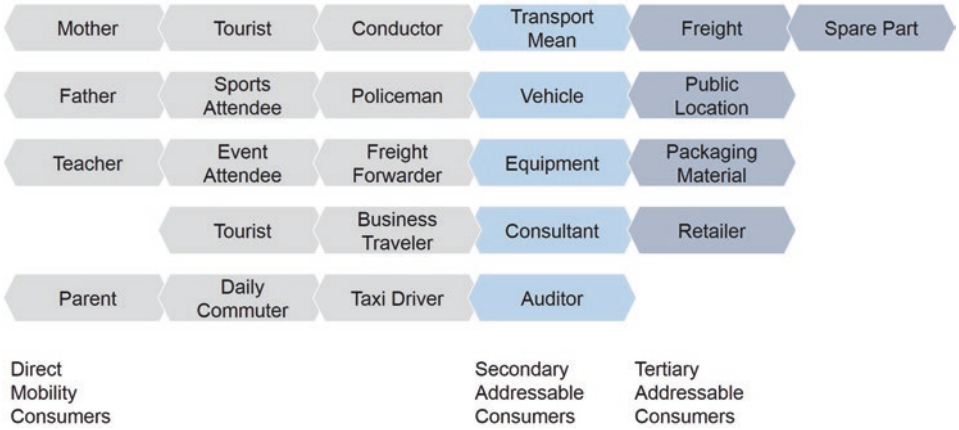

Fig. 5.2 Outline of addressable personae throughout one or multiple Smart Mobility service offerings

demonstrates the multi-sided viewpoints in the case of three usage profiles: a family, a teacher, and a parent.

The three examples reveal that driven by the first motive to consume mobility, further requirements and mobility consumption opportunities result. Here service providers have the opportunity to cross-sell their offerings to second and third tier consumer groups. Once

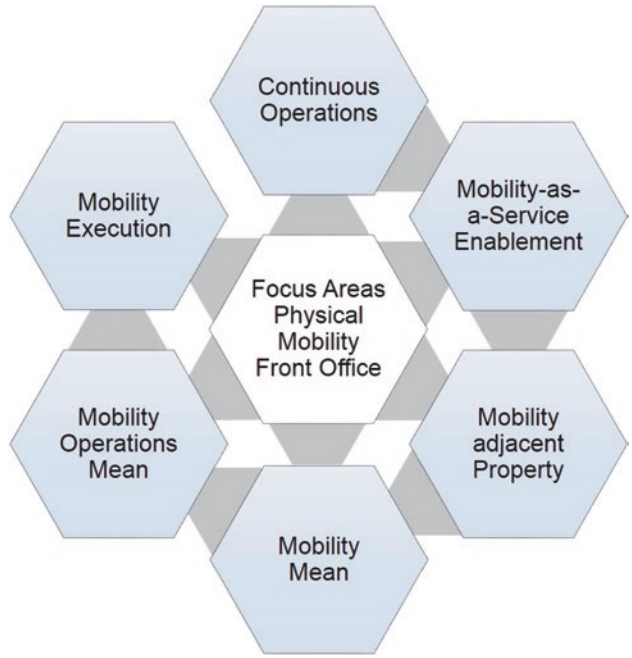

Fig. 5.3 Core activities of the Physical Mobility Front Office

this mechanism is built into the underlying *business model*, further usage potential and revenue drivers are made addressable. Those might then result in a new business model variant or an adaption of the original one.

A functioning *Physical Mobility Front Office* is often the first contact point for consumers. Here those personae reside that we encounter along our travels and ensure the trip's progression and completion. The task list of the Physical Mobility Front Office is structured along the following core activities, as outlined in Fig. 5.3:

- Continuous Operations
- *MaaS*
- Maintenance of mobility-related transit areas and mobility-related property management
- Operating content and information portals as the mobility broker
- Operating and maintaining means of mobility that are in private and government hands, provisioned by private communities or individuals
- Operating infrastructure assets
- Executing and deploying mobility offerings.

Compared to the *Physical Mobility Front Office*, the *Mobility Back Office* is the home base to those personae that are in charge of physical, infrastructure, and space related, structural, political, and digital tasks. In Fig. 5.4 the most relevant and apparent user groups are listed. Projecting into the future, we will encounter even further back office related

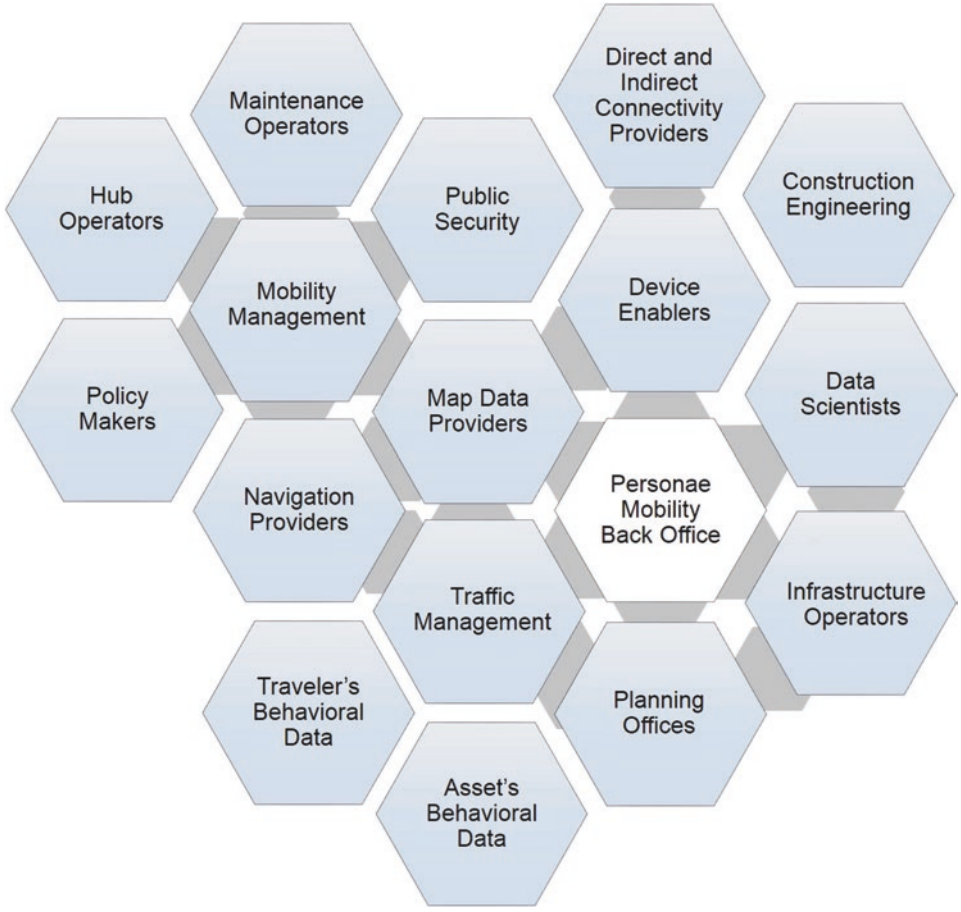

Fig. 5.4 Personae in the Mobility Back Office

groups that to date do not yet exist or emerge throughout other non-mobility matters into a mobility relevant business.

An environment that is characterized by default of services and technology, like the Smart Mobility one, needs further analysis of the ecosystem's stakeholders (app providers, service providers, content distribution systems, hardware providers, system integrators, and connectivity providers). The last refers, for example, to the telecommunications industry and private connectivity "operators" that emerge through 5G technology [85]. The examples from the travel industry in Sect. 2.5 illustrate the opportunities. Those above listed stakeholders we allocate to the *Digital Mobility Front Office* (see Fig. 5.5).

Smart Mobility defined as an ecosystem encompassing the service portfolio reaches completeness once the offerings and prerequisites are targeted in a systematic manner.

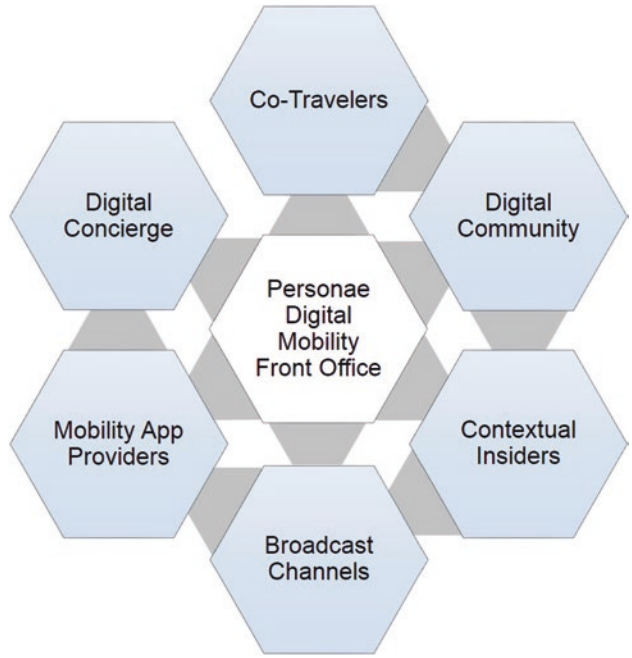

Fig. 5.5 Personae in the Digital Mobility Front Office

Otherwise the portfolio is being looked at solely, for example, from the increasing number of digitalized mobility offerings that flood the market or the portfolio is being rated by the preparedness of the markets to provision connectivity, to have the budget to own smartphones, or to establish a sensor-based monitoring of the transportation network.

A complete outline of Smart Mobility offerings should at the minimum embrace the following groups:

- The *Physical Mobility Front Office* with reference to the cluster of mobility service providers that ensure a safe and punctual departure and arrival, whether individuals or cargo transportation orders
- The *Mobility Back Office* with reference to those infrastructure units and providers that ensure mobility offerings are being executed, namely providers of hardware, software, and connectivity as well as devices belong to that group
- The *Digital Mobility Front Office* that is in charge of enabling and fostering digital consumption and service expansion.

The dependencies of the three groups on each other resonate with the increasing digitization in the market: without the Digital Mobility Front Office the portfolio of service offerings is incomplete and limits future business opportunities. Even more, the business with unknown business partners remains untapped. Another downturn would then slow down the accessibility of additional consumer groups, as outlined in Fig. 5.2.

Now, all previously introduced other personae fold into the three-tier grouping as outlined in Fig. 5.6.

Mobility Operations Characteristics	Smart Mobility Enablers						
Physical Mobility front office	Driver	Those that share mobility property	Those that share mobility property	Train	Rail Tracks	Storage	Signaling
	Conductor	Those that share mobility property	Those that share mobility property	Street	e-Bike	Drive-in	Traffic Light System
	Police	Maintenance Engineer	Car	Subway station	Plane	Loading Zone	Switch
	Inspector	Construction Engineer	Bus	Watergate	Runway		
Digital Mobility front office	Digital Concierge	Mobility App Providers	Broadcast Channels	Contextual Insiders	Digital Community / Communities	Co-Traveler	Contextual Expert
Mobility back office	Mobility Manager	Operations Planner	Traffic management unit Public	Rail Operator	Maintenance Service Unit Public	Digital Map Provider	Traveler's Behavior Analyst
	Public Security Office	Policy Making Unit	Traffic management unit Private	Hub Operator (Airport, Port, ...)	Maintenance Service Unit Private	Connectivity Providers	Travelers' Behavior Analyst
	Traffic Data Provider	Construction Data Source Provider	Incident Advisor	Hub Navigator	Door-to-Door Navigator	Device Enabler	Data Scientist

Fig. 5.6 Smart Mobility Personae

5.2 Smart Mobility Role Model

5.2.1 Impact of Smart Mobility on Existing Sectors

Barbara Flügge and Heinrich Pfriemer

Automotive manufacturers will no longer sell their cars piece by piece, instead they will offer mobility packages. They will have to turn themselves into mobility provides. Their future business model will orient itself to a constant cash flow, away from margin per car produced.

The mobility of the future or the future of mobility will force governmental or semi-governmental transport providers to re-focus as well. In such organizations political influence is paired with huge investment budgets and Key Performance Indicators (KPIs) to function under the premise of the industrial age, the latter measured by scale, mass, and standards. Taking the majority of today's mobility innovation projects into account, it becomes evident that they mainly focus on product improvements or product service improvements. Examples are new wagons, railway routes, and better use of tracks.

Currently digitization is mainly regarded and executed in cost saving measures, like the implementation of ticket machines with little or no user experience and with a clear neglect of the principle of sophisticated service offerings for the elderly, for example. Prices on homepages are not coordinated with local pricing methods and result in puzzled clients. Real mobility requirements of the population are less regarded than political prestigious projects.

If public transport providers want to come close to the promise of digital change and the future request for mobility, this requires the implementation of a holistic digital strategy

driven by institutional and organizational leaders and an establishment of new strategic roles such as the Chief Digital Officer or Mobility Manager.

5.2.2 Transformation into the Digital Era

Barbara Flügge

Mobility more than any other area will evolve into a service oriented system of synergies and effects. Not only do roles and responsibilities change, but grounded in the *IoS Role Model,* services now offer new and disruptive white spaces for formerly strategic, functional, and task oriented positions. We hereby introduce the *Smart Mobility Role Model* as an opportunity to identify new positions and opportunities.

Service Provider Mobility *service providers* relate to public and private organizations that supply transport and/or transport networks. Furthermore, mobility providers supply ticketing, travel offers, seats, and cargo and freight targeted space on buses and trains. Once a mobility service opportunity is launched as a public tender, listed providers design and supply the service on behalf of the government institution.

Service Hosting Virtual services such as ticketing, the sale of travel and freight transport, packaging materials and their bookings, for example, are being offered by *service hosting* providers in conjunction with web or app access, at the counter or in the means of transport itself. Physical offerings such as rail tracks, streets, or bridges are usually offered by public institutions in cases where they are not privatized. The maintenance and hence physical hosting of these assets is conducted by public or private organizations. Although the trend in some regions veers towards privatization, in other regions we observe a trend back to government ownership of assets.

Service Gateway The service provider and the hosting unit rely on in-house or third party organizations such as IT companies and system integrators, the so-called *Service Gateway*. The challenge will be – and not only in the field of mobility – to calibrate, connect, and embed organically grown data impulses from supply and consumption channels with standardized formats. The resulting business for *Data-as-a-Services* then contributes not only to the interoperability of data provisioning but expands the business model of the service gateway.

Service Broker Mobility related *service brokers* are manifold: being a transport or local public transport company, a hospitality service provider such as a hotel, restaurant, tourism office, travel agency, or shopping mall, a VIP service provider, or a car-sharing or leasing company. Digital brokerage takes place via those brokers or third party service providers such as global distribution systems providers Travelport [35] and Amadeus [36]. Brokerage, in addition, takes place through travel content providers. Those providers

that monetize their business through search engines and comparative portals turn more and more into influencers. These influence the price design and pricing schemas, or the perceived price compared to the real price that has been commented or evaluated in rating systems and via recommender engines. *Service brokers* focus on pricing, on the one hand, and on defining deployment concepts to establish Smart Mobility in the markets, on the other hand, for example through local and international franchising concepts.

Service Aggregator Service bundles such as train-to-fly or train-to-rental are examples of aggregated services once the offering is launched in one package and priced as such. *Service aggregators,* for example the Swiss Railway SBB, offers through its GA Travelcard [86]. The card is purchased on an annual basis and to date permits the use of any means of transport, including trains and buses, and gives reduced entrance fees to museums and further promotions. Innovators such as the initiators of the MaaS alliance offer profile, hence personae, dependent bundles. Those vary by the number of hours used in public transport, whether bus or train, and the estimated amount of mileage consumed by a rental car. The pricing then follows a utility driven business model.

Service Channel Maker Consumption channels for mobility turn more colorful than ever before: whether an app, the multi-functional terminal at home, or the smart bus stop. *Channel makers* are often the real innovation drivers who design and create on behalf of established institutions or who invent new "docking stations" to win new customers and bonding mechanisms in their very own start-up. The key objective is to increase the probability of consumption: the higher the reach and usage numbers the higher the conversion ratio, hence the real booking or consumption of an offering.

What is the role of today's players in the field of mobility? Focusing on a segmentation of public and private mobility offerings or by a separation of customer and business partner narrows down the way of looking at this question. Especially in times of rising infrastructure burden and more apparent competition among regions and cities an isolated view is outdated.

The real target of companies and governments should be to strategically position themselves in the market based on the influence they want to pursue. Thus companies as well as governments need to be clear about their strategic objectives. A service oriented acting is then feasible through the use of the Internet of Service (IoS) concept, digital means and tools. The IoS approach does not only enable mobility related services to get traded digitally, but any other services. Techniques and methods are necessary to assess and ease complexity and thus make IoS deployable.

Service Consumer As outlined before mobility consumers are manifold. They reach from individuals to organizations, interest groups and families, institutions and occasional travelers. We speak here as primary consumers. Secondary and tertiary *service consumers* are those that get dragged into the offering by the primary consumer and his interest; see Fig. 5.2.

In the following example we demonstrate the IoS role play. Moreover, occupying distinct roles and switching from one role to another are already daily business for some of the

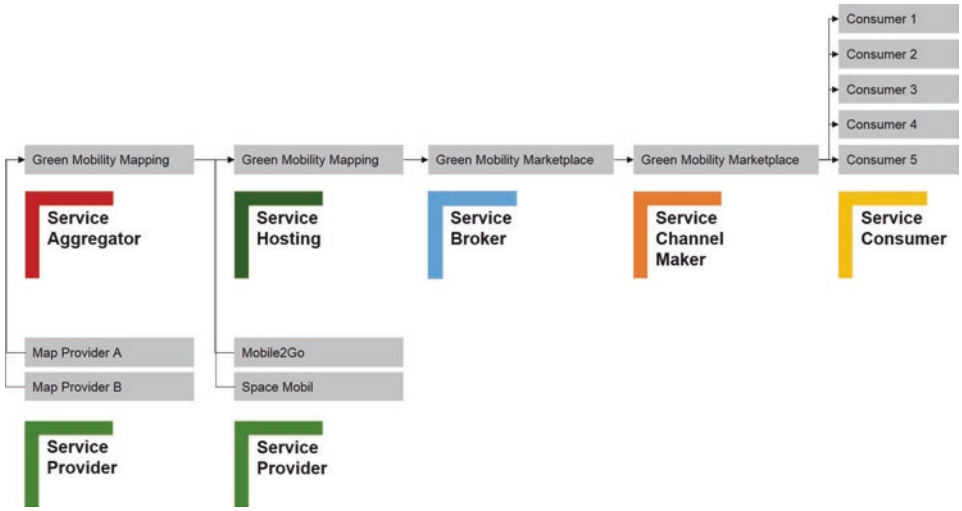

Fig. 5.7 The IoS Role model in use – an example

service providers. The ability to turn the focus into one or multiple roles and make the strategic move are two of the critical success factors to turn an offering into a realistic offering.

Example: The Real Eco Mobility Changing a role and turning on new services impacts suppliers as well as business partners. How organizations are being connected is now introduced in the example of "real eco mobility". We define three organizations that are part of a field trial: Mobile2Go, Spacemobil, and Green Mobility Mapping. All of them offer mobility services. Mobile2Go acts as MaaS provider, Spacemobil offers loading and storage capacity in static and moving rooms, and Green Mobility Mapping offers interactive maps for spaces and ecological profiles. Next to the services they offer, all three organizations consume services, too. Mobile2Go is now seeing a chance to transfer into a marketplace operator driven by its business activities with Spacemobil and Green Mobility Mapping. See Fig. 5.7 for an outline.

In case further business partners seek to enter the network of Spacemobil, Green Mobility Mapping, and Mobile2Go the graphical outline then helps to identify in which positions the existing players encountered competition and which newly added dependencies among the organizations changed the portfolio of Mobile2Go as marketplace operator.

5.3 Service Enablement and Service Enrichment

Barbara Flügge

The connector among the outlined service roles is the service itself. Once service design is made the depiction of to-be-traded products and services takes place in a handy manner and in a consumable and tradable format via digital consumption channels. This step we

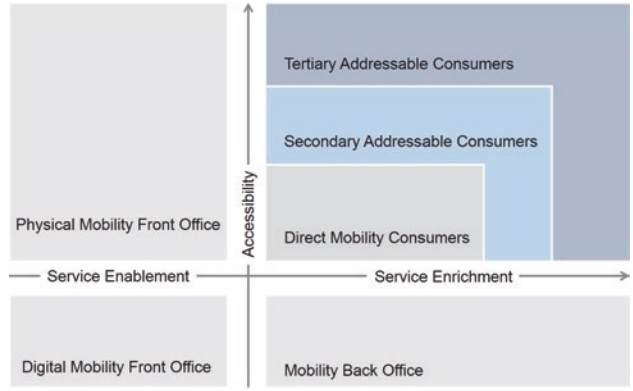

Fig. 5.8 Service enablement and enrichment in the mobility provisioning process

refer to as *service enablement*. In a second step, *service enrichment*, the service depiction gets enriched with further characteristics including bundling variances with other services and/or products. These service relevant steps follow the consumers' requirements and get executed in their respective task areas in conjunction with the *Physical Mobility Front Office*, the *Digital Mobility Front Office,* and the *Mobility Back Offices* (Fig. 5.8).

As part of the global study of 20 cities, a second analysis of service provisioning concerning mobility design, preservation, and measurement was conducted. This took place independently of the cities. The following 52 services in Table 5.3 might sound very familiar to experts from traffic management and operations units. The listing that is far from complete does however illustrate the variety and variances of distinct activities in the mobility field.

Service Dialogue Process Services such as the ones listed above are typically categorized according to essential and sufficient characteristics. A deep and multi-layered analysis is required to be able to capture all relevant aspects. In the course of the diagnosis big data and further intelligent building blocks facilitate the process. As the diagnosis takes place in a dialogue among service consumers, enablers, field and desktop personnel according to the *IoS Role model,* we refer to the analysis as the *Service Dialogue Process*.

One element of the Service Dialogue Process is benchmarking. Mobility consumers, for example, judge the offered service by usage, comfort, and savings potentials: see Fig. 5.9. Independent of its form and geographical allocation, any ecosystem seeks benefit and savings potential through intelligent offers. The most relevant ones are summarized in the *savings polydiagram* in Fig. 5.9.

Getting back to the service examples shown in Table 5.3 those got sorted in a third step in the *IoS Role Model*. The objective of the third analysis is to identify clusters of tasks that link one role with another and thus fosters interaction among the role owners. The analysis results in *linkage clusters*. The applicability of the linkage clusters we then checked for all of the 20 cities and beyond. It turned out that the linkage clusters are applicable to

Table 5.3 Service portfolio (extract) concerning mobility provisioning in an ecosystem

Accident prevention analytics and measures
Accommodate traffic mode to usage pattern
Accommodate traffic mode to demands
Adapt bus and station schedules to peak hours
Adapt bus schedules to climatic conditions
Adaptation of parking spots to user needs, intelligent parking spots, parking spot overview service for users for the whole city
Analysis of insurance driven measures for accident prevention and mobility safety
Analysis of intermodal infrastructure with respect to walkability needs
Analysis of traffic network with respect to ticketing and pricing schema for cargo and individual passengers
Analysis of transit related transport offerings and demand driven extension
Assess fuel efficiency for bus related procurement decisions and more intelligent and efficient routes
Assess pollution level in specific districts and ban some vehicle types for limited amounts of time in order to improve air quality
Bike lanes outside the city in recreational areas
City planning concerning bus lanes
City planning concerning pricing for public transport with regard to customer satisfaction, investment decisions, demand/supply analysis
City planning concerning space management to adapt infrastructure to demands
City planning concerning space management to adapt infrastructure to special interest demands
City planning concerning traffic lights steering
City planning for goods and service delivery
City planning to accommodate business' demands
City planning to accommodate daily living demands
City planning to accommodate sidewalks to citizens' demands
City planning to assess extension of street systems
City planning to expand intelligent routes including intermodal transport solutions with special focus on reducing stress levels of pedestrians
Conduct of insurance offerings for dangerous routes and crossings
Conduct of premium and risk analysis
Cost/benefit analysis for service provider
Customer interaction with respect to fare management
Customer interaction with respect to maintenance, expansion, and renewal of transport infrastructure
Customer interaction with respect to serving special needs and interests such as less-able passengers

Table 5.3 (continued)

Customer satisfaction analysis concerning complaints
Customer satisfaction concerning on-demand and predictive booking capabilities
Customer satisfaction concerning sustainability measures and recommended use of means of transport
Customer satisfaction concerning traffic provisioning
Customer satisfaction with respect to increasing service quality – measured in accordance with sustainability objectives
Customer satisfaction with respect to pricing and ticketing procedures
Decision support for infrastructure measures through visualization and simulation techniques
Demand analysis for intelligent intermodal transport systems with one central app and payment method
Demand analysis with respect to investment decisions for production, education, retail, and hospitality service providers
End user applications which integrate all information about all available modes of transport including public bike sharing stations, car-sharing, etc.
Flexible public transport stops and re-assessment of infrastructure every year
Improve navigation for cyclists
Improve security for cyclists
Inform customers about the amount of gender separated seats in the respective vehicle they plan to take
Intelligent fare management in conjunction with persona driven analysis of pricing and usage behavior in the targeted ecosystem
Maintenance related demand/cost/benefit analysis for provider
One payment card for all modes of transport (cars, buses, bikes, etc.) for individuals and cargo
Parking spot planning and allocation according to demands in a district
Road taxing for highly frequented and emission critical roads
Sustainability analysis
Sustainability management and deployment in collaboration with asset and infrastructure provider
Sustainability measures
Traffic analysis per 1000 inhabitants
Traffic flow analysis with respect to as is, and adaptability to demand driven requirements
Traffic management for residential areas

Fig. 5.9 Benefit and revenue drivers in ecosystems – the savings polydiagram

any other ecosystem, whether a city or any other type. Figure 5.10 introduces the linkage clusters.

Through the concept of linkage clustering one essential step is made to facilitate service deployment in entire ecosystems and markets. A service provider could identify its linkage cluster. Service design gets deployed in a task and role oriented manner. Moreover service design evolves into a valuable and critical element of business modeling. This transformation process itself denotes the transformation of mobility offerings from the old world towards Smart Mobility in the digital era. We identified the critical nine transformation elements as illustrated in Fig. 5.11. We introduce a detailed depiction of organizational transformation maturity throughout Chap. 19.

Digital Moments Another element in the service dialogue among consumers, providers, and intermediaries is the element "*moment*". Terms such as the *digital moment* or *moment of truth* describe the instantly, hence immediately, perceived "okay" of a consumer that lets the service provider know that the consumer chose the right offering and it met his expectations. This ultimate acceptance is the best confirmation a provider could get. The positive outcome of the service delivery will most likely turn into positive referrals and recommendations.

However, in case a service provision turns into a mismatch or a low-quality delivery experience, negatively perceived services fall back directly onto the service provider. They cause denial and frustration. The mismatch could not only harm the service provider

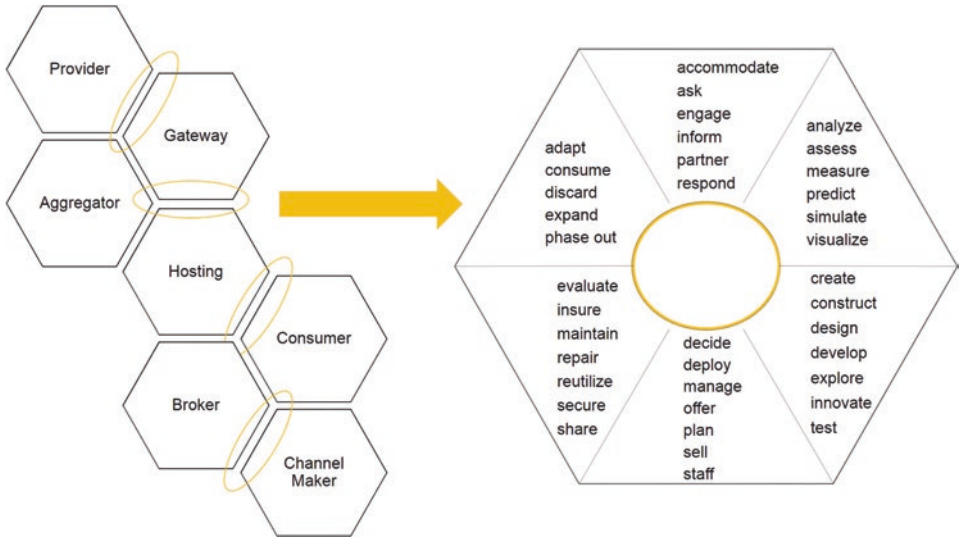

Fig. 5.10 Typology of linkage clusters in accordance with the IoS Role Model

Transforming from	To
Anlagen intense service offerings	Asset independent service offerings
Partly accomplished mobility integration	End-2-End Mobility
Ownership	Subscription
Product-embedded technology	Technology as connector
Isolated profit model	Integrated profit model
Professional associations and social legislation	legal vacuum in smart phone applications
Non-standardized data models	Connected data
Transport company	Technology company
Sustainability measured by consumer	Sustainability monitoring of the ecosystem

Fig. 5.11 Transforming from mobility to Smart Mobility

giving him a hard job to be chosen again, but harm the platform that issued the service. Subsequently, service broker and channel maker get dragged into a negative spiral.

We physically encounter these moments by simple eye contact, checking a graphic in a display, or encountering a spelling error on the digital bulletin board of a public transport operator. Another moment of truth comes into play when figuring out pricing information,

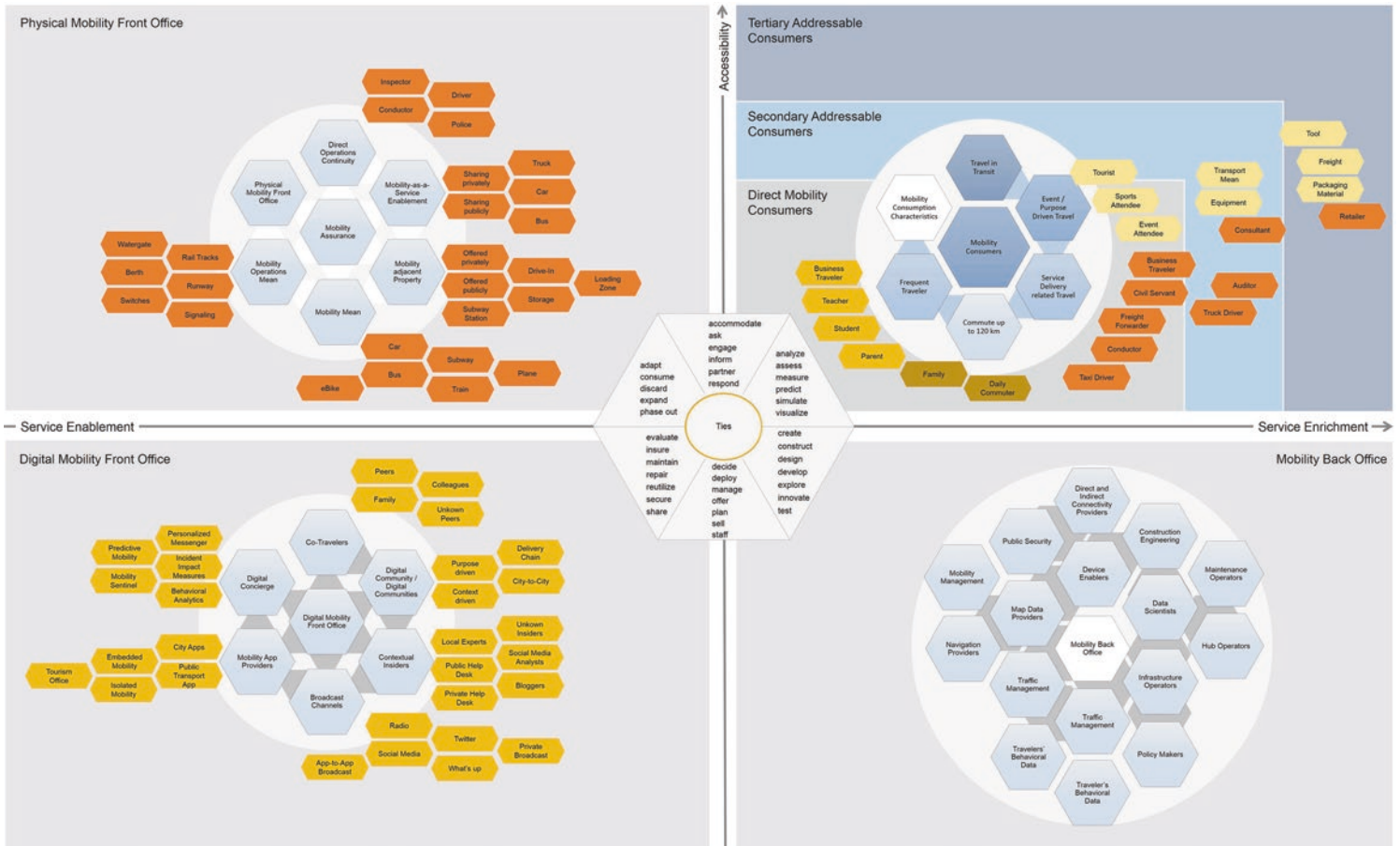

Fig. 5.12 The Smart Mobility Ecosystem

positively gaining instant clarity about the offering or negatively registering hidden elements or misleading information, for example in the case of discounts or rates. Next to customer retention, another application field is dynamically offered pricing and service bundles driven by capturing the "right digital moment".

Mathematical models and emotional media, recognizing facial and gesture-related expressions for example, will be of further use in capturing situational and emotional influencers when using apps or making several click attempts in a portal.

5.4 The Smart Mobility Ecosystem

Barbara Flügge

By combining now the complex of roles, services, and linkages, the *Smart Mobility Ecosystem* is born. Figure 5.12 denotes all elements in an overall view. With regard to the infographic, please refer to the book's website at springer.com.

Focus of this Publication

6

Barbara Flügge

Abstract

With this book we start a multi-dimensional journey from socio-ecological to socio-economic aspects of mobility overall and in selected areas. Mobility by nature projects into other areas of life through a conscious, creative and sometimes unexpected use of information technology and digital accomplishments. Here we focus on functional, economic, and societal aspects. Legal aspects are being considered selectively in some usage scenarios, for example in the field of autonomous driving. This book serves practitioners by introducing initiatives and usage scenarios, checklists and how-tos in order to manage and deploy Smart Mobility. The Smart Mobility Procedure Model guides and informs from distinct entry points and maturity levels. The so-called Building Blocks of Intelligent Mobility (BIM) serve as a blueprint and cover strategic, project related, and innovation triggered activities.

"You can take a watch apart and analyze its parts, but they won't tell you the time of day."
(Ken Wilber)

Focus With this book we start a multi-dimensional journey from socio-ecological to socio-economic aspects of mobility overall and dive deeply into selected areas. Mobility by nature projects into other areas of life through a conscious, creative, and sometimes unexpected use of Information Technology (IT) and digital accomplishments. Here we focus on functional, economic, and societal aspects of mobility. Legal aspects are considered in a few selected usage scenarios, for example autonomous driving.

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The authors introduce usage scenarios, the applicability of technological, creative, and network theory adjacent methods and building blocks that are applicable to governmental and business stakeholders. The book hopefully inspires initiative leaders and forward thinkers, public and private organizations. We address this book to all those that are situated in other than the introduced or exemplified geographies with distinct condition frameworks that seek to foster the benefits of Smart Mobility and aim to gather ideas and a suggest a procedure model. Our journey starts with an outlook into the year 2050.

In the Year 2050 How does the year 2050 look like? An estimate by the United Nations [87] predicts that 70 % of the world's population will live in mega cities and the remaining 30 % in rural areas by 2050. Transport volume is projected to increase by 80 % and individual transport volume by 51 %. Those latter estimated numbers are based on the actual numbers from the year 2005.

Mobility is already at present an accelerator for economic wealth and growth. Not all of the mobility needs can be provisioned in a digital format or transformed, for example, into a 3D printed spare part. Human beings expect more and more to accomplish in their professional and learning curves. They also commit to and pursue more activities in their private lives whether family and/or interest driven. With mobility as a critical success factor, non-mobility turns into a slowdown and disadvantage. Hence, mobility evolves into a luxury good which access and usage could turn into a limiting factor once public and private service providers are unable to meet the right to mobility for everyone. Ultimately, mobility turns into a prerequisite that once it is achieved, hence deployed, it allows the individual to ask for more, acting and pursuing further activities. There might be an argument that mobility fits into *Maslow*'s *hierarchy of needs* [88]. We see mobility highly ranked, in the grounding of human aspirations, the physiological level!

Unanswered needs often result in uncertainty and a greater effort to identify opportunities. As depicted in Fig. 6.1, the time span left between now and 2050 asks us to act against a growing field of uncertainty. We identify three key areas of uncertainty. Firstly, there are unpublished efforts in assets and infrastructure maintenance and rebuild. Numbers so far are being calculated in an isolated manner, for example by urban planning departments or government transport departments responsible for road planning and highway connections. Secondly, there are unknown and uncalculated efforts on how to estimate mobility and other daily business demands in rural areas. Thirdly, there could be an additional effort caused by the shift of duties, for example when you think about the logistics related efforts that turn into infrastructure efforts, or when you think about the construction maintenance and rebuild that will be handed over to facility management. As long as we look at these individual elements in an isolated manner, these elements that are a key factor of Smart Mobility design, then any area whether a city or other hubs such as seaports and airports, will suffer.

Without the appropriate measures, uncalculated and non-calculable efforts in conjunction with asset and infrastructure maintenance and renewal augment. The public sector and politicians will be faced with questions concerning mobility management and demand fulfillment.

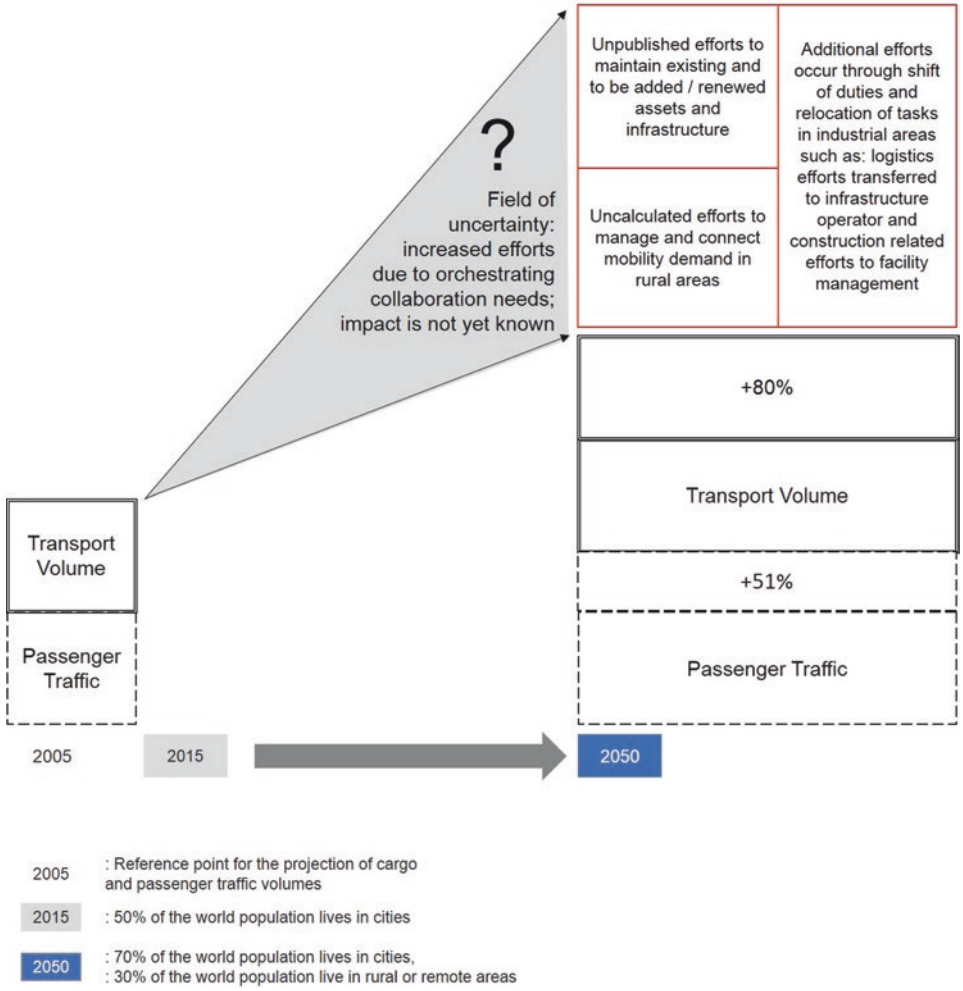

Fig. 6.1 Mobility in the year 2050 – the field of uncertainty

Carriers and the retail industry will start considering de-listing rural areas due to low-if-existing business rationale and margins. Furthermore, positive events such as concerts and sport events generate additional mobility management efforts and could turn into traffic related bottlenecks. The same applies to negative events that, for example, ask for the evacuation of a subway platform or an airport caused by a technical defect.

Elsewhere we encounter discussions about competences and responsibilities and to-be-expected, unexpected, or unnecessary re-assignments of competences to another department. Structural transitions are reasonable once the decision making process takes place in a fact driven, transparent, and outcome oriented manner. We observe, for example, structural transitions in industrial assignments. Who is retailer and who is wholesaler? Are those companies that serve as postal providers not per se insiders into mobility

management needs? Organizations expand, change, and shift their activities and leave their industrial home turf more and more:

- German Post turning into an automotive company by acquiring Streetscooter, an electric vehicle manufacturer [89]
- Airport operators turning into event organizers, shopping mall operators and city planners [90].

From an entrepreneurial point of view a smooth transitioning from product to service, from industry A to industry B, goes hand in hand with considering holistic concepts to address as many distinct personae as possible.

In contrast, those transitions that cannot be followed due to a lack of transparency or information generate uncertainty. In the public sector, uncertainty allows constituents to get a voice in case public interests arise due to protest movements, media reports, and news updates. For example, the case of Stuttgart21 and the discussion about turning the upper ground central station into an underground station complex in a geological ambitious terrain. Or tearing down an entire city district and transitioning the constituents into a new, suburban, and more remote area. In the latter example, the centrally located city district is a target for real estate businesses to serve as upscale investment hubs and resulted in increased housing and condominium prices.

Once we accept that the functional and network elements of an ecosystems, its energy, production, nutrition, and fulfillment flows, and the connectedness of the population, are applicable to any city, region, or an event, both participation and collaboration turn into two crucial sponsors for any habitat, any ecosystem: to foster an ecosystem continuity or to foster a new issue in case of a timely event, for example. We even go further with our hypothesis that any citizen is able to establish his assets as service provider – if he wants to do so. The *sharing economy* scales digitally and there are no limits in the digital ecosystem!

Both the public sector and its adjacent segments can only benefit from the *digital economy*. Offerings are doable with creativity, foresight, and innovative strength and safeguarded by the corresponding local governance framework:

- The Open Government Data Lab initiative of cities such as Boston [91] or Linz [92]
- The smartPORT initiative from Hamburg Port Authority [46]
- The Project "Z" of the automotive cluster Styria (ACStyria) to create a role model region for autonomous driving [93]
- The Round Table "Autonomous Driving" of the German Federal Ministry of Transport and Digital Infrastructure [94].

What are further opportunities that emerge from a holistic acting? As outlined in Fig. 6.2 constraints turn into opportunities such as:

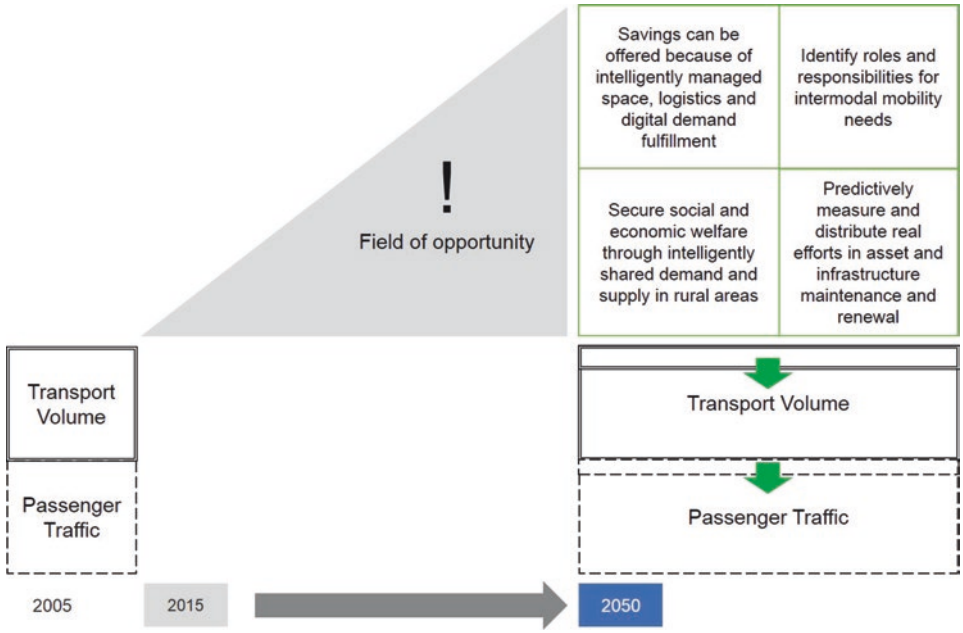

Fig. 6.2 Mobility in the year 2050 – projecting sustainable growth

- Savings through intelligent space management and predictive logistics and cross-organizational collaboration
- Shared cargo deliveries to ensure social and economic welfare in rural areas
- Establishing an innovative and modern role model for intermodal mobility management
- Shared assets and infrastructure following a shared service center approach.

In case you already imagine your very own fields of opportunities, please write them down! Here are some more inspirational examples:

- Imagine that we were able to predict the savings that could be offered because we transformed the physical demand fulfillment into a digital format. Because we used our catalogue of KPIs to measure a city's transportation capabilities and even more compared the outcome with other locations.
- Imagine that we identified the roles and responsibilities for intermodal transport needs and aligned the stakeholders with each other. Imagine that we deliver the blueprint of a zero traffic city, meanwhile ensuring the transport of goods and services in a timely manner.
- Imagine that the field of opportunity is digitally managed to save time and money for physical and semi-automatic business processing amongst organizations. Imagine that it is your account that co-designs and deploys an innovative, creative concept for sustainable growth in the areas they operate, produce, manufacture, deliver, and reside in.

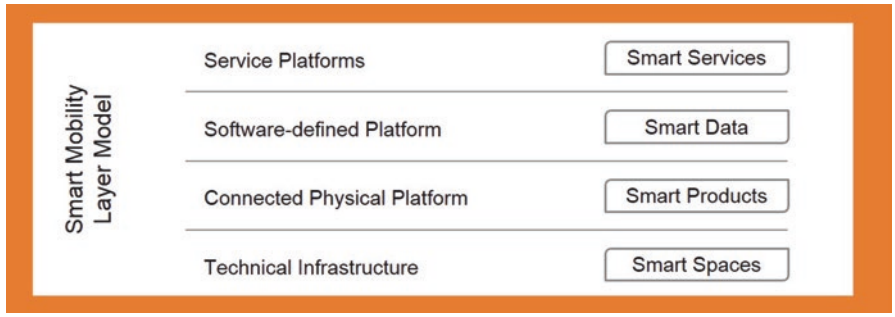

Fig. 6.3 Structural overview of the Smart Service World (With kind approval © acatech 2015)

Turning your focus to the realization of Smart Mobility, we now outline the structure of the following parts and chapters.

Realizing Smart Mobility In Part II we introduce a variety of usage scenarios. Some of them are fictitious, others real examples and deployments. The fictitious ones will have a short shelf life as enterprises and government leaders are already on the move. Part III depicts also the fields of seamless navigation, smart ticketing, and mobility diagnostics.

Part III introduces the *Building blocks for Intelligent Mobility* (*BIM*), see Chap. 12. The Smart Service World from acatech [95] serves here as a structural foundation with its four layers: Smart Services, Smart Data, Smart Products, and Smart Spaces, see Fig. 6.3.

The *Smart Mobility Procedure Model* we introduce serves as motivator and coach along your very own mobility initiative. Regardless your starting point, the procedure model guides you through the key tasks and activities. The *Smart Mobility Reference Architecture* gives input and insights for colleagues from the IT and product management departments.

Part IV outlines recommendations and introduces areas of transformation opportunities in a practical manner. New roles and responsibilities demonstrate how a holistic mobility management could look like. The service paradigm and innovative offerings provide a further subject as well as a deep dive into maturity assessments.

The book concludes with a summary, followed by a glossary and references.

Part II

Smart Mobility hits the Road

Smart Mobility Usage Scenarios I

7

Stefanie Baumann and Michael Püschner

Abstract

Mobility is a basic human need. It promotes encounters between people and enables the exchange of goods. However, increasing mobility comes at the price of higher costs for people and the environment. Therefore, society requires new mobility solutions. Along with electric mobility, the connectivity and automation of transport will play an important role. In combination with autonomous shuttles and multi-modal transport services, alternative drivetrains will be changing our transport and conveyance systems. If the mobility transition succeeds, the classical boundaries between individual and public transport will dissolve in favor of new, innovative business models. This chapter attempts to structure the existing Smart Mobility appliances by means of a layer model for digital infrastructures. The wide range of examples testifies to the very advanced stage of some of the appliances.

Contents

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Mobility is a basic human need. It promotes encounters between people and facilitates the exchange of goods. In a highly interconnected world, with logistics networks spanning the globe, and travelling becoming easier by the day, mobility is a fundamental part of our economy and a critical success factor for a modern and competitive industrial society. In short: mobility creates prosperity.

Despite digital communication channels, the individual *demand for mobility* has increased dramatically. At the same time, owing to the exponential increase of online trade and the ensuing constant availability and "same day deliveries", the delivery sector is growing – both locally and globally. Neither efficiency improvements in logistics nor a lower global economic growth (e.g. due to lower growth rates in China, as is currently the case), will succeed in sustainably abating the traffic.

However, increasing mobility comes at the price of higher costs for people and the environment. Traffic growth engenders more congestion, accidents, and noise and has a higher environmental impact, for instance due to the sealing of large areas or to carbon emissions. Hence, our society requires new mobility concepts and solutions for a transport and conveyance system with the minimum of negative externalities. Another challenge will be to facilitate access to mobility in order to foster social participation. The issue of economic value creation will likewise have to be considered.

Along with electric mobility, the connectivity and automation of the transport sector will play an important role in the development of our mobility system. In combination with autonomous shuttles and multi-modal transport services, alternative drivetrains will act as drivers in the mobility transition, profoundly changing our present form of individual transport. This is accompanied by the development of new, innovative business models in the Smart Mobility sector.

From Smart Parking Solutions to Autonomous Public Transport Shuttles Smart Mobility implies the dissolution of the classical transport sectors: rail transport versus road traffic, passengers versus logistics. According to a target scenario for road traffic in 2030 drawn up by *acatech*, the National Academy of Science and Engineering [95], this strict separation will be a thing of the past. Rather, the system will center on the customer's wish to get from A to B – quickly, easily, cost-effectively, and sustainably. Mobility thus becomes a service and is less dependent on a specific mode of transport. The user will be conscious of only a fraction of the processes and interactions of the various players involved. Like with a smartphone, the applications in a "Smart Mobility World" will be running in the background.

Smart Mobility Requires Digital Platforms and Technical Infrastructure Based on technical infrastructure like the 5G technology (Smart Spaces), future vehicles and ideally other modes of transport (Smart Products) will be able to interconnect across different

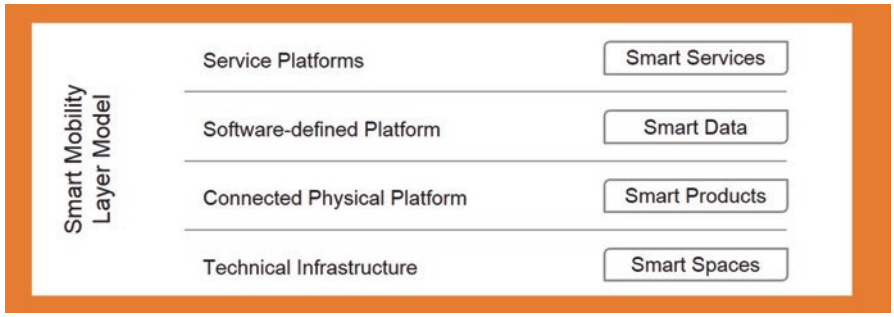

Fig. 7.1 Structural overview of the Smart Service World (with kind approval © acatech 2015)

manufacturers. The interconnected vehicles collect a variety of data that can be linked by means of intelligent algorithms, generating new information (Smart Data). This intelligent data is the basis for new services, combining, for example, digital applications for mobility options such as train, bus, rental bike, taxi, and car-sharing car. In 2015, an acatech working group headed by Henning Kagermann and Frank Riemensperger elaborated a structure for the Smart Service World, describing the different actors and their role within a digital ecosystem. The result for the mobility sector is outlined in Fig. 7.1.

The following applications and usage scenarios can be directly assigned to one of the layers of the mobility system shown in the above illustration of Smart Services, Smart Data, Smart Products, and Smart Spaces. Other usage scenarios illustrate the interaction between the users and Smart Mobility platforms. All scenarios have in common that they are centered on the user. New mobility solutions will only be successful if the user perceives an added value. This could consist, for instance, in time savings owing to optimized route planning or in a consistent, comfortable payment system for various modes of transport. In addition, the respective scenarios are complemented by examples that illustrate how much is possible even today.

7.1 Smart Services

7.1.1 Mobility Platforms for Route Optimization and Intermodal Ticketing in Transportation

The sharp separation between car, train, and bus constitutes an obstacle to a multi-modal transport and conveyance system. Mobility platforms are a first step in combining the hitherto physically separated transport modes. They indicate the optimal route and allow for intermodal ticket booking without determining one specific transport mode. If integrated into the navigation system of a vehicle, the mobility platform can not only propose an alternative traffic route in the event of an upcoming congestion, but can also suggest options for switching to a means of public conveyance such as the tube, the suburban railway, or a regional train.

If the driver opts for the switch, the vehicle will guide him to the next tube or train station, book the according ticket, and save it on the driver's smartphone or smart watch. In order to curtail the search for a parking space, the vehicle receives information as to free parking lots at the respective station and can immediately reserve a suitable parking space. Once the driver leaves his vehicle at the station, his smartphone or smart watch takes over for the rest of the trip, guiding him to the right platform by means of an indoor navigation system.

Examples for Mobility Platforms Even today, there is a substantial range of platforms that individually plot the best route from A to B. To this end, they combine public transport, car-sharing, taxis, rental bikes, and long-distance trains, sometimes even flights, providing the user with various route options to arrive at the desired destination. Most of these platforms serve purely informational purposes.

Mobility platforms like moovel [96] or Qixxit [97] go a step further: Via a personal account on these platforms and their applications, users can directly book and pay for car-sharing vehicles, taxis, or long-distance trains all over Germany. There is hence no need for a re-direction to the respective partner sites for the ticket booking. In Stuttgart, moovel has further succeeded in integrating the regional transport providers into the app. This enables customers to experience a seamless journey from planning to arrival.

7.1.2 Smart Parking Solutions

Automated parking services ("valet parking") in combination with intelligent parking guidance systems can significantly shorten the search for parking spaces and enhance the efficient use of available parking spaces. Particularly in metropolitan areas, this reduces the considerable traffic volume due to vehicles cruising for parking and facilitates the switch between different modes of transport.

Examples of Smart Solutions to Find and Book a Parking Lot In the research project City2.e 2.0 [98], Siemens joins forces with the Berlin Senate Department for Urban Development and the Environment, the VMZ Berlin (operator of urban mobility and traffic management for the city of Berlin), the Institute for Climate Protection, Energy and Mobility (IKEM), and the Robotics Innovation Center of the German Research Center for Artificial Intelligence (DFKI). On a section of 250 meters at Bundesallee (a main thoroughfare in the West of Berlin), the project demonstrates how the search of a free parking space in the street can in future be curtailed. Applications such as park pocket [99], parkenDD [100], or ParkMan [101] offer parking lot search and booking services, without requiring much technical equipment for the respective road sections. These applications are, however, limited to specific cases: Via Park Pocket, free parking lots can be found and booked in multi-story and underground car parks. ParkenDD currently offers this service for all public parking lots in Dresden, Ingolstadt, and Zurich. ParkMan, on the other hand, is based on a specific community duly reporting free parking spaces.

7.1.3 Automated Logistics

Smart Services allow for a fundamental restructuring of the "last mile" of the transport chains, the delivery to private and commercial customers. Automatically controlled transporters deliver their parcels to stationary deposit facilities or to mobile "deposits on wheels" that are either established in the city center or in respective residential areas or can be ordered. Automated vehicle control resolves many of our typical delivery problems. For instance, transport times are reduced, making a higher delivery frequency possible. Distribution hubs in the city centers allow for new business models, particularly in the food sector. For courier services, driverless vehicle fleets constitute a cost-efficient alternative for short-term small-distance deliveries. This opens new vistas for local service providers. Optimizing long-distance transport by means of driverless trucks constitutes an important pillar of these new business models. All in all, the entire transport chain gains in speed and efficiency.

Example for the Autonomous Last Mile The company Starship Technologies [11] offers a cost-effective delivery option for the last mile in the form of small automated vehicles, just big enough to hold two grocery bags. The customer can order the delivery via an application, determine an appropriate time slot for the delivery and track the position of the "delivery-bot". The app will also serve to open the bot's delivery box. Other companies are likewise experimenting with autonomous transport options for the last mile. Amazon, Walmart, and Deutsche Post (Germany's national post service) are considering drones.

7.1.4 New Flexibility in Public Transport

A mixture of car pool, taxi, and car-sharing, the automated public transport shuttle (PT-Shuttle) brings its passengers safely through the traffic. Depending on the specific purpose and on the local demand structure, the public transport shuttle has 2–10 seats. It can also be combined with logistical transport. Passengers use an app to order the desired shuttle option and board the shuttle at one of the many virtual stops marked on an online map. At these virtual stops, passengers can get on and off the shuttle without disrupting the surrounding traffic. The shuttle is able to automatically calculate an optimal route combination for different passengers and to predict the travel time in advance and with high accuracy.

Example of Digital Transport Services In the urban transport sector, we are currently confronted with several companies capable of assuming the role of game changer, i.e. of revolutionizing the rules of that entire market segment. These include taxi hailing, ride-sharing and ride-selling services such as Didi [102], Lyft [103], Flinc [104], or Wundercar [105]. Their respective transport services forward passengers to rental cars with driver, private drivers, or regular taxis. The platforms themselves do not own any vehicles, but can, even today, resort to an extensive pool of active drivers. The declared aim is

to increase vehicle utilization and thus in particular contribute to reducing urban traffic. The dissolution of the traditional boundaries between individual and public transport has sparked off a broad public debate in Germany on the current Public Transport Act. Current developments indicate that several transport service providers such as Didi and Lyft are preparing to position themselves as providers of autonomous robot taxis – a goal that could indeed be realized in the foreseeable future.

7.2 Smart Data

Digital Maps Collect Real-Time Data to Generate New Information for Map Users The use of digital maps has become a matter of course for the majority of people who move by car, bicycle, or on foot. Once a critical mass is reached, the motion data which is thus collected helps to generate real-time traffic information. Thus, for instance, an alternative route can be proposed to the driver while on the road, helping him to avoid traffic jams. This saves time and reduces the environmental impact of congestions. The collected data are, on the one hand, spatial data, relating to geographical reference points and specific points in time. On the other hand, it is likewise possible to visualize data on leisure activities and cultural events, current weather and environmental data, or data on public facilities such as playgrounds or swimming pools. Here, open data, i.e. data that are freely available and freely usable, play an important role. A map-based mobility platform is centered on the harnessing of data: large amounts of unfiltered information are analyzed and pooled according to their possible use. The user of digital maps is only given the information relevant to him in the respective situation.

Examples of Application Fields of Digital Maps The map manufacturer HERE [106] is responsible for the equipment of a variety of vehicles with onboard navigation. The availability and analysis of data across the systems of different manufacturers improves the traffic information the user receives in real time. The intelligent routing system could, for example, suggest a re-schedule of the intended stop at the supermarket on the way home in order to avoid after-work traffic jams. Information like user preferences (based on past motion data) or the availability of charging stations can be considered in the route planning.

Smart localization services can also be used in order to realize social benefits. The company Aclima [107] has joined ranks with the US Environmental Protection Agency (EPA), several universities and Google to survey environmental data like, for instance, nitrogen and carbon pollution due to exhaust fumes and smog. In addition to the stationary measuring units provided by EPA, the sensor data of vehicles is collected on a platform. Thus, air pollution can be recorded over a day at different city locations. On this basis, solutions for the reduction of pollution can be found, such as mitigating congestion or introducing a speed limit on certain road sections. Alternatively, the smart navigation software can adapt the route so as to reduce the additional pollutant emissions to a minimum.

7.3 Smart Products

Communication Between Vehicles, Traffic Light Systems, and Public Transport Even today, field trials are experimenting with interconnecting vehicles, traffic lights, and local data centers. Objects are thus becoming smart. A prerequisite for the Internet of Things is the digital connectivity of products and objects. In other words, sensors collect such physical data from the surroundings as are available in real time – locally and globally. Vehicles, traffic lights, or lanterns serve as interconnected physical platforms. The collected data are exchanged via cloud-based platforms or directly with according objects or road users. Both the efficiency and the safety of traffic and transport can thus be significantly increased.

Optimizing the Traffic Flow – The Example of "Phased Traffic Lights" Owing to intelligent traffic lights ("smartPORT Traffic Light") [46], people and goods are transported more efficiently through the harbor area. The ever increasing port traffic is optimized by means of a phased traffic lights effect. In order to enable communication between traffic lights and trucks, the Hamburg harbor has launched a pilot project which equips trucks with RFID chips. The traffic lights will accordingly register an approaching truck. They then can switch to green earlier or, as the case may be, prolong the green phase to enable the truck to pass without stopping.

7.4 Smart Spaces

Technical Infrastructure as the Basis for Smart Mobility In order to ensure an effective interaction between the different transport modes and technologies, a basic technical infrastructure is required that will enable communication between users, vehicles, digital platforms, and infrastructure elements. In order to obtain a level of connectivity sufficient to meet the requirements of the traffic and transport structures, different information and communication technologies will have to be used. An extensive broadband infrastructure is necessary for real-time transmissions; the same applies to converged networks, i.e. fixed and mobile networks with a uniform standard (All-IP networks). In the future, not only will vehicles communicate with road users, but also the lighting systems or street signs, for instance to optimize the flow of traffic or to transmit information to the autonomous vehicle. 5G [85] is exemplary in the development of existing technologies towards innovative services in the mobility sector.

Example of an Intelligent Transport System Based on 5G The interlinking of transport modes and infrastructure elements is an essential prerequisite for the realization of a future transport system in which autonomous vehicles identify the best route or electric cars the next charging station. An Intelligent Transport System (ITS) therefore implies data communication via the mobile phone network. The fifth generation (5G) will be more than a mere evolution of the 4G data exchange system (LTE and LTE-A) as it will also take

critical requirements of the mobility sector into account. These include lower latencies, reliability, and availability, as well as energy-saving communication protocols. The 5G networks will enable direct communication – vehicle to vehicle as well as between vehicles and other devices. In mobile applications, this is so far only possible to a limited extent.

7.5 New Concepts and Roles

The applications described above offer just a glimpse of the development potential in the field of Smart Mobility. Some applications are still at an early stage of development while others are already swiftly evolving; still others have already become part of people's everyday lives. The decisive prerequisite for the realization of Smart Mobility services is a *digital ecosystem*.

Smart Mobility Usage Scenarios II

8

Barbara Flügge

Abstract

Usage scenarios are a good tool to manage the distinct viewpoints on Smart Mobility when investigating the topic, developing solutions, and piloting Smart Mobility. Regardless of the starting point or interest, usage scenarios give a head start for Program Management, Smart Services, Smart Data, Smart Products, or Smart Spaces. The following chapter puts personae into the focus. Examples are taken from the healthcare sector, intermodality concepts for personae living in the city and in the country side amongst others.

Contents

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8.1 Personae on the Road

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How does the Smart Service World with its four layers Smart Services, Smart Data, Smart Products, and Smart Spaces now apply to individual personae and consumer profiles? What are the key elements to manage projects properly? In the following we describe a selection of user oriented scenarios and introduce the critical project steps. The selection promotes a variety of personae, addressable application areas, and results to introduce the connecting element of mobility beyond the traditional mobility needs such as travel and delivery. Regardless of taking into account a private need or a business decision, mobility turns more and more into a central element of our living and economic spaces. We even postulate that the fundamental need of mobility is as equally important as nutrition and safety.

To better acquaint the readers browsing through the use cases the following structureand key elements as outlined in Table 8.1 are used in the sections below. Orientation gives the *Smart Mobility Basic Structure* as outlined in Fig. 8.1.

8.1.1 Medical Tourism and Travel-In-Company

What do healthcare scenarios look like in the in the context of Smart Mobility? The following examples give insights.

Medical Tourists and Other Tourists Medical tourists are defined as patients that by intention and purpose are seeking medical treatment or medical advice in a foreign country. The search for medical aid is motivated by the patients themselves [108]. The following considerations confront medical tourists as well as other tourists who require healthcare and emergency services such as transport services and support [109]:

- Search of qualified and highly experienced physicians
- Search of suitable, yet certified clinics and practices
- Price for medical and adjacent services
- Quality rating following external quality standards
- Effort related to preparatory measures, conduct, supply, transport, and aftercare
- Redemption of medical treatment, insurance relevant as well as mobility related efforts, and
- Involvement of further medical tourism relevant stakeholders that remain unknown to the patient, but are crucial to the above stated considerations.

Applying the significant design elements, the usage scenario with respect to mobility turns into the following, as outlined in Table 8.2.

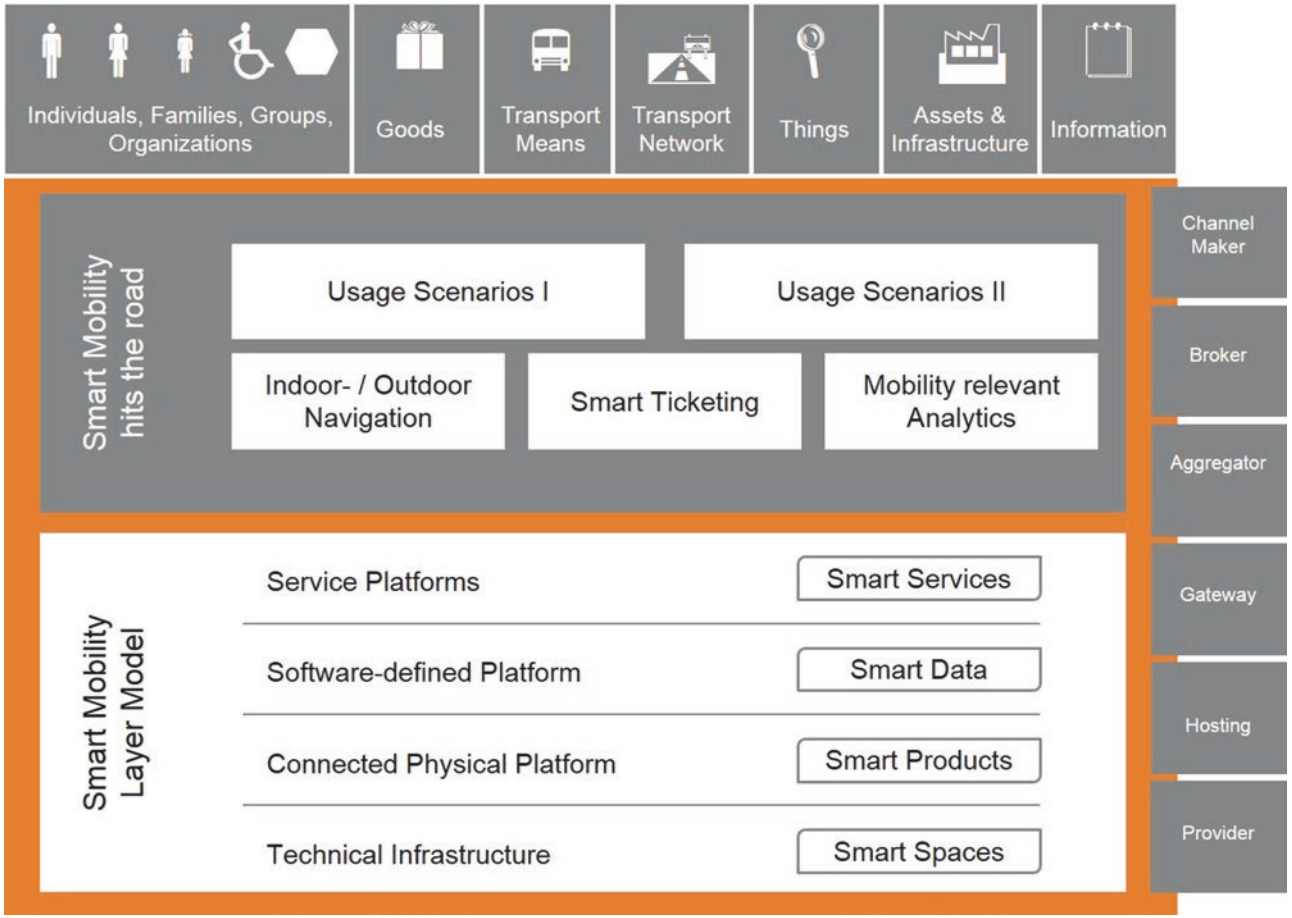

Fig. 8.1 Smart Mobility Basic Structure

Table 8.1 Template for use case structure

Elements	Describing the key elements and details
Addressees	Stating the investigated ecosystem(s)[a]
Motives	Status quo or situation that triggered the need for change
Value Drivers	Value driver
Owner	Owner and/or affected person of the encountered situation
Personae	Addressable target and user groups
Market Offerings	Existing and/or competing market offerings
Solution	Examples of market offerings and approaches where available or notable; listings could take place within the market offerings section
Degree of Deployment	To which degree the named market offerings have been deployed as a productive environment; notes will be made where feasible
Roadmap	Project stages and deployment options such as field trials

[a] Examples: airport site, port site and port city, community, region, city, city district, university campus, event location.

Table 8.2 Usage scenario for medical tourism

Elements	Detailing the key elements
Addressees	Tourist locations and regions with high numbers of casualties Locations with low medical coverage Locations with high need for nursing and auxiliary personnel
Motives	Mobile nursing and healthcare services and service relevant information bundling
Value Drivers	Event triggered travel planning and booking throughout the entire service cycle despite distinct service providers, selection, booking, billing, return transport, emergency care and temporary care, and household personal provisioning Adaptability of retrievable information and data to international, multi-language contexts Coupling of travel and event data such as flight bookings, hotel, pick-up services, hospital admission, duration of medical treatments, accompanied return Add-on services for healthcare insurance providers Increase of predictability of medical action planning in particular in tourist regions Differentiate physicians and hospitals by following a framework for accreditation that fosters transparency and competitive advantages
Owner	Healthcare insurance, hospitals and new service providers with focus on full service provisioning

Table 8.2 (continued)

Elements	Detailing the key elements
Personae	Billing agency, clearing house, doctor, nursing agency, patient, transport company, travel companies and agency
Market Offerings	Manual offerings are available to a large extent Digital offerings in the field of analytics Service bundles in cooperation with multiple service providers such as nurses, care agencies, nursing service, nutrition consulting, and general practitioners
Roadmap	Analysis of the healthcare business network Conduct of a interconnectedness analysis Design of mobility patterns of travelers to derive personalized and individual treatments of tourists in holiday resorts

Facilitating Travel-In-Company Digitally Mobility means freedom. Especially the elderly people, people with disabilities, and/or those that do not feel comfortable being on their own in an unfamiliar environment are searching for freedom. However they often give up due to high coordination efforts in traveling with others or simply because of missing companions that support them.

Family members and friends help to watch out for travel-in-company offerings. Examples of a companion could be equipment such as wheelchair or a walker, or a qualified person, or a person that knows the area. We all know once having encountered or observed a situation where help is needed how difficult and challenging it could be to just visit the physician or the municipal office around the corner. It does not take a lot of creativity to picture tedious and time consuming coordination efforts, lengthy and hard-to-overlook booking and invoicing tasks.

Smart Mobility in this context is really smart once effortless business processing and non-IT expert knowledge facilitate the travel-in-company. Furthermore we promote a *digital assistant* that manages the end-to-end mobility process from the first instance of getting to know about the travel need to getting the traveler back home. Beneficiaries of the digital assistant are both, the traveling person and his companions. We refer to this digital assistant as a *Digital Concierge*.

Nowadays, travel offers with respect to the above outlined needs are highly personalized and need to be manually found and configured. Often the offerings with respect to international travel needs are not localized to the traveler's needs or translated. And overall, offers do not exist!

In our vision the Digital Concierge assesses all relevant offerings and compiles from preferences and the traveler's profile a condition framework that can be looked up and hooked into the offerings of caring personnel, experts, and people that are familiar with the location, for example. That matchmaking process issues a booking request and ensures the

service delivery – in a nutshell. Up to the time that an autonomous vehicle is an option to serve itself as digital assistant, the Digital Concierge provides a certain amount of relief. Even further it discloses the dos and don'ts of a functioning matchmaking application that will be surely be embedded in the digital service functioning of autonomous vehicles.

Applying the significant design elements, the usage scenario with respect to mobility turns into the following, as outlined in Table 8.3.

Table 8.3 Usage scenario for travel-in-company

Elements	Detailing the key elements
Addressees	Accompanied travel in the own environment Accompanied travel in foreign territory such as vacation and for business trips
Motives	Be mobile
Value Drivers	Event triggered travel planning and booking throughout the entire service cycle despite distinct service providers, selection, booking, billing, return transport, emergency care and temporary care, and household personal provisioning, especially booking of intermodal mobility requirements and means of transport selection Adaptability of retrievable information and data to international, multi-language contexts Coupling of travel and event data such as flight bookings, hotel, pick-up services, and accompanied travel Add-on services for healthcare insurance providers and non-profit establishments
Owner	Experts in travel and healthcare industry Travelers Family members Friends Digital service and tool providers Special equipment and transportation providers
Personae	Accompanying person, family, friends, traveler, transport and travel company, transport provider, rental companies for mobility and medical auxiliaries
Market Offerings	German offering called Begleithilfe.de (English Accompanying Help) [110] Otherwise manual, non-digital offerings
Roadmap	Analysis of the network offerings for specially equipped means of transport and vehicles as well as auxiliary means Conduct of a interconnectedness analysis for the accompanying person Design of mobility patterns

8.1.2 The Personal Mobility Account

Mobility and innovation go hand in hand. Consumers of mobility enhanced devices that are conducting their business tasks raise their expectations of a functioning, yet innovative, offering. Whatever process, information, and data are being elaborated, subject to business processing, and presentable in a mobile manner, the mobile format asks for a much more sophisticated and safeguarding approach for business users than what consumers have been willing to forego for private purposes. Processing time, device independent app usage and processing, security layers according to task profiles and geography are a few examples that business users stated as key requirements in our studies.

Further benefits relate to the disclosure of mobility needs from users in their private lives. What appears to be a paradox is easily explained through the following example. Technicians, field workers, or caring personnel fulfill everyday high expectations as part of their duties – they are on the road, document and note down requirements and wishes, and they represent in a highly professional manner their employer on-site – regardless of whether the travel on-site is filled with obstacles, requires huge effort, or if the targeted location is a remote location and difficult to access. Further tasks from a private traveler perspective expect to be fulfilled in a similar timely and efficient manner: collecting the kids from sport lessons after work, bypassing the grocery store to get the food at home, the booking of a private doctor's appointment, or managing to purchase a gift while traveling.

Hence, users experience a *dual identity* of requirements and expectations for their very own mobility. A dual identity, as we call it, is capable of separating logically private and business mobility matters. It preserves the separation of budgets and accounts. As the dual identity overlooks and maintains bookings and payments in accordance with the employer's compliance framework, it follows other guidelines and allowances that have been maintained in the user's profile.

The *personal mobility account* thus administers the required functionality such as identification and authentication, payment, reporting, and the personal user-dependent configuration of rooms of trust (trust gates). *Trust gates* describe those digital entry doors that are kept open for handing over earmarked user's data or preferences based on his approval or that are kept closed because of a user's denial to hand over data or preferences. Alongside any digital data and business processing we encounter multiple trust gates within one process. In a three-tier process, the first gate would be kept open for information purpose and accordingly classified data. The second gate relates to preference related data that influences, for example, the proposed mobility means. A third gate is opened with a user's permission to transmit payment information.

The personal mobility account facilitates the use of trust gates in mobility related and intermodal applications. Once created, the user enriches a trust gate with his preferences and his requirements related to intermodality, billing, tolerances with regard to to-be-selected routes, geographies, and preferences. The administration is digital only and accompanies the traveler through a physical medium such as a mass storage device

(e.g. a USB stick or a micro SD card). Thus the device transmits the traveler's preferences and further operations-related data once it has been placed, for example, into an autonomous car, a third-party fleet car, or a car from the shared mobility offering of the district where the traveler lives. The car then adapts itself to the traveler's preferences. Important hints regarding meetings, appointments, and interests are communicated and taken care of while traveling. The billing takes place in accordance with predefined preferences: on a monthly basis, subscription based or based on the mileage or consumed time.

The characteristics of the personae that travel regardless of the distance, the daily way to work or the operation site, or the well-prepared vacation have been described in detailed in Sect. 5.4. But what about travel behavior? To make Smart Mobility work it requires insights. It is recommended to offer *persona-driven mobility accounts* that are able to make behavior triggered and behavior dependent mobility offerings re-usable. Re-usability could then be adapted by geography and medium. The account supports the users' acceptance of shared vehicles and autonomous vehicles once they successfully offered a personalized treatment.

When applying the key elements, the usage scenario with respect to mobility turns into the following, as outlined in Table 8.4.

Table 8.4 Usage scenario for personal mobility account

Elements	Detailing the key elements
Addressees	Transport such as autonomous vehicles, shared vehicles Transport with high ratio of change of personnel District, city, or region specific fleets
Motives	Transmitting preferences
Value Drivers	Transfer consumer related settings from one means of transport to another digital method
Owner	Mobility consumer
Personae	Mobility consumer Service channel maker such as hardware manufacturer and device manufacturer as well as connectivity provider Service broker such as rental car company of a city or region, insurance company and others Service gateway such as automotive industry, shared vehicle fleet operator, navigation and entertainment system operator
Market Offerings	None
Degree of Deployment	Not available to date
Roadmap	In planning stage

8.1.3 Deployable End-To-End Ride- and Interest Sharing

As Robin Chase, the founder of Zipcar, stated "shared network assets always deliver more value than closed proprietary ones" [111, p. 19]. Encountering more than 300 ride-hailing service providers in Germany or observing the market opening up in countries such as Malaysia and China, providers might ask "What comes next?" in ride-sharing. One example of service enrichment is driven by SAP [112]. The TwoGo ride- and interest sharing offering started with alike thinkers and sharing enthusiasts that wanted to change the habit of individual, one-by-one commutes to the working location, back home or to a meeting or event venue.

The rationale behind the offering started with an assessment of the previously consumed mobility efforts from a company's and commuter's perspectives:

- The average commuter in Germany rides 46 kilometers in 54 minutes.
- The commute in the USA generates 1.3 metric tons of greenhouse gases with an average of 1.1 persons per vehicle per commute and an investment in 215 square feet of parking space that gets occupied for 1760 hours over a commuter's working year.
- Companies in rural areas seek to lower parking costs and reduce travel expenses for consultants, sales and mobile personnel; moreover costs savings occur due to fleet size reduction.

In every subsidiary around the globe within SAP, small, medium-sized and large enterprises and their employees, all make use of TwoGo. Starting with commuting services, the offering now has the following features (see Table 8.5).

Table 8.5 Ride-sharing features of TwoGo

Instant use	Cloud-based solution
Ease of booking	Mobility booking is done as calendar entry, via text message, in devices such as smartphones or tablets, automated backend processing
Matchmaking functionality	Authentication service Matchmaking driven by person's preferences Mapping public and private available transport means Driver or co-driver maintains a preferred commuter list
Viral offering	Turning mobility into a communication package that bundles up with lottery, active requests, and other purpose driven mobility needs
Multi-purpose functioning	Meet-your-colleagues-while-commuting Pick-up service for employees Delivery services for goods Site2Site and round trips Analytical dashboard for organizations and institutional service providers such as government departments

Table 8.5 (continued)

Instant use	Cloud-based solution
Ecosystem wide and cross-regional, international use	Time zone functions Multi-lingual Local maps
Personae	Individual travelers and/or groups; goods, equipment, spare parts, services, collateral
Alignments and integration potential	Mobility-as-a-Service Alliance Public transport and ecosystem-wide bundles
Business model metrics	Enterprise license to cover annual fee per user (driver or co-driver) regardless the number of rides and distance Employees use app[a] free of charge Individual users use service free of charge

[a] https://itunes.apple.com/ch/app/twogo-by-sap/id673140392?mt=8.

Similar to BlaBlaCar, ride-sharers like the idea of exchanging information and knowledge. From a company's perspective commuters get to know each other and depending on a consumer's interest and willingness he has the opportunity to network and establish good contacts. In the offering from TwoGo, users can decide whether they are only a member of their internal company group or want to drive with the entire ride-sharing community. Moreover, planning and budgeting efforts to attend a conference or a sales meeting turn into a positive event.

By adding products, equipment, and goods ride-sharing turns into a multi-usage and even more optimized space management functionality. Beyond an organization's interest, entire construction sites could turn equipment and tool delivery into a whole new meaning for onsite shared assets and co-shared rides to lower traffic congestion, air and noise pollution, and reduce waiting times and delays.

Example of the Ford Smart Mobility Program for Passenger Transport As part of its company strategy, Ford launched a program to investigate Smart Mobility through the analysis and conduct of usage scenarios in the field of individual mobility. The undertaking of 25 experiments on a global scale concluded in the formation of a new business unit called Ford Smart Mobility [113]. These experiments, as outlined in Table 8.6, take place in cities as well as Ford sites. The corresponding cities are added in parentheses.

The Ford program is a great example of orchestrating the variety of usage scenarios for individual mobility needs. A number of the experiments are conducted alongside so called challenges. Challenges refer to competitions of schools, universities, and local appeals.

Table 8.6 Usage scenarios of the Ford Smart Mobility program

Accessory Challenge [Johannesburg]	Data Driven Insurance [London]	Future of Mobility [Argentina]	Proposed Australia Accessory Challenge [Australia]	Share-Car [Bangalore]
Big Data Drive [Dearborn]	Data Driven Healthcare [Gambia]	Infocycle [Dearborn, Palo Alto]	Mobility Integration [Chongqing[a]]	Summur Golden Hour [Delhi]
Car Swap [Dearborn]	Dynamic Social Shuttle [London, New York]	Los Angeles Parking Lot 2.0 [Los Angeles]	Monsoon App Downpour [Mumbai]	Summer mHealth [Tamil Nadu[b]]
City Driving onDemand [London]	Fleet Insights [Dearborn]	Painless Parking [London]	Remote Repositioning [Atlanta]	Traffic Tamer [London]
City Mobility [Lisbon]	Ford Car sharing [Germany]	Parking Spotter [Atlanta]	Rapid Recharge and Share [Dearborn]	Urban Commuter [Shanghai]

[a] City in South West China; [b] Province in India

In addition to the chosen locations Ford could benefit from the existing infrastructures that are provisioned and supplied through the production sites and sales offices: examples relate to shift related mobility requirements and service supply between locations and sites. Another benefit of targeting Ford's own infrastructure relates to the direct addressing and solicitation of Ford's own communities, meaning production and sales personnel, their families and friends, and the associated local habitats, as test users as part of the field trials.

8.1.4 Mobility Management for Facility and Asset Management

While researching digitization opportunities, especially the service front for real estate managers and the housing industry, the idea was born to investigate mobility driven collaboration opportunities for personae, for example real estate personnel, rental and housing agencies, and tenants.

Mobility Requirements in the Real Estate and Housing Segment The housing and real estate segment is characterized by highly connected and interlinked sub-industries and adjacent industries. The approach to mobility and service needs is driven by a multi-perspective analysis. The key reflection points for service and mobility needs have been defined as follows:

- Task oriented reflection of the process from property construction to operations once the idea is born and the construction site has been selected – characterized by 13 tasks:
  - Billing, constructing, designing, evaluating, implementing, installing, measuring, moving in and out, planning, procuring, renting, and selling.
- Activity oriented reflection along the business process from the moment of purchasing the property to utilizing it – characterized by the 13 key process clusters:
  - Target group driven promotion of the property
  - Finance, insurance, and credit counselling
  - Sustainability and energy efficient related mounting, development, reconstruction, and modernization measures
  - Technical emergency, monitoring, and security services
  - Cleaning services related to the property and its environment, being a garden, the access areas, or parking
  - Driving, pick-up, and transport services
  - Communications and leisure offerings
  - Housekeeping services
  - Counselling and mediation of social services and home care programs
  - Waste and recycling management
  - Infrastructure management
  - Social and commercial community management
  - Operations management, monitoring, and benchmarking
- Considering all aspects concerning sustainable property build and management:
  - Those aspects take place ideally in accordance with the 11th United Nations Sustainability Development Goal (aka SDG 11) titled "sustainable cities and human settlements" [114].

Applying the key elements of the usage scenario with respect to mobility leads into the following, as outlined in Table 8.7.

Table 8.7 Usage scenario for facility management

Elements	Detailing the key elements
Addressees	Housing industry overall and particularly facility management in certain sites
Motives	Create distinguishing features such as branding, image, attractiveness Foster settlement Upgrading residential areas and connected target areas such as commercial and recreation zones Deploy sustainability goals in the district, the city, and/or the region

Table 8.7 (continued)

Elements	Detailing the key elements
Value Drivers	Offer flexible housing and cohabitation throughout the district, encompassing life with own mobility pooling Promoting ecological home building Sustainable resource management by bundling efforts for repair, gardening, modernization, and new build projects by real estate agencies, construction companies, or house owners and tenant communities Implementing target group specific housing under the premise of mobile accessibility Add-on service offerings for residents through grocery and household related delivery bundles, transport services in case of medical needs or to the hospital Add-on service offerings for real estate and facility operators for own personnel and for loading and unloading points. The latter aspect targets the joint use of loading and unloading equipment and transport means
Owner	City planning office, construction company, facility manager, mobility service provider that is associated to or operates its own real estate segment as in the case of the Swiss railway company SBB, traffic planning office
Personae	Architect, building administrator, construction company, facility manager, furnishing company, insurance agent, parking operator, planning office, real estate agent, real estate owner, rental manager, retailer, tenant, traffic planner, whole sales, urban planner
Market Offerings	Manual offerings with minimal use of IT except website or Internet commercial Isolated offerings that for example are focusing on the promotion of real estate and housing or that offer information on targeted locations or sites
Degree of Deployment	Manually without ICT-enabled services that would encompass all 13 process clusters Pilot phase with respect to sustainable district planning [115, 116]
Roadmap	Conduct of a interconnectedness analysis Coupling task oriented with activity oriented service description

Asset Related Mobility Fulfillment In conjunction with the above described scenario for the real estate business another adjacent scenario is targeting assets and the degree of utilization. The service *mobility provisioning* relates to real estate, housing, education, and working environments where assets such as fleets and loading space are made available outside the office or opening hours, at weekends, or on holidays.

Applying the significant design elements of the usage scenario with respect to mobility leads into the following, as outlined in Table 8.8.

Table 8.8 Usage scenario concerning needs-based mobility provisioning

Elements	Detailing the key elements
Addressees	Purpose related living and working areas (district, university campus, community area)
Motives	Create and communicate distinguishing characteristics in branding, image build, and attractiveness Countermeasure cost pressures driven by increased usage of resources or their limiting availability Deploy sustainability goals Increase resource utilization of unused or dormant vehicles
Value Drivers	Innovation leadership Cost reduction Personae driven and requirement driven mobility provisioning Increase commuters' security as well the security and health conditions for residents
Owner	Privately organized interest group, public sector related association, automotive manufacturer
Personae	Co-driver External infrastructure supplier concerning infrastructure such as bridges, bridge operations, crossings, railway systems, road management system road surface, surface condition and maintenance, waterways, and many more Internal vehicle and asset related infrastructure supplier concerning assets such as equipment, navigation, personalization software and technology Service providers such as driver, fuel station provider, maintenance provider, manufacturing, repair, asset and component recycle and upcycle providers that act according to the circular economy principles, telematics service provider, test engineer, traffic network provider, urban planning officer and further community planning officers and servants, vehicle and vehicle component provider
Market Offerings	Digital offerings through automotive companies Digital offerings through service brokers such as navigation service and hospitality service providers Digital offerings through individual service providers in the field of navigation and telematics solutions Mobile offerings concerning destination and location-based services Landmark-based navigation services still yet to come
Degree of Deployment	Partial service bundles are offered digitally, the overall end-to-end business process is still characterized by process breaks and limited data forwarding Degree of test fields and trials in Europe is still low and often focused on automotive technology such as driving operations, reach of electric cars, and others Example for deployment: ZipCar USA [25] Projects in progress: inclusive district initiative in Garching, Germany

Table 8.8 (continued)

Elements	Detailing the key elements
Roadmap	Conduct of a interconnectedness analysis with respect to city, working, and/or living environment and reach Defining the requirements catalogue for localization and personae related vehicle provisioning and usage Coupling of individual digital services for mobility provisioning and offerings onsite

8.2 Intermodality

Ralf Helbig, Ludwig Haas, and Barbara Flügge

8.2.1 Setting the Stage

The over-arching objective of *intermodal traffic management* aims for an optimum coverage of mobility needs with the least additional traffic modes. Multimodality in that respect aims to shift mobility of passengers and goods from road to other means of transport [8].

The example in Fig. 8.2 demonstrates that a business traveler's options, hence his preferences concerning comfort, available budget, and time made available to meet business partners and share lunch or dinner, do not coincide with the available time and the offered means of transport. In real life, business travelers do not spend less than one hour managing one business trip as outlined in Fig. 8.2. The presented case is an easy one. Efforts with respect to intercontinental travel could expand up to four hours of effort per person, and more. Those measures resulted from our own observations and those of power users that travel more than 40 % of their working time in a calendar year.

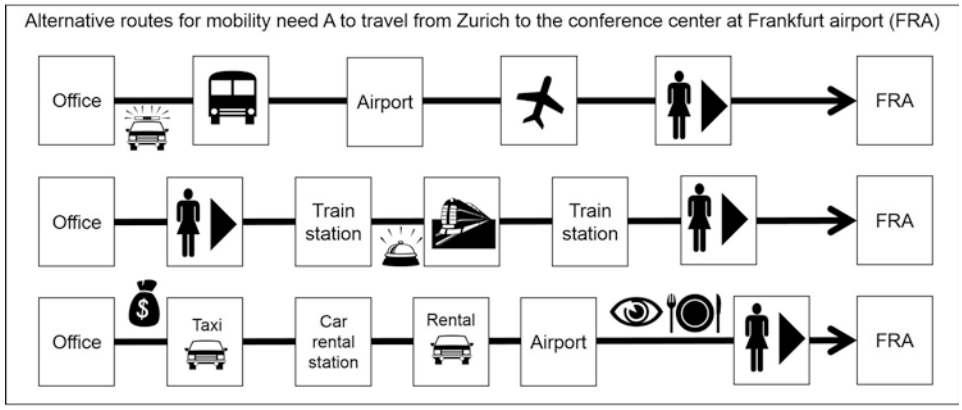

Fig. 8.2 Intermodal on the road – exemplified depiction of alternatives for one mobility need, 'A'

John's Travel Needs The following explanation aims to shed light on the current status, the main challenges, and possible future scenarios. When talking about intermodal mobility we mean an intelligent and interconnected mobility that enables a continuous journey from a starting point (A) to a destination (B) using more than one means of transport. John, working in Munich and engaged to Susan, who is living 20 kilometers outside Saarbrücken, could serve as an illustrative example.

As John is visiting her every weekend and does not have his own car, he tries to find reliable, continuous transport at reasonable cost. His solution is to take a bicycle that is located near his front door and cycles to the subway station Böhmerwaldplatz. From there he goes by underground to the central station Munich, where he gets the ICE-train to Saarbrücken. Having arrived there he walks to the parking lot beside the station and drives using a car-sharing provider to Susan in the countryside, because they have planned for a trip to France, in case the weather is nice. In this example John has booked his trip from his starting point to his destination with his mobile app with only one transaction though making use of various means of transport.

This sounds quite simple but is, in spite of digitization, not yet a reality. Its realization is dependent on a functioning complex, interconnected mobility system that needs to consist of at least the roles of traveler (customer), service mediator, service provider, and infrastructure operator. Additional roles in this kind of ecosystem could be payment provider, clearing, regulator, insurer, or other suppliers of add-on services. Each part of the chain has to render its special key tasks requiring certain business and technical capabilities.

The overarching usage scenarios for both private and business travelers' needs are detailed in Table 8.9.

Table 8.9 Usage scenario intermodality

Elements	Detailing the key elements
Addressees	Addressed are the movements within an ecosystem such as a campus, a village, a region or city, a company area, or an event location Addressed are the movements among ecosystems such as city to event location, village to a company area, or among cities, regions or villages
Motives	Realizing the mobility need based on travelers' needs concerning time, budget, and comfort: – Commuting to place of work or location of interest – Business related travel – Private travel for vacation, shopping, or visiting – Transit travelers with stopovers at a central station or a city prior to boarding a cruise ship – Shipping and delivery related travel for goods and services – Event or purpose driven mobility need – Field operations caused by security guarded events and/or caused by exceptions such as incidents, evacuation measures, and natural catastrophes

Table 8.9 (continued)

Elements	Detailing the key elements
Value Drivers	Targeted, purpose driven caring along the trip Cost efficient planning and deployment for the entire end-to-end mobility process Preciseness in arriving, transit, onward journeys, and returns despite incidents and unplanned occurrences Travel comfort and stressless arrival and return Safe arrival and return Spending time wisely for leisure, meetings, coincidental encountering
Owner	Service provider of public transport and publicly organized mobility Service provider of private means of mobility Service provider of mobility as such Transport management operator – private and public
Personae	Personae following the mobility consumer profiles
Market Offerings	Event triggered door-to-door offerings capturing intermodal needs on the spot are missing Selective digital offerings are available with respect to an upfront combination of two modes (rail and bus, rail and fly) that however do not reflect incidents and events Individual digital offerings concerning usage-based mobility, as the one from UbiGo Sweden [117] Transport mode related mobility booking systems such as the GATravelcard from Swiss Railway [86] or Qixxit from German Railway [97]
Roadmap	Analysis of the transport route network Conduct of a interconnectedness analysis Personae driven design of mobility patterns

8.2.2 A Matter of Interest

Translating our persona's trip, namely John's trip, into an intermodal concept means that he can communicate his intended journey to the service broker (transportation operator, mobility portal, travel agency, or such) on various channels. John then receives information about possible options to fulfill his travel requirements. To achieve this, the service mediator has to oversee all possible service providers that offer transport on this route, combine and match them with the customer's need, and display the identified options in a simple way for easy selection, maybe even considering some preferences of the customer such as inexpensive, fast, comfortable, or lowest carbon footprint. This step is already realized by companies such as Quixxit. But still buying a single ticket for the selected combined trip is only partly possible today if at all. The challenge for service brokers such

as Quixxit in selling this trip in one package is to decompose the selected journey into its single components, calculate the total price for the customer, process the transaction, and make bookings and payments to each single service provider of this travel chain.

Only then the bicycle-sharing company, the subway operator, the railway and the car-sharing operator are ready to promote ticketing relevant data to the mediator. And provide their transport services to John, being responsible for an easy and economical trip for their respective section. Thus, they need to be able to provide the required means of transport at the right time and location, managing their timetables reliably. In case of any delays or changes, John should not only be informed on time. The service mediator should even offer him ad hoc alternative options to minimize the delay as much as possible and without additional costs for John.

Next to vehicles the service provider also requires access to infrastructure such as railway lines, streets, traffic control, or similar. The operator takes care that the infrastructure reliably supports the smooth handling of traffic. Thus he has to maintain the infrastructure, adequately expand or remove it, and control traffic under his remit.

The Status Quo Concepts for intermodal mobility have been described quite explicitly and are well understood at the process level. Many approaches have been visible on the market for quite some time, implemented by renowned mobility companies. But still there is no resounding success. It seems to be hype, similar to new technologies such as UMTS (Universal Mobile Telecommunications Systems) that in the beginning of their market entries were not able to transform technological potential into attractive and useful services for the customer.

Currently, there are various providers that combine several offerings of potential travel routes and show customers how they may fulfill their travel needs. Providers can even optimize their trips according to customer preferences, such as the most eco-friendly, the most comfortable, or the cheapest. Thus, they are able to bundle and display timetable information and further offerings according to the customer's specification. Booking and paying for a trip with multiple sections and different means of transport in one transaction, receiving only one ticket, is not or only partly possible in today's applications.

This is not caused mainly by technological shortcomings but rather by a lack of clear positioning in the ecosystem or a lack of required business capabilities. Most of the established actors do not have a clear strategic picture of their role in these ecosystems, because they are uncertain about how participating in intermodal mobility will contribute to their enterprise targets once they join the game. To be successful, you need to have both a clear strategy and the necessary business capabilities for the targeted role.

Looking Behind the Curtain Let us look at the motivation of each participant of such an intermodal mobility chain. First the service broker is likely to be a new player in the ecosystem as the offering of timetable information and selling of tickets to the customer is usually under the control of and is one of the functions provided by the service provider. Thus, new players are mostly regarded as a threat as they are the ones that take over the customer interface at least in the selling and maybe even in the customer care phase. Their main success factors are the usability, the completeness, and the quality of information.

Usability is in the sense of how easy and intuitively the customer can find the travel chain that best fulfills his individual needs. Completeness, means ideally all available service providers with their sections and timetables as well as all additional services and functions that can be combined with the travel chain, including payment. This role is a purely data driven business model and players such as Google, Uber, or new start-ups enter the ecosystem. They of course are experienced in the way they address customers via digital channels, how they deal with customer data, design user friendly interfaces, and handle these huge data volumes and varieties. In addition they have clear perceptions of how to play the game and are of course neutral in the sense that they do not provide any of the transport themselves. Therefore, they are very much considered as disruptors by the traditional service providers, hijacking the direct customer relationship that is regarded as one of the most relevant success factors for the service providers. This is a potential conflict and can already be observed in a kind of battle for the customer as service provider. For example, Lufthansa, SBB, or Deutsche Bahn try to extend not only their sales capabilities and channels to tie their customers tightly to them, but also their means of transport such as Flinkster car-sharing or allying with local public transport carriers. Hence, service providers, especially the large ones, try to act also as service mediator even though they cover the mobility chain only partially. It is regarded as most important in this role to be the first contact in a multi-stage travel chain. As a consequence, the target groups with their requirements must be considered and served carefully in order to identify the addressable segments and find whether there is even a business case, and to cater to their needs better than the competitors.

Service provider and infrastructure operator could profit from such intermodal mobility concepts by increasing the capacity utilization and by equalizing the distribution of traffic volume during the day to finally reduce unit costs. Thus, there are benefit potentials for each role in this ecosystem, but while the established companies have the means and the most important capabilities to be part of the game, they very often lack a clear formulation of their strategic positioning and motivation. On the other hand, new players such as Google know exactly what their strategic position should be and what they want to achieve, but they lack important capabilities to provision all components with their respective operators and ensure correct settlement among the service providers. Provisioning entails the decomposition of a travel chain into its single sections in order to commission single sections from the respective service providers. In order to confirm the trip, you need not only technical capability, but much more importantly bilateral and multilateral commercial agreements.

8.2.3 Where Is Intermodal Mobility Heading?

As hardware and infrastructure in the mobility sector have low to very low rates of change as railways and streets are not rebuilt overnight, or vehicles, especially in rail transport, are not swift purchases, in the short term the main impact in this area will be achieved by software. Thus digitization and technology development are one of the most important

drivers for possible development scenarios. Real added value can be generated for customers such as proactively informing travelers in case of disturbances or changes during a journey and supplying possible alternative options for the best way of proceeding. This could be a feature the traveler wants to take advantage of and so would be ready to book one ticket for the whole journey, having been assured of a holistic care package during the trip. This of course is only facilitated by mobile devices.

But facilitating intermodal mobility is not primarily a technological issue but much more an issue of the strategic positioning and role definition within its value chain. Consequently, latest trials put a lot of effort in connecting various service providers to enable full door-to-door offerings for customers.

For instance, SBB and local public transport in Switzerland are cooperating to set up a new common platform where they plan to use common applications and data to sell one ticket across various means of public transport. All participants have agreed on a common pricing model and on using common functions in the selling process, and on providing compatible information so that door-to-door connections within Switzerland can be offered to the customer. Besides the technical harmonization and standardization that is involved in this transformation, there is also a lot of negotiation required between each of the service providers about the price model, the income distribution, so that this platform is able to process payments. A specific challenge is the distribution of income when the starting point and destination are unknown, as it is the case when selling an annual or monthly ticket (e.g. GA, BahnCard 100).

Even car manufacturers such as Daimler and moovel set up networks of service providers that cover single sections of the travel chain to enable booking and even payments for door-to-door journeys. In this case, several transport partners (service providers) are connected in one mobile app; these are mainly Daimler partners or providers whose shares are held by Daimler. Thus they are able to mediate and integrate travel sections on bike in Nürnberg, the Rhein-Ruhr-Area, and in more than 30 German cities; local public transport in Berlin, Hamburg, München, Stuttgart, Nürnberg, and the Rhein-Ruhr-Area; the car-sharing provider car2go and flinkster; as well as Deutsche Bahn and mytaxi. Thus, moovel is capable of offering door-to-door trips within Germany. In many cases it is still route information, but in some cases payment is already possible. Preferences in selecting the best fit solution for one's own needs is still not feasible. Hence, these are early trials to mediate intermodal mobility services that still have to be improved and that demonstrate that it is a major challenge to unify a traditionally scattered and very diverse network into one common connectivity platform where all timetable and price information is accessible and compatible with each other.

In general there is still a long way to go and the described solutions that are currently available are probably only first steps into the new world of mobility. From a technological perspective far more advanced solutions could be realized even today. For example, an IoT-enabled solution could be the "Be-In Be-Out" concept, where metering occurs when a traveler enters or starts to use the means of transport and when he leaves or stops using it. This approach facilitates a post-usage charging of the services and sections used. This of course changes billing completely and could be handled much like a telephone

bill. Based on the sections and means of transport used, as well as the times the customer traveled, the monthly charge can be calculated and discounts provided depending on the intensity of usage. In this scenario conductors are no longer necessary. Instead they could be hosts or provide other passenger services. In addition, a lot of value added services could be offered to increase the comfort of the passenger, such as ordering coffee or water in advance to be served in the train or put in the booked car, or similar.

This seems to be a wonderfully uncomplicated way to travel, but the question still remains: How do we reach these new stages of mobility and overcome all those stumbling blocks, only some of which were described above? From our perspective, the most important enablers will be increased availability of formerly proprietary data, new payment possibilities, de-regulation, and economic pressure on established mobility companies.

8.2.4 Connecting Everyone – Intermodality in Rural Areas, Small and Medium-size Communities

Is intermodality a concept that serves mobility demands in the countryside at all? How many means of transport are being made available in the future for those that prefer to live outside a larger urbanization? There is a shrinking offering of public transport buses, trains, and taxis even to date.

An Undertaking in a Metropolitan Region in Germany The discussion in the German metropolitan region of Erlangen, Fürth, and Nürnberg about the extension of the so-called city-region-train led to an extensive exchange of arguments [118].

The promoters of the project considered it a long-term investment over the next 10–20 years and argued with the following key performance measurements in mind:

- Economic value that is generated
- Comfort for passengers with distinct needs
- Sustainability gain through using the train instead of spending time in the car waiting
- Stimulator for subsequent investment and investors allocating businesses and employees in the region.

The website, although in German, demonstrates the variety of material and knowledge transfer that aimed to provide utmost transparency to the constituents and households. Info sessions have been held. Detailing about the structural impact, budgeting, cost-benefit studies, train route, and moreover alternative proposals and comparisons on a technical level, have been provided.

The three cities even founded a governmental body, a territorial division so to speak, to manage their interests jointly. Similar to a maturity model, a cause-and-effect model has been designed to depict hard and soft criteria to assess the impact of each of the alternatives. The model included a projection of employment, skills and competence building,

present and future attractiveness of the region, and a smoother and more relaxed mobility experience for employees to get to work.

It is not intended to decide for or against the efforts of the local government, but here we illustrate how participation on a community level could look like.

The Integrity of Public Transport The following is presented in the context of mobility engagements that are driven by the national ITS organization of the Czech Republic [119]. By aiming to "contribute to better and safer lives and to a cleaner environment" the initiative's leaders seek to keep a high level of modal split in the Czech Republic. Even more it is stated that the integrity of public transport needs to be kept. Public transport in the Czech Republic is in good condition throughout the country. A dense road and railway network with a density of 0.12 kilometers of lines per square meter is comparable with the density in Belgium or Germany. Significant progress has been made by issuing a National Timetable Information System which steers all public passenger transport timetables:

- Access to the scheduling data is open, free of charge, and can be re-used by dispatchers and journey planners
- A mobility card is in use by 3 million of the 10 million inhabitants
- The mobility card manages public transport booking and fare management.

The accompanying legal framework ensures a stable operation. The details, with reference to the Czech Act No. 194/2010, are:

- Ensuring transport services every day of the week, mainly to schools and school facilities, public authorities and work
- Defining the objectives of public transport and expressing the public interest
- Defining the responsibility on federal, regional, and municipal levels that are covered in multilateral agreements
- Preferring public transport
- Defining transport performance and quality criteria
- Managing operator selection and public transport contracting.

One of the leading projects that concerns intermodality is the design and issue of a sustainable urban mobility plan for the city of Pilsen. The plan outlines concrete measures and decision making criteria to facilitate about 90 mobility related projects. Further evolutions focus on the extension of walking and cycling services, reducing noise through better parking-related regulation and operation. Moreover, the establishment of a city-wide mobility coordination role is being planned. The better reach to constituents via the mobility card benefits the launch and processing of other and new citizen services.

8.3 Business and Social Needs in the Age of IoT, Industry 4.0, and the Circular Economy

Barbara Flügge

8.3.1 Autonomous Driving

Autonomous driving, often referred to as *driverless driving*, is a hot topic in mobility and innovation led discussions. Autonomous driving is defined as self-steered and targeted maneuvering of a vehicle without driver or co-driver interaction. The lifecycle stages of autonomous driving have been well described by Prof. Lemmer [120, p. 10]. A phased approach ranges from accompanied vehicle functions, partly automated, highly automated up to fully automated. In case of partly automated vehicles the car is steered automatically for a certain time period. In fully automated vehicles continuous steering is provided. The latter aspect is what is now referred to as autonomous driving.

Early tests such as the one on BOSS, a 2007 Chevrolet Tahoe that has been modified for autonomous driving, Google's 2011 or Audi's 2016 competition reveal passion and inventors' spirit, but also a down-to-earth interest in making the vision come true. Others encounter the barrier of the Vienna Convention on Road Traffic from 1968 in which Article 8 states that "every moving vehicle or combination of vehicles shall have a driver" [121]. Others encounter autonomous driving as a feasible offering made out of technological progress, assertiveness, creativity, and a good portion of realism.

Regardless of a positive or a critical viewpoint, the relevant questions and topics should be discussed in a constructive and critical manner. The following reflections follow a presentation by Prof. Lemmer [120] and are expanded by authors' insights:

- Legal frameworks
  - Driven by the Vienna Convention on Road Traffic from 1968 and national and/or legal frameworks that might vary by region, service provider, and political assertiveness, the following questions arise:
    - Is the Vienna Convention being renewed or will there be a totally new convention?
    - Will mobility consumers purchase in the future a service that manages the tolerance of autonomous vehicles in a certain country or region?
    - Will the adaptability of an autonomous vehicle become tradable directly in the car?
- Technical considerations
  - What is the status of an autonomous vehicle? What does it take to be completely reliable – as a car?
  - The automotive industry developed, over the past decades, features such as sensor technology, actuators referring to propulsion technology, and geo-positioning. Will there be a scenario, hence usage-based, interpreter or a sentinel?

  - What about the feedback of incidents and countermeasures?
  - How are the co-drivers being informed and supported?
- Behavior and ergonomic considerations
  - How is the interaction between co-driver and vehicle designed, managed, and technically resolved, for example in the case of technical outages?
  - What are the co-drivers' roles and responsibilities in the future?
  - Human Machine Interaction (HMI) related research is a key contributor to those considerations and more [122].
- Societal considerations
  - Considering that technology helps to improve traffic and road safety and diminish accidents that are caused by human mistakes.
  - What is happening in cases where new assistant and feedback systems become error prone on their own and cause or influence accidents?
- Acceptance variety
  - Users of autonomous vehicles trust the technology and the car as a means of mobility
  - How are market potentials realized in a sustainable manner and in which time frame to build on that trust and expectation?
- Migration
  - What does a migration path look like when integrating an autonomous vehicle in traffic management systems and defining the so called connected and demanded reaction capability and reliability in hybrid traffic situations? Hybrid traffic is referred to as a mix of autonomous vehicles and traditional driver-led vehicles.
  - Will there be separate lanes?
  - Will there be a call for districts that focus solely on autonomous vehicles?
  - What does the migration path look like for autonomous vehicles and their "human", hence "human compatible", behavior?
- Infrastructure
  - How is infrastructure being adapted – meaning street markers in a digital, physical, or autonomous sense?
  - Who covers the efforts in infrastructure measures?
- Insurance and liability
  - With respect to insurance and liability the key question concerns who is in charge in critical situations and when unforced errors occur: will the autonomous vehicle undertake driving lessons and pass a license test? Who is going to train the car? Will there be training-on-the-job?
- Vehicles are open systems and offer entry points
  - Who opens them and who controls access?
  - Who steers, monitors, and maintains in future?
  - Digital infrastructure maps fuel the vehicle with hints about incidents (weather, congestion, traffic jams, bottlenecks, accidents). Are drivers' and co-drivers' preferences being considered, too?
- The self-driving vehicle learns independently by experiencing critical situations, incidents, and co-drivers' reaction:

- Does it need a driving license?
- Who trains the vehicle?
- Who insures it?
- Is there a control instance such as a technical control board?
- Which lock-in effects occur with respect to service usage?
- Are there options to retrieve driving behavior and service usage ad hoc, real-time, and in a predictive manner?
- How will service providers and the developer community respond to potential lock-ins and what are the countermeasures?
- What happens if automotive and/or technology providers manage, steer, or prohibit third party services? Is there a gateway to allow private and shared services?

New Autonomy Looking into autonomy related innovations from the manufacturing and aviation industries, procedures and a governance framework serve at least as a starting point to learn about the discourse of autonomous maneuvered vehicles. In the *new autonomy* we are considering the autonomous vehicle as a persona – an approach that has been introduced earlier in this publication – and further considerations and uncertainties about *self-learning systems* arise.

Especially in the field of traffic safety the condition framework and the deployment capabilities of autonomous vehicles among geographies, hence ecosystem-to-ecosystem, need to be checked in a careful manner. Distinct regulations based on geo-political or any other decisions might be encountered: these might result in distinct values and parameters setting tolerances with respect to speed, reaction time and reaction windows, braking behavior, configuration flexibility to accommodate personae with distinct 'driver' habits and profiles, or simply to foster the use of autonomous cars and design distinct offerings.

Further differences might occur in the case of co-driving from one municipality to another: for example, distinct accreditation guidelines about the purchase and supply of *open-service-systems* in the car in the departing municipality and different ones in the targeted municipality. Regulators thus might make use of special agreements and tolerances to leverage political strength, and economic and societal circumstances, among other parameters. Will there be an agreement among distinct regulatory parties? Or will there be a service offering called "tolerance metering" that guides the vehicle when crossing one region or municipality and adapts the parameters?

Another related industry that has an impact on autonomous vehicles is the insurance industry. Tending more into usage-based and geography-dependent policies the industry is fighting for a *personae-driven design*: opening up a person's driving and giving access to behavioral data is already a model in use. How does the insurance industry respond to the above-described tolerance and parameterization efforts? Who is being insured in the car – the persons in the front seat or will there be a responsibility shared with the co-drivers in the back seat? Might there be one co-driver in the autonomous car that agrees to take on the prime insurance coverage – similar to the agreements we encounter when sharing a flat and the rental manager asks for one main tenant? What kind of liability offerings will

enter the market? In this context we need to ask if those that co-drive need to gain more insights about the others that share the car. How do we know about the ones that jump in and jump off? More intimacy is provided in an autonomous car compared to a ride-share in a bus, a subway, or train compartment. A number of these questions derive from the overall definition of roles and responsibilities.

The network itself, such as the ones that participate in ecosystems (e.g. a city, port, or an event location) generates further *networks-in-networks*: the autonomous vehicle itself connects with other vehicles, exchanges experiences about resource consumption and driving behavior, might share services, or issues new service needs. There is a long way to go to cope with disruptive elements such as risk factors on the street, unplanned errors, and a self-learning, *artificial intelligence* fostered attitude. Nevertheless, looking back at the entry of robotics in a production environment and its influence on organizational set-ups and workers' profiles, the impact of autonomous vehicles will be far more intense to all of us that are on the move.

How do municipalities prepare now for the *new autonomy*? Urbanizations that already work with asset registries continue data capturing and digitization. Asset registries are a key element to feed the car with appropriate data and preciseness about disruptions such as weather, street conditions, accidents, bottlenecks, and maintenance and construction sites. Deviations and intermodal offerings can be added, too. Those and further activities take part in the mobility management efforts of the ecosystem.

The project initiative *Neue autoMobilität* (*NaM*, in English *New autoMobility*) launched by acatech [94] focuses on the above stated topics. Experts from distinct associations, interest groups, private and public institutions, and enterprises exchange, assess, and work on a holistic view of autonomous driving and its impact on economic, political, and societal governance frameworks.

How far are we along the line? The city of Gothenburg, Sweden, launched an autonomous driving initiative with business stakeholders, such as Volvo Automotive, and a €55 million investment [123]. The future of autonomous driving is nearby and closer! It is Gothenburg's aim to deploy autonomous driving and parking in the city center by 2020.

8.3.2 Continuous Business Process Enablement

Achievements in the age of Industry 4.0 influence not only the high degree of connectivity of components, machines, and participating organizations such as suppliers, OEMs, manufacturers, and logistics service providers. Those achievements hopefully imply a more responsible dealing of natural resources, material, and packaging.

Tagging Consumption Needs to Influence Production and Distribution Taking a look at the business world, mobile and desktop boundaries are blurring. The demarcation between working-while-traveling and desktop related work in one location is disappearing. Business processing is conducted in a smooth manner and is even not noticed by the

user himself. The intelligent business process has the insight into which replacement or maintenance order the technician is handling, approving, or requesting. The insights for decision makers with respect to critical and risk-encountered incidents grow: being fault signals, emergency scenarios, evacuation, or ad hoc measures relating to street related, rail or air traffic diversions that are necessary because of an unexpected operation to de-activate a World War II aircraft bomb. Digital intersections should be of least effort for the technician. Made invisible, digital capabilities allow distinct devices and brands. A standardized usage protocol connects data wise only the relevant, and not just all of the relevant, characteristics.

One of the five *Cradle-to-Cradle*® requests concerns the re-utilization and treatment of components in manufacturing [124]. The sharing of components and products is another request we derive from that principle. It should stimulate a conscious decision by the consumer to use and not own a product. Hence the purchase of a new product transforms into the usage of a re-utilized product or component.

By material re-utilization an organization and its extended supply chain identify the material streams that can be re-utilized when the product is taken back. This asks for reverse supply chain management capabilities. Furthermore, transparency about the entire bill of material within the production and fulfillment lifecycle is required.

Another Cradle-to-Cradle principle is about the elimination of waste and to produce and use renewable energy. An outcome of this principle is denoted as the *circular economy* movement. Furthermore, responsible production is also subject to people management and guidance along the supply and demand fulfillment activities. Socially responsible companies demonstrate responsibility with regard to their staff, and endeavor to make sure that companies in their supply chain are not violating these principles. Thus, ecosystems that share a set of values facilitate the process of following this principle.

How does a *circular economy* driven supply chain look like? We, the demanding consumers, can look up shareable products and components. Instead of an isolated view of our demand, we gain insights into re-utilized components, for example those offered by fair trade and fair phone initiatives. Through IT, we are able to combine our matchmaking efforts on value, excitement, reach, and service competence with a health check on circular offerings. The fulfillment lifecycle is anchored in the Cradle-to-Cradle design principles. It does not stop with the delivery. Rather it evolves through the return, storage, and deployment of shared and re-utilized products, components, and processing materials. Waste is eliminated wherever possible. With respect to infrastructure usage, we recommend a *digital asset map,* for example, to outline shareable space and means of transport, offering assembly lines and technical equipment on the spot.

Equipped with digitally enforced technical means such as tools and means of transport we then turn to our companions. Trucks and machines continuously collect data points and transmit them into the backend system. Data capturing on the spot is mean and/or asset specific and guides our focus to operations' duration and temperature or vibrations. The goods and items that are being sourced, delivered, produced, assembled, unloaded and unpacked, and finally delivered allow us to consider weight, volume, quality, and humidity

– measurements, restrictions, and potential risks. *Cyber Physical Systems* (*CPS*) help in monitoring the correct, expected, and commercially agreed upon functioning of an item and issue maintenance activities in case of a predictively diagnosed risk. Ultimately, CPS orchestrate the collaboration between trucks, goods, and machines.

The use of *Augmented Reality* (*AR*) simplifies the logistics processing, too. Integrated in business process transactions and inter-organizational collaboration it supports the mobile and desktop personnel.

Back to *circular economy* technologies, as the ones above foster not only a managed lifecycle of products and components, but a continued lifecycle. Products and components return into the consumption, production, and usage processing.

Smart Mobility is capable of orchestrating the re-introduction of components and products into the manufacturing and demand process. Furthermore, it connects tools, production relevant material, and components with fleet management systems in a continuous manner along the production and consumption lifecycle of resources. Smart Mobility even serves to intelligently support experts on-site to monitor production, auditing, and inspection.

A Continuous Mobility Demand Cycle Operations at any hub like cities, constructions sites, and event venues should run smoothly. Timely arrival of packaging and means of transport are one of the prerequisites to facilitate the hand-over of goods from one supply chain partner to the next one. In between a number of information sources arise – not all of them are visible to those that decide upon the next steps.

Ideally information coming from different sources interacts in a pre-defined and purpose driven format. The approach allows port operators to monitor transport orders in real-time, in the office or using mobile devices like tablets or smartphones, and to undertake any activity to transport goods more efficiently and safely.

The dispatcher oversees all the relevant transport activities of the fleet in the port area. Around 20 geographical areas have been identified, the geo-fences. Geo-fences reflect critical landmarks and areas such as bridges and freeway intersections with high traffic density. Further examples are the parking spaces for trucks offered by gas or truck stations. Any occurrence within the geo-fence triggers the provision of information to the truck driver's cabin. In parallel it does the same for the dispatcher. Equipped with a geo-positioning logic, the truck sends out a signal whenever it enters and leaves a geo-fence. Data are collected based on the direction, the position, and the speed of the vehicle. Data such as the license plate are only visible to the fleet manager and freight forwarder the vehicle is registered to. In case of sustainability measures such as road usage reduction, however, license plate recognition and directly steered interaction with the truck's navigation cockpit could transform the steered vehicle into an autonomous driving vehicle.

In emergency cases within one specific geo-fence, a dispatcher sends out a pre-notification to any truck driver. The dispatcher is able to collectively address all drivers at once. In another case he submits a pick-up order directly to the driver who is closest to the loading area. The driver himself receives the notification and routing change instantly.

The pick-up notification contains all the relevant information. No physical interaction is required, for example to note down the order numbers or check out the onsite delivery guidance. Drivers seek to arrive on time, smoothly, and without stress at the respective destination. Ideally no traffic jams occur. If so, a simulation feature indicates ahead of time the countermeasures to be taken. Those could turn into a newly appointed storage area or pre-gate entry notification.

Through seamless mobility for cargo, local road managers, construction site supervisors, and dispatchers will be informed in a timely manner about the number of incoming, transiting, and leaving vehicles. Teaming up with the digital site facilitator, the analytical tool, the dispatcher decides on the ideal route for the drivers to take and which critical areas to focus on. Criticalities occur, for example, owing to blocked inbound streets or incidents that require immediate notifications and alerts for any nearby or soon-to-arrive participant.

In the frontrunner project of *Smart Logistics,* truck drivers, dispatchers, hub road management, and decision makers were provided with traffic and infrastructure information directly into their vehicle or any of the chosen workplaces. Any information is contextual: driven by the individual's location, final destination, and tasks to complete. Mobility offerings as outlined at the very beginning of this chapter get pretty nasty if they are not able to meet small time windows. The window of opportunity, for example in the case of a drive-through bridge, turns easily into a window of disaster if it is closed for 20 minutes.

Thus, the interconnectedness of the transport infrastructure (roads, water berths, railways, bridges and terminals) is safeguarded with digital mobility offerings. The following key findings resulted from our observations in a real-time deployment:

- Digital enablement of multi-modal data and dependencies results in smoother traffic situations within the overlooked area.
- When visitors and travelers make use of the digital mobility facilitator the pressure is taken off and they are able to focus on what they need to do.
- The interconnectedness of the transport infrastructure (roads, water berths, railways, bridges and terminals) is safeguarded with digital mobility offerings.

8.3.3 Business and Social Arguments

The real-life scenarios we introduced earlier in this publication took into consideration a three-tier point of view: (1) the processes are assessed from a persona point of view, then (2) the identified requirements follow the needs of the individual personae. Finally, (3) a third viewpoint evolves by looking at the stakeholders' roles that they perform in the observed persona-specific E2E mobility process.

Often, the structured descriptions of processes on the lower levels contain process variants that only deviate from the main process in minor detail. This effect can be observed when comparing the requirements from a business traveler's point of view with the event

attendee's point of view, for example. Any variant to an overall E2E mobility process is therefore driven by the observed persona. The *usage scenarios* from a persona point of view assure a 360° insight into door-to-door mobility processes.

To underpin our assumptions, we conducted a series of 10 *customer journey mappings*. Thus, the door-to-door experience from 10 individual travelers was observed, measured, and represented in a coherent, detailed format:

- Identifying the interviewee profile with respect to the observed role and travel characteristics
- Describing one day in the life concerning mobility
- Identifying one particular section and capturing the emotional experience, and ultimately
- Conducting a negative projection on the emotions with the highest rating.

Out of the 10 individuals we captured the travel profiles for each of the demanding consumer groups: direct, secondary, and tertiary mobility consumption groups. Our interaction with these mobility consumers resulted in valuable insights concerning the travel experience, such as KPIs and measures of seamless mobility:

- Identification of common denominators
- Missing elements in door-to-door mobility offerings
- Turning the adoption potential into a true usage of digital means.

Any of the above observed travelers is making use of digital means, whether this is an existing app for a particular location, a trip booking system for combined hotel and flight bookings, or a company-wide booking procedure that results in a digital notification about trip charges, a digital compliance calendar, and an electronic document that contains the booking code and seat reservations.

Despite the above outlined expectations of Smart Mobility, the digital coverage of seamless and intermodal mobility offerings was rated 'partly available' to 'poor' by the participants. Poor is given for two reasons according to the interviewees: (1) the lack of interoperability, transparency, and interconnectedness among digital mobility front office services, and (2) ticketing is up to the traveler to prepare upfront and he has to be prepared to browse onsite for offerings. The frustration caused for travelers ended in 2 of 10 cases aborting travel plans.

For all observed travelers, the participants of the customer journey mapping reasoned that the common denominator for good mobility offerings is a combination of:

- Reliability
- Punctuality
- Security and safety
- Orientation in gated areas, trains to optimize changes during transportation
- VIP services, and
- Useful spending of time.

Table 8.10 Business and social arguments driving digitization

Persona	Business arguments	Social arguments
Business Traveler	Number of travelers e.g. within an organization, e.g. traveling in Europe. Sizing of the Business Traveler Market. Growth of the Shared Economy and subsequently freelancing businesses and individual travelers without a back office is supposed to grow by 3000 %. Overcome the administrative burden for travelers and/or travelers' assistants and/or back offices despite changes, delays, and on-the-go obstacles.	Align with community members on the spot. Travel in a shared economy-friendly environment. Save time to connect, work, and relax by transforming one hour of back office and front office efforts to plan and deploy travel and adjacent business arrangements as cost efficiently, smoothly and effectively as possible.
Event Attendee	Top four event countries in Europe: – 2.7 million Germany, – 230,000 The Netherlands, – 210,000 Austria, and – 190,000 Italy in the year 2013[a] – 1 million attendees traveling to the 20 top fairs in Germany and Switzerland.[b] Consider, for example, the number of fans and sport enthusiasts plus accompanying family and friends in the US market that are traveling, e.g. for the Super Bowl or US Open	Turn focus onto sports event. Save time and money for travel arrangements. Avoid delays and unnecessary transport changes for attendee and accompanying family and/or friends. Align with community members on the spot. Travel in a shared economy-friendly environment. Save time to connect, work, and relax by transforming one hour of back office and front office efforts to plan and deploy travel and adjacent business arrangements as cost efficiently, smoothly, and effectively as possible.
Traffic Management and Operations Unit	Unit supervises and is responsible for all specific urban transport and transport-related planning activities in a state, community, city, region, or on country level. Maintenance and Repair are next to Remodeling and New Traffic Management the most critical and costly element in mobility provisioning.	Be responsible for the availability of transport services. Be responsible for security planning and risk mitigation due to traffic related impacts.

Table 8.10 (continued)

Persona	Business arguments	Social arguments
	Traffic congestion costs in Europe, for example, could range up to 1 % of GDP per year[c]. As mobility needs increase, the demand for and the challenges to smooth, yet cost efficient and effective traffic management provisioning, increases even further. Depending on the scope and the geographical reach, traffic management and operations cover highway/regional and community streets, public buses and trains, subways and trams, and public transport offerings for public schools. Smart Mobility impacts the layout of a city and/or region and any other observed zone (e.g. industrial or academic). Therefore traffic management units have an economic interest in land use planning and re-purposing of bus lanes, streets, and parking zones, for example.	Traffic management operations are one of the mostly highly regarded institutions (especially if run as a public/government unit) that has the mandate and the role to contribute directly and influence proactively climate protection and sustainability measures – e.g. through shared economy offerings, e-Mobility buses. and trucks that traverse in an urbanization. Be partly responsible and/or actively involved in delays and changes from one means of transport to another. Example: train is breaking down and the mobility service is being substituted by buses.
Digital Concierge	Represents the persona of the digital configuration advisor and mobility algorithm calculator. Appears as an avatar to the Smart Mobility service consumers and service providers.	Processes the mathematical algorithms to calculate the ideal alternative routings for one or a group of travelers despite upcoming, predictable and unpredictable incidents and exceptions. Notifies users. Sends alerts. Distills data sources from own and third party data source providers.

[a] Association of the German Trade Fair Industry, http://www.auma.de/en/press/seiten/press16-2014.aspx, accessed September 16, 2016.
[b] Source: Heidelberg Mobil international GmbH.
[c] European Commission Impact Assessment (2011) "Roadmap to a Single European Transport Area", https://sustainabledevelopment.un.org/content/dsd/csd/csd_pdfs/csd-19/learningcentre/presentations/May%204%20pm/3%20-%20Julius%20Langendorff%20-%20EU%20White%20Paper%20Single%20Zone.pdf.

A functioning digital business processing asks for the resolution of the following four requests:

(1) Data gathering from distinct and not always known data sources
(2) Missing interoperability of distinct systems and apps to respond to consumers' needs
(3) Missing ticketing solutions that cover intermodalism in an easy-to-consume manner, as well as
(4) A comprehensive, usability oriented representation of travel details and accompanying documents.

Digital services are partly made available in two variances: (1) by local, isolated offerings for the departure, the transit, or the final destination, travelers are not able to oversee the entire process and modifications. (2) Digital services are not multi-modal; mostly they are offered in an isolated manner focusing on the two main means of transport(e.g. air travel and travel by train).

Concluding our field test, we encountered a series of business arguments and a series of social arguments that foster the deployment of the market potential of Smart Mobility. A successful deployment requires both sides of the coin to be leveraged, as outlined in Table 8.10.

Indoor and Outdoor Navigation in Smart Mobility Usage Scenarios

9

Carsten Günther and Matthias Jöst

Abstract

Business and privately motivated journeys today are often driven by ad hoc decisions and a mix of different means of transport. A very distinct property of any mobility scenario that claims to be Smart is the fact that it needs to incorporate contextual and personal preferences during the selection process of a given means of transport at a given time and place. This results in great challenges, especially where different means of transport intersect, like at train stations, park and ride spots, parking garages, where travelers switch from one mode to another. In order to support a smooth transition, Smart Mobility systems need to allow for a seamless transition supported by an indoor-outdoor navigation solution. This chapter will highlight the different components needed to build up a seamless indoor-outdoor navigation solution, including spatial data management, indoor positioning, visualization of indoor maps, and a user-friendly turn-by-turn navigation. Furthermore, it will also discuss possible business models to justify the investments needed for an indoor-outdoor navigation system.

Contents

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9.1 Introduction

Innovative mobility concepts as introduced in Chaps. 7 and 8 rely on the fact, that they support a context- and preference-driven selection of means of transport, in order to get from A to B via C. In a world with increasing mobility all around, travel decisions are taken rather more spontaneously than previously planned. Smart Mobility systems need to cope and support those dynamic travel decisions.

A change from one means of transport to another poses quite a lot of stress to a traveler, as he needs to orientate himself at often unknown places in a limited time frame. Transport service providers try to support a fast and efficient orientation by utilizing signs, wall charts, or color codes on walls or floors. In recent years, the general architecture of train or tram stations has been optimized to support an efficient orientation and boarding. Nearly 100 years ago, the Swedish architect Alfred Grenander [125] developed a color coding scheme for the Berlin tube stations. According to his concepts tube stations on a given track utilize different colors on their tiling, pillars, and signage framings. These strategies should facilitate orientation for the visually impaired (e.g. U-Bahnhof Samariterstraße) [126]. Even today in Berlin, these colors are used for U2, U5, U6, and U8. Cities and transport companies spend large amounts of money on multi-lingual pedestrian guides [127], but still cannot eliminate all sources of uncertainties and inconveniences.

Other explanations of public transport services describe that “one should know at least the direction of the desired destination stop in order to get in at the right stop” [128]. When changing transport, one does not only have to keep the number of the next means of transport and the direction to the next stop in mind but also the direction of the new means of transport is important (which can be indicated by the name of the final stop or the interstation). Even more, the exact location of the boarding stop may be different depending on the direction. “It needs to be considered that stops for the opposite direction are not necessarily vis-a-vis but might be in another close by street” [128]. These conditions might cause trouble and confusion. Therefore transport services point to a last resort concerning orientation in public space: “Whoever is unsure about the choice of the stop or the direction of the tour should simply ask other passengers or the staff” [128].

This is exactly where the benefits of an IT supported system may lie. The traveler wants a simple and reliable navigation system which is easy to handle – just like the navigation system in his car. But while navigation systems in cars (running on a head unit or on smartphones) have been widely accepted, there are only a few navigation devices and solutions for pedestrians [128].

Table 9.1 sums up the main differences between vehicle and pedestrian navigation.

Table 9.1 Differences between vehicle and pedestrian navigation

Characteristic	Vehicle navigation	Pedestrian navigation
Data availability	Almost ubiquitously available in high data quality.	In urban areas already commonly available, also with a high accuracy. Indoor data primarily available for some public spaces like shopping malls, airports, train stations.
Degrees of freedom	Limits on public streets.	Three-dimensional degree of freedom. Indoor-outdoor transitions.
Hardware	Head units or smartphones, connected to the car's power supply.	Smartphones with limited battery capacities.
Positioning	GNNS-based, for head units supported by car sensors like wheel rotation, steering angle, etc.	Hybrid positioning, e.g. via GNSS, WiFi, Bluetooth Inertial Sensors, etc.
Interaction	Speech-driven or touch-/button-based interaction at the head units or smartphones.	Primarily touch interaction on smartphone displays.
Human focus	Traffic and navigation.	Environment, social interaction, and orientation.
Navigation instructions	Voice commands containing distance, angles, and street names.	Primarily visual but sometimes also haptic feedback or voice commands.

The support of pedestrians with mobile IT solutions is advisable in the course of the introduction of Smart Mobility offers, for example the introduction of a mobile pedestrian navigation solution with automatized localization via a built-in infrastructure.

9.2 Indoor-Outdoor Navigation – Requirements and Benefits

A number of requirements need to be considered in order to include the support of pedestrians in Smart Mobility solutions:

- Service provisioning needs a high grade of reliability.
- Orientation and navigation information has to be easy to understand and easy to adapt to the respective situation.
- Support of positioning and navigation has to work seamlessly in case of indoor-to-outdoor transition and vice versa.

- While outdoor navigation can rely on the well-proven satellite positioning technologies (GPS, Galileo), indoor navigation has to utilize specific technologies and a dedicated infrastructure to acquire a position.
- Calculated routes have to include the pedestrian's individual and situational preconditions (i.e. state of health, handicaps, pieces of luggage, companions).
- Routing and description need to be up-to-date, i.e. currently closed areas or newly opened arcades have to be taken into account for calculating the route; landmarks mentioned in the navigation instructions have to actually be there.
- A great variety of devices needs to be supported.
- High investment costs need to be backed up by low integration efforts of new devices and new technologies.
- The required data volume has to be handled with care due to the costs of data packages and roaming offers for users.
- Offline functionality should be part of the solution because of the eventuality of poor mobile communication coverage in some building areas (e.g. underground areas).

The above list of requirements for pedestrian navigation systems in Smart Mobility scenarios reveals that the initiation and operation of such a system is highly cost intensive. For this reason, there has to be a certain benefit for the user.

Benefits of the system are both individual and social in nature. An essential individual benefit of a personal orientation and navigation system is an increase in the user's safety. The user can determine his position and the route to his destination. It helps him to find his orientation as well as ways to places where he can seek further help. Therefore, it satisfies the second most important basic need of mankind (according to *Maslow*'s *hierarchy of needs*): the need for safety [129].

Furthermore, the system covers many aspects which define pleasant, comfortable, cost- and time-saving travelling. The user can take for granted that a change of transport as well as his orientation at traffic junctions will flow as smoothly as possible.

Thus, the acceptance of using different means of transport and transport offers rises because the travel recommendations will take personal preferences into account. Individual positive experiences with Smart Mobility solutions concerning safety, reliability, comfort, and the saving of time and costs will lead to an increase of the system's usage. Therefore, establishing pedestrian navigation systems will lead to a stronger use of public transport and car/ride-sharing and reduces private traffic.

The above mentioned values of individual and social benefits justify efforts for the development and operation of indoor and outdoor pedestrian navigation systems at traffic junctions.

9.3 Technical Requirements

The conception, implementation, and operation of a pedestrian navigation system requires a number of technical prerequisites. Navigation of pedestrians in urban spaces differs

significantly from navigation of other means of transport: higher degrees in choice of movement, complex spatial situations, more blurred positioning, and the user's shared attention necessitate new and more intuitive concepts of interaction with this kind of system. Well-known, classic, map-based approaches cover only parts of the requirements profile.

9.3.1 Spatial Data Management

The underlying geo-database is the basis of the provision of navigation systems. While previously two companies from the Netherlands and the USA, TeleAtlas [130] und HERE [131] have dominated the market, most recently, the quantity, quality and correctness of free geo-data (initiated by crowd-based services like OpenStreetMap [132] has soared. In many metropolitan/urban areas in Western Europe these data do not take second place to commercial data – they even outperform them [133]. This is primarily true when the focus is not on mere car navigation services but on other more individual means of transport (bicycle, inline skating, routing for the handicapped) or pedestrian navigation.

By extending the field of application to indoor navigation, the geo-data aspect gains additional weight, since extensive data sets from commercial or free suppliers are hardly available or are right in the process of construction.

The following aspects, which have partly been mentioned in the requirements above, describe the special challenges of indoor navigation:

- Data formats. Often based on Computer Aided Design (CAD) plans that incorporate fine-granular building construction data and structural properties that are not relevant for navigation purposes. Also the non-spatial information of those building plans is related to structural information and not to navigation aspects (e.g. whether a door is usually open or not).
- Complexity and fragmentation. Large buildings like stations often have a very complex spatial structure (i.e. several floors, halls, transitions, galleries, and much more) and complex ownership structure, which results in different contact persons and access restrictions to the spatial data and the premises for the installation of positioning technologies.
- Correctness of data. In indoor navigation, the pattern of utilization is often alterable and dynamic, especially with regard to frequently changing lines of shops in arcades. Furthermore, some doors or gateways might be closed at night or blocked during modifications of the building.

First approaches and procedures try to use the enthusiasm of free (non-commercial) spatial data communities in order to include indoor areas and buildings in a wide range [134]. But to date, these approaches have failed because of missing tools and the agreement about the method of collecting data and prospects for an automated indoor positioning technology.

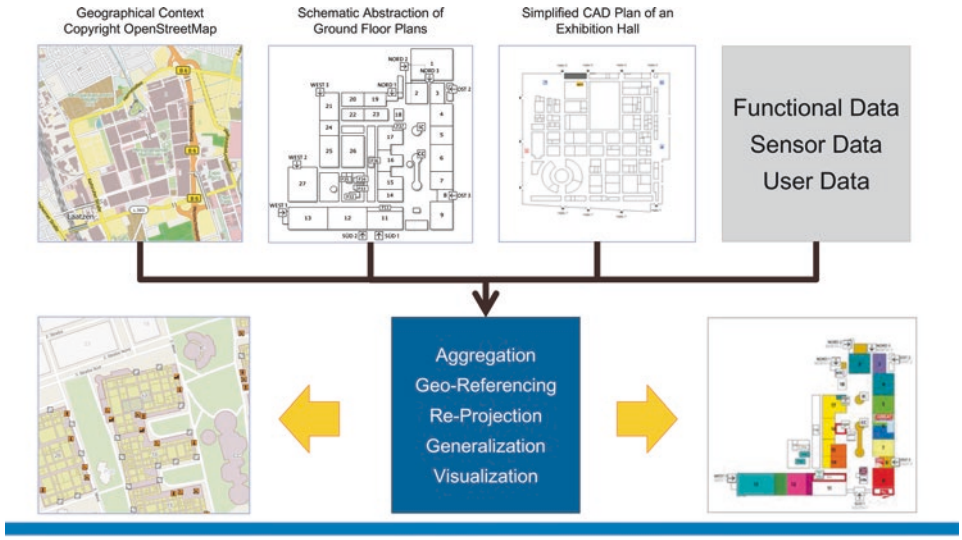

Fig. 9.1 Spatial data integration and fusion: Fusion of GIS data, CAD and record of detailed measure plans using the example of the exhibition grounds of Deutsche Messe AG in Hanover, Germany (with kind approval © Heidelberg mobil international GmbH 2016, Deutsche Messe AG 2016, OpenStreetMap.org 2016)

Figure 9.1 highlights a synchronized approach which integrates both spatial data from non-commercial databases (in common formats) and spatial data from facility management applications (in the form of CAD maps), in order to generate a joint spatial presentation, that is furthermore extended by non-spatial data like sensor information or point of interest data.

9.3.2 Indoor Positioning

The first basic requirement for every navigation is accurate localization (positioning). Localization approaches can be distinguished in absolute and relative techniques. Relative methods use the known starting point and calculate the change of position with the help of sensors. Absolute methods locate within the known reference system, for example Global Positioning System (GPS). IT/radio engineering is the basis of most of the methods.

Mere satellite-based location solutions in urban spaces with street canyons and above ground and underground buildings (like stations) are too error prone and need more time to locate the user. Therefore, they do not support the situational and quick use required for pedestrian navigation. More recent approaches try to solve the problems of positioning by using hybrid localization which combines different localization strategies and sensor data. In a first step, rough localization is carried out by the radio cells of the mobile telephone supplier, which is then – in a second step – refined by WiFi signals and thirdly – if

available – supplemented by GPS data. This well-known method is only partly applicable to indoor scenarios as radio signals are absorbed or modified by the structural environment and lead to inaccurate or even wrong user positioning.

Complexity and fragmentation of buildings directly influence the possibilities and reliability of the use of indoor localization technologies. Reliable positioning can only be ensured by a combination of different approaches and techniques (sensor fusion).

Table 9.2 compares different positioning technologies and rates them with regard to their specific advantages and disadvantages and the capital expenditure for realizing them.

Many solutions also offer the possibility of a more or less intuitive manual positioning since sufficient results of an automatic localization are not given. Examples for manual positioning are manual input of names of shops or stopovers or scanning of location barcodes.

Table 9.2 Comparison of positioning technologies

Type	Method	Pros	Cons	Overall costs
WiFi	Cell of origin	Device independent	Less robust, precision	$
WiFi	RSS fingerprint	Precision	Operating system restrictions, calibrations	$$
WiFi	Triangulation (TOA, RSS)	Precision	Operating system restrictions, fragile	$$$
Tags and Marker	BLE/iBeacon/ Eddystone	Device support, energy consumption	Operation, robustness	$$
	RFID (active, passive), NFC	Precision	Range, user interaction, infrastructure, device support	$$–$$$
	QR tags	Robust, flexible	User interaction	$
Other	Magnetic	Precision, autonomous	Calibration, robustness, device support	$$
	Inertial sensors	Autonomous	Calibration, precision	$
	Image recognition	Autonomous	User interaction, calibration, device storage or connectivity, energy consumption	$$
	Ultra-wideband	High precision	Special hardware	$$$
	Light (normal/ infrared)	Precision	Infrastructure necessary, error prone	$$

$ stands for low-cost realization, usage of current technology and infrastructure;
$$ stands for medium costs to develop, implement, and operate;
$$$ stands for high costs to develop, implement, and operate.

9.3.3 Map Visualization

The traveler's surroundings are visualized by current spatial data and positioning information. During the past decade the use of digital map services like Google Maps [135] or Bing Maps [136] has developed from desktop platforms to mobile devices (e.g. smartphones). These applications are, however, often mere adaptions of desktop applications which are adjusted to touch interactions for smartphones with big screens.

One can generally distinguish two types of the digital map displays:

- Grid-based visualization relying on pre-calculated image tiles
- Vector-based map rendering on the smartphone as 2D or 3D maps.

Because of the increasing data volume and increasing processing capabilities of smartphones, vector-based map applications have proven to be (most) suitable devices. This is particularly valid for indoor applications without publicly available online map services. 3D visualizations have to be easily operable because of the very complex interactions induced by the situated and spontaneous use of mobile indoor navigation solutions. Figure 9.2 shows examples of visualizations.

Limitations of mobile web browsers are the reason for grid-based map displays as state of the art for mobile websites. These solutions can hardly be found in indoor services because a server-based map generation is inevitable.

Augmented Reality (AR) views have gained importance compared to the map-based view. AR includes extra information via live images from a camera and requires an especially accurate positioning which is frequently restricted by spatial conditions.

9.3.4 Turn-by-Turn Navigation – Landmark-Based Guidance

Apart from geo-data, localization, and visualization, calculating the routes and their presentation in apps is the fourth pillar of realizing interactive indoor navigation systems. In the past decades, mathematical literature has comprehensively analyzed the problem of calculating routes. On the basis of graphs made of edges and nodes, algorithms calculate the fastest way from a starting point to the desired destination [137]. The route is then visualized either as linear cartographic symbol on the map or divided into single segments and then presented as navigation instructions. Both methods are used for motorized mobility but are only of limited suitability for pedestrian navigation because the user does not focus constantly on the mobile device. The required detailed segmentation of routes would also include too many and even inappropriate navigation instructions.

Procedures based on landmarks appear to be (most) appropriate for pedestrian navigation. The user does not receive instructions based on distances but is directed with the help of (only) a few significant landmarks (and therefore does not have to look at his mobile device continuously). The challenge of this approach lies in the selection of

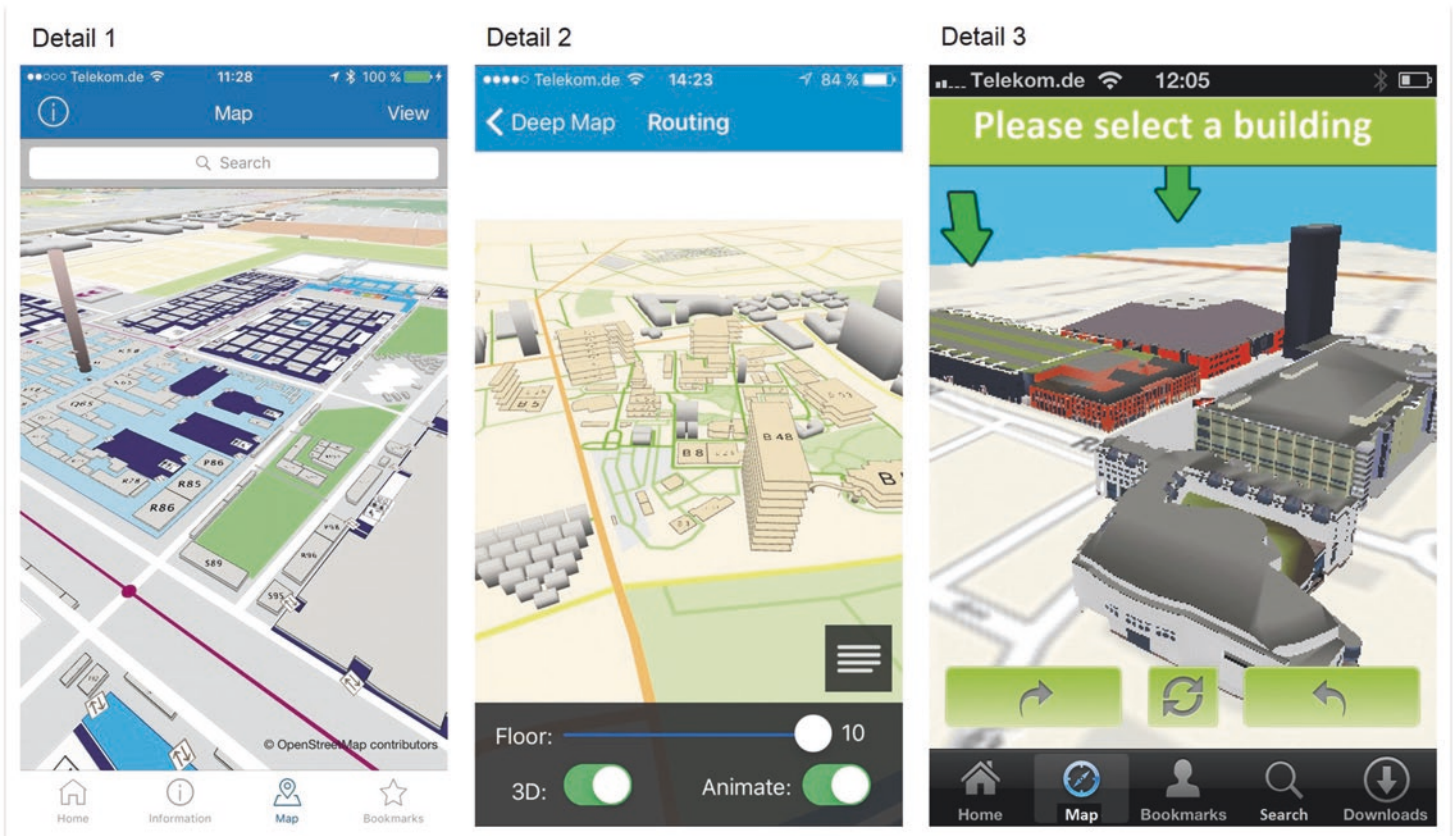

Fig. 9.2 Examples of visualizations – indoor and outdoor map services (with kind approval © Heidelberg mobil international GmbH 2016, Deutsche Messe AG 2016, OpenStreetMap.org 2016)

suitable landmarks and in the allocation of the necessary current data [138]. Essential characteristics of the selection of landmarks are [138, 139]:

- Visibility and location of the landmark
- Uniqueness and attractiveness with regard to visual, semantic, and structural qualities of the landmark.

The development of future indoor navigation services still has plenty of room for improvement in order to realize intuitive and appropriate results.

9.4 Indoor Navigation and Business Models

The investment in indoor and outdoor navigation solutions opens the field for new sources of revenue which can in turn be connected with innovative *business models*. Sources of revenue are, among others:

- Higher level of utilization of public mobility offers
- Location-based service offerings alongside the indoor/outdoor routes
- Big data analyses on the basis of spatial data.

Mobility offers in urban areas are characterized by an increasing variety of choices and include both classic offers of public transport networks as well as customized offers like Uber [30] or myTaxi [140].

A distinctive feature for all providers is the user's convenience, which includes not only the type of transport itself but also the usability of new digital accesses (payment and services information apps) as well as convenient transport changes at intersections and interchange stops like stations, parking garages, or Park & Ride sites. Indoor navigation services can increase the user's convenience and can lead to a higher degree of capacity utilization.

The upside of providing an indoor navigation systems and the potential knowledge of the user's position might be the possibility of location-based marketing. Prospects range from simple mobile advertising to push messages and even complex advertising campaigns (a combination of display ads and mobile ads) so as to call attention to shopping facilities and services along the route. Stored user profiles enable the application to calculate and display routes which cater to the user's personal interests and preferences. A route can then be calculated either along shops for clothes and cosmetics or electronics stores.

A third, new marketing channel can be developed through big data analyses of compiled spatial data. The evaluation of aggregated and anonymized movement profiles enables service providers along the route taken by mobility users to tailor their offerings to the user's needs and be more efficient.

The provision of a seamless indoor/outdoor navigation still requires extensive technical work. Up-to-date data, reliable indoor positioning, and intuitive handling are preconditions for the user's acceptance of such a system. Provision of an integrated indoor/outdoor navigation solution will be an essential element for the acceptance of a transport service provider and the success of Smart Mobility scenarios, and could be a unique feature of competing providers of urban mobility.

Smart Ticketing

10

Senta Belay

Abstract

Advanced mobility offerings, as Smart Mobility proclaims, are directly connected to the purchase or booking of the access right to travel or use a means of transport. Each and every mobility consumer is busy considering the outcome, be this a paper or a digital format, a smart card, or checking the confirmation to access a plane or train. Access permission provides security and comfort that the seat is reserved and the trip is happening. The future of ticketing has already been penetrated by digital means and will most likely surprise not only consumers, but also transport operators, with new media and inventions.

Contents

To substantiate trends in the travel and tourism sectors in the long run and present these similar to service oriented acting holistically and in an intermodal manner, consumers need a "wow" factor! Wow refers to the experience before booking a service. Wow refers to the simple one-stop shop that fulfills the entire booking-to-payment lifecycle.

Despite already functioning product selection pages, product ordering and payment offerings, the traditional way of service acting in the mobility industry will not succeed.

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Those traditional, punctual approaches that cover one or multiple mobility related functions are being substituted, yet enhanced, by entire offerings and bundles. And this becomes abundantly clear when the services needed are no more point-to-point type solutions but rather a bundle of products and services that encompass an end-to-end service need. The ideal offering, "click-to-purchase", facilitates the business traveler, the family, or the group of friends that consume the offering that best fits their needs. A pre-selection of carriers, multiple data or order entries, or endless price comparisons in the tariff jungles disappear.

The European Union Directive "*one ticketing*" [141], postulates the design and issue of one single ticket, the digital enabler so to speak, that fosters intermodal bookings and subsequently Smart Mobility:

> Integrated ticketing (i.e. combining all transport methods on a single ticket) is the natural partner to full availability of multimodal travel information and planning services. [141, p. 3]

Smart Ticketing is one of the three key elements in door-to-door mobility enablement – next to outdoor and indoor navigation and a diagnostics triggered business process management. How did ticketing evolve over the past years? Is it lagging behind or is it far more advanced? The following gives some useful insights.

10.1 Trajectory of Ticketing

To put the trajectory of *ticketing* in context, we make use of a simple process where an individual passenger buys a ticket and uses a service from a single mobility provider. The carrier offers three stations on a particular leg of a route; A, B, and C. The mobility offerings might be a subway ride, a flight, or the use of a rental car.

Travelers that arrive at A or move away from C switch often from one means of transport to another. C might even be a transit station or an airport. Other travelers return the rental car at A and then use the metro. For each and every segment, tickets are made available – once or temporarily valid. Any of the ticketing – whether a boarding pass, a subway stub, or a mobile app – appears to the consumer as a distinct design element that is not interconnected on the regional level or internationally where multiple currencies come into play, for example.

The necessary media are not apparent to the consumers either and therefore remain uncovered. More often it is the role of the travel agencies, ticketing machines, or cash registries that permit the use of the means of transport once the payment is successfully executed. Still encountered in various regions, this is essentially a ticket agent at the respective stations receiving coins and cash before allowing the passenger to get on board to utilize the service.

10.1.1 The Ticket as Design Element of Smart Mobility Offerings

The ticket is the anchor of mobility. A typical example is where a bus driver allows passengers to board a bus when they post the right amount of coins into the coin receiving

machine, called naturally the "*farebox*". There is quite a lot of effort involved in terms of ensuring the flow of cash and coin from the different stations, as well as onboard the carriers, to the offices. These revenue accounting systems where cash is accounted for rely heavily on manual means to ensure theft is avoided. Moreover, this enables the mobility service company to know the extent of the usage of its service. This element of reconciliation is still in use today.

In the past, there were few if any mechanisms to reconcile the actual amount of service rendered to the actual amount of money collected. This then evolved by correlating a predetermined amount of tickets or paper tickets with the available amount of carrier space. Mobility usage got reported by the tickets sold (the stubs) and reconciled with the amount of cash collected. This is still the case in one form or another used in a number of public transport companies globally; even in some advanced economies in the world. Furthermore, public transport offerings are still subsidized, as discussed in Sect. 2.8.2. In other cases ticketing processing and reconciliation is subject to commercial operators that rather focus on usage-based offerings and less on a maximum amount of space. The focus overall is in the provisioning of a fair and bookable service that is accessible to all actors in an ecosystem. This relates to the continuation of less frequented bus lines in remote areas or districts, for example.

Over the years, the original representation of coin and cash in relation to mobility products has seen massive changes. Of special note is the visible separation of the presentation and control layers. The most relevant milestones in the evolution of ticketing designs and digital enablement are depicted in Table 10.1. The table entries document the change and the progress made. The transformation from paper stubs and cash towards a digital consumerization of mobility services can hardly be overlooked. Especially in public transport

Table 10.1 Milestones in ticketing[a]

Year	Milestones	Comments
1993	Calypso	
1995	Seoul: Upass and T-Money	
1997	Hong Kong: Octopus Card	
1998	Transport for London: Oyster Card Foundation of ITSO Great Britain	Integrated Smart Card Organization (ITSO)
1999	Shanghai Public Transit Corporation (SPTC): SPTC Card Foundation of the EMVCo LLC	EMVCo is a consortium of the six credit card companies that manages the smart card payments standard. EMV stands for Europay, Mastercard, Visa. Further members are JCB, American Express, China Union Pay and Discover.
2001	Japan: Suica Card Singapur: EZ-Link Card	The Suica Card is a RFID chip, developed by Sony, and includes a payment function; replaces cash or credit cards. The Japan Rail East Railway Company is the provider of Suica Cards.

Table 10.1 (continued)

Year	Milestones	Comments
2002	Taiwan: Easy Card	
2003	VDV Germany Calypso Networks Association	
2004	EMVCo: upgrade (2004) Foundation of the NFC Forum through NXP Semiconductors, Sony and Nokia	NFC stands for Near Field Communication.
2005	First pilot with VDV Germany, Saarbrücken	
2006	Singapore e-Purse: CEPAS	
2007	European Union: Project launch of IFM (Interoperable Fare Media) of the European Union, called EU-IFM Japan: Pasmo 10 million EZ-Link Cards ISO/IEC 14443-1:2008	Pasmo is a card similar to Suica. Pasmo is operated by a private transit operator in the greater metropolitan area of Japan. The usage of Pasmo Cards is primarily focused on Tokyo. However, both Suica and Pasmo are interchangeable. ISO/IEC 14443-1:2008 is the first international standard for integrated circuits cards published by the International Standards Organization (ISO).
2008	Quebec: Opus Card	
2009	30.01 million Suica Cards Singapore: NETS FlashPay Singapore: SeP (Symphony for e-Commerce) based on CEPAS	
2010	EU-IFM Project phase completed and deliverables published	
2011	AFIMB France EU: SETA (Single European Transport Area) Google Wallet launch	
2012	MoU-IFM Alliance between standardization organizations and Union of International Public Transit Association (UITP) Foundation of Smart Ticketing Alliance (STA) ISO 24014-3 Standards published for interoperable ticketing management systems	Founding members of STA are the Integrated Smart Card Organization (ITSO), the VDV with the core application called VDV-KA-KG, the Calypso Network Association (CNA) and l'Agence Française de l'Information Multimodale et de la Billettique (AFIMB)

Table 10.1 (continued)

Year	Milestones	Comments
2013	Transport for London (TfL) Pilot: EMV Sign-off of the 4th Railway Package of the European Union	EMV stands for Europay, Mastercard, Visa.
2014	Great Britain announces use of ITSO standards Apple Wallet launch	
2015	Singapore launches Smart Nation initiative and the introduction of cashless, electronic payment system Introducing Samsung Pay The Global System for Mobile Communications Association (GSMA), the Near Field Communication (NFC) Forum, and STA work on harmonizing the specifications of NFC technologies in transit areas	
2016	Further innovations will follow	

[a] A comprehensive overview of ticketing advancements is provided by the (German only) website SecuPedia, http://www.secupedia.info/wiki/Hauptseite, last visited: September 30, 2016.

management systems a transformation took place. The table entries also outline the most notable regions where transformation occurred and still takes place.

Transformation can also be observed in the presentation layer where one single product evolved. Examples are the cash to be paid for a one-way passage on the service provider's carriers to multiple products, such as return services or services including other onboard amenities like "priority seats", "meals", etc. Other examples refer to monthly or yearly passes for families, the elderly, and students. In some cases these are issued by distinct parties depending on geography and context as described earlier in the ecosystem of actors (in Chap. 5.3).

Access to these services is given in the presentation layer. Verification takes place by a person, visually or by a verification layer such as a boarding pass, a paper ticket, or a validator. Examples of validators are turnstiles that allow access with a valid ticket. The validator will ascertain that the right amount is paid for and grant the access, as for example in the central station of Rotterdam. Validation marks appear in the form of a magnetic token, a barcode, or QR code. Others make use of NFC technology in combination with WiFi or Bluetooth to allow passengers to Bring their Own Device (BYOD). Overall, any of the used technologies or procedures confirm the actual presence of a valid permission to travel, and signal the authority that a service, hence ticket, has been pre-purchased.

Innovations at all points across the products and services flow have evolved. The presentation layer has been by far the most visible. The Physical Mobility Front Office gets more and more enriched by the Digital Mobility Front Office (see Sect. 5.3).

Card centric systems, where chips are loaded on devices or cards and next give access to load various services on them, have evolved. This approach has heavily influenced the last 20 years in the evolution of the ticketing sphere, especially in the level of sophistication and standards with regard to the payload characteristics that a specific format can have and in which systems it is readable from. To enable a vision of *E2E mobility* and *Mobility-as-a-Service* however, there is quite a large burden as to harmonizing the way that the chip and the fare media have been used in the context of Smart Ticketing and smart travel. *Fare media* in this context refers to all ticketing relevant technologies that are in use for loading products and services onto the respective media. Next to the devices, credit and debit cards, loyalty cards and frequent flyer cards make up fare media.

Approaching E2E mobility from this angle requires a huge amount of work where the industry has to come together and agree on the definitions of fare media and which media are going to be readable by which readers. It also goes without saying that security mechanisms are in place to protect the users and the money loaded so it is utilized only by authorized users.

The efforts of various organizations such as ITSO in the UK [142], Calypso in France [143], AFIMB in mainland Europe [144], and VDV in Germany [145] work in tandem to come up with a mechanism for standardization of such exchanges of information on the *fare media* and presentation layer. The desired outcome from a traveler's point of view is an interchangeable format, used in different regions and states. Standardization efforts are conducted, for example, by the named institutions. Joint efforts are necessary to foster interchangeability, especially by taking into account the necessary steps, such as:

- Definition of transfer protocols and data formatting
- Definition of authentication and security mechanisms before, during, and after data transfer
- Usage agreements concerning user data
- Usage agreements concerning the transfer of money and money-like currencies.

Driven by the IoS Role model these efforts are further executed by interoperability providers (*Service Gateways*).

Fare media formats help to get closer to Smart Mobility enablement. The configuration of the medium be it a smartphone, a dongle in a car, or a credit card is then subsequently a simplified download of "credit points" that can be freely used based on the traveler's needs. The previously old-fashioned payment procedure and reconciliation of cash turns into digital processing upfront – without reformatting or physical checks.

10.1.2 Usage-Based, Hence Subscription-Based Billing

Another paradigm in the end-to-end mobility sphere is the advance in technology. This has evolved in particular from the services industry in the connected and digital age where by a subscription to a service, access to further products and services are guaranteed. In the travel and transit industry this translates to account-based ticketing.

Efficiency gains are projected as the logic embedded in the fare media and chip card is removed and the card/fare media is delegated to being a single identity confirmation tool. The logic of the products and service actually reside in a backend system. In essence this replaces the card centric ticketing systems that have been well positioned in the industry over the last few decades.

The concept is equally applicable to the above described single A-B-C route and could possible augment, and in the long run be, a viable option as a replacement of card centric transit. In addition, it is the most logical one that addresses the more complicated end-to-end mobility scenario – where multiple products and multiple services are being provided to the traveler (the end user) from multiple providers – to fully orchestrate in a seamless manner.

In a single product/service scenario the backend is a simple haulage operation of cash and coins collected to the banks and assigning relevant entries in the income statements of the company. This involves a process of collecting cash from the ticket offices to the bank, getting the relevant receipt, and posting entries in the debit side of the general ledger to finalize the actual transactions that have happened.

There is no mechanism to ascertain the matching of products and services to the number of consumptions of the service. There is no auditable track. The auditability starts at the point when the bank has received the cash and noted the amount. As we evolve further, a simple Point of Sale (POS) system takes the control of products and services one step further – equipped with a cash register to account for the tickets issued.

For each token or product issued, the relevant cash received is accounted for at the level of the ticket counter, or cash desk. In the case of transit across states, as in rail and high-speed travel, the simple purchasing of tickets at the ticket counter is also augmented by a reservation system whereby the products and services are not only exchanged for a payment, but also assignment of the ticket to a particular seat that has to be accounted for. Hence the ticketing system evolves into a reservation system.

In E2E mobility a ticket is used as a permission to travel without the need to assign a specific seat and a ticket, much in the same way as the airlines currently do from a booking and reservation standpoint.

One further thought. The moment we start thinking that a seat needs to be assigned to a traveler, we need to identify that traveler. This identification raises the bar once more from a purely anonymous trip to one where travel has to be booked for and reserved to a particular person – thus the need for a customer/traveler identity management system arises.

10.2 Enhancing Smart Ticketing

In all described cases an intelligent, usage-based accounting system is key. It builds upon two elements:

1. Identification of the user
   - How much information should be needed for rendering travel?
   - Is it anonymous travel only or are we considering a true end-to-end mobility? Will there be a mix of transit modes, needs for reservation in some cases, or just validation of travel rights in others?
2. System to achieve the seamless nature for order capture and payment
   - How many services need to be orchestrated for the traveler?
   - A desirable outcome is the removal of complicated or multiple ticket purchases from the customer to a backend where logic and process execution steps are held and render only the most pertinent needs.

Figure 10.1 illustrates the *Smart Ticketing* schema.

Consumer and Identity Management Similar to a Customer Relationship Management (CRM) system, the consumer and identity management maintain the customer's profile, including financial details. There is the option of having the bare minimum of an anonymous customer who will have a unique identifier that is capable of being attached to a product and/or service. However, whatever type of service is going to be provided, such a customer will need to be identifiable. Usually this is achieved by a numbering system, for example consider the smart cards in circulation in most cities. Smart cards do not have a specific owner or customer identity attached to them in the system but there still exists a unique identifier for the smart card.

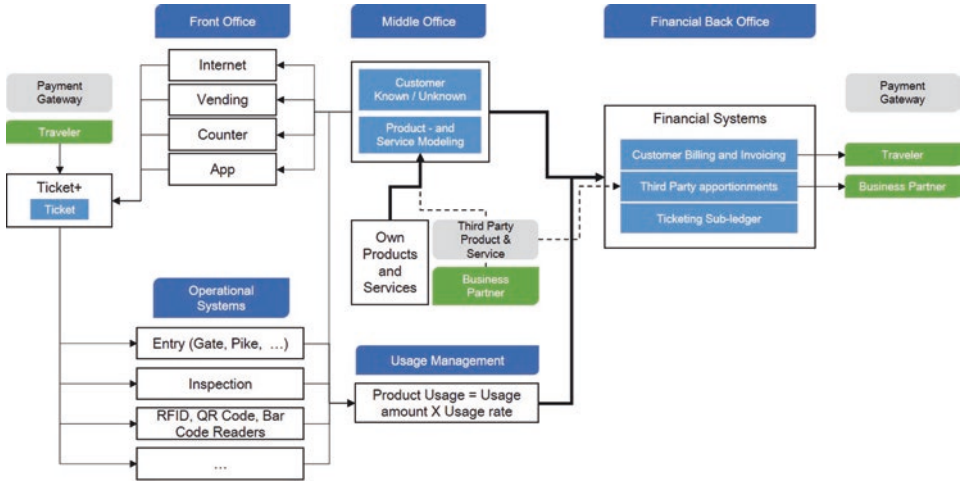

Fig. 10.1 Smart Ticketing – overview schema

At the other end, a smart card could have an identified customer whereby the profile could be rich, including various attributes of the identified customer such as choice of transit modes, frequented routes, and add-on service needs. In the case of travel modes, the attribute for the identified customer such as the choice of aisle or window seats, first class business or economy class, etc., are also captured.

As the industry is gradually evolving, we see that many operators are building a CRM system and have more ability to allow opt-in for the end users, allowing previously unknown customers to become a known customer in the system.

In most cases, the choice to be identified, as well as further provided details of the travel needs and choices, should present automatically to the customer and such a system should provide this option: and that is exactly what is happening in the industry.

Product and Service Management This is the core of end-to-end mobility. The system should be capable of designing the service, be able to distribute the service to the end user, and be able to measure the level of usage that each customer has utilized. As outlined before *service enablement* and *service enrichment* take (see Chap. 5.3) place here.

Product and Service Design To provide an *E2E mobility* scenario, all the products and all the services that are available to the end consumer are accountable. These could be provided by one carrier or multiple operators in a multimodal approach. And there also could be added services that are not core travel or transit, but rather services that are ancillary. The system thus needs to be aware of all available product and service combinations that the end user might need in the quest for end-to-end mobility.

Similar to the telecommunications industry the product, the mobile device, has been enriched with services such as voice, data, roaming and others. The phone has an identifier, the phone number. The services provided are billed per usage and consumption that the phone number has utilized over the standard course of a month. The provider in the telecommunications industry should have considered all the product combinations available (all available types of phone devices), all the service combinations (voice, data, roaming), and in addition considered if the service is provided by itself or by a partner in another country. The same logic now applies to the travel industry.

The product in the case of the travel industry could be a card (either chip, magnetic paper, app, smart card, etc.) that would have a physical representation of the available product. It could also be a reserved ticket for travel where an assignment is needed. The service piece will hence be the core service of travel from A, via B to C, or it could be additional multimodal transit (which should be attached to the same product), or all other add-on services that could be attached to the same product.

Hence the product design phase takes into consideration all available products and services and ensures that the combination of this and all the logical analysis resides in the system. The next steps will be the actual distribution of the products and services to the end user. The other aspect of the product and service design is the consideration of the rate at which the product and service should be charged. This part will have to be built in and represented as

the amount to charge for the service usage. In our initial example of the A-B-C route, each leg could have a separate rate to be applied when the customer travels. Hence, the products and services should have a corresponding rate at which the service is to be consumed.

This matters quite a bit, as the definition of the rate could be multifaceted. In the single journey of "A", it could be an x amount. Alternatively, if we scale this route and say there are a 100 or even a 1000 or more combinations that could be traversed by a customer, then the design of assigning a rate of x amount will not be scalable enough. In this instance, in the transit industry a "zone" approach is created to assign simplistically a certain rate for a certain zone.

This zoning might not be sufficient as cities get larger, and E2E mobility needs get even more complicated. Current advances in technology offer parameter-based such as distance-based or time-based rates. In essence, the traveler can choose whichever commute and travel he needs. More advanced mathematical models will soon enhance the decision-making process by incorporating sensual and emotional states of the traveler. Further decision criteria resonate from the number of clicks a traveler used in his app before booking. The most commonly used models to date employ a flat rate of distance based or time based billing.

Compared to the telecommunications industry, it has created a plan for telephone or mobile subscription. A similar travel plan could be designed to apply to not only a single operator's route but multi-modal routes, in an easy way. This fosters a complex combination of travel needs but later one will be able to clearly and exactly invoice the service. The plan, whether it is monthly, quarterly, or anything else, can easily be modified and adjusted.

Product and Service Dissemination All the carriers that are involved in providing travel services disseminate product and service offerings in a slightly different way. The airlines industry is heavily reliant on the *Global Distribution Systems* (*GDS*'s) and it leverages the strong inventory building and distribution capability of GDSs. In the transit industry, as there is no or minimal need for inventory build and seats. And added to this, the cost of the ticket itself is too small, so the business is more reliant on automated ticket vending machines. Because of the pricing and booking habits long distance and high speed trains have much closer distribution opportunities similar to the airlines industry: the distribution is made online and the representation layer, the boarding pass is similarly digitized and presented as QR or any other code.

Measurement and Billing Once a digitized product or service has been bought, the consumption measurement becomes a simple authentication and knowledge of whether the said ID holder of the product or service has actually used the mobility provider's offering. This is an operational task and is linked to knowledge about usage.

Assume, for example, the product is a one off-travel, like a plane journey, then the boarding gate will be in a position to identify if the boarding pass does indeed belong to the person holding an authorized passport that is being whisked through.

In *multimodal* transport, where the product is not designed for a one-off approach, but rather as a rate plan, the operational readers (such as the turnstiles, the conductors, the gates, etc.) identify the on-boarding time and the off-boarding time. This is will be the measure to be used to properly account for the service usage.

One could argue that the card centric type, where the fare logic is directly embedded in the fare medium, and the medium is gradually deducted according to usage, might be the ideal case. The readers would need to be aware of the amount of fare in the medium and be able to deduct accordingly per usage. There is a huge cost associated with deploying such a system. In E2E mobility travel this becomes very difficult. That is why the idea of only identity on the fare media has evolved.

The amount of operational know-how that the readers will have to possess becomes a bare minimum – and all logic for processing is sent to the backend. Such will be an approach to measure usage amount, based on the product and service design that were designed previously. In such cases, an account-based ticketing system will work elegantly to provide the required billing information for the service that has been rendered to the end user. This can be done for all transit and all multimodal approaches, so long as the engaged parties and service providers have been taken into consideration in the initial design of the products and services for the end user.

Finance Management In end-to-end mobility, the other main complication is to effectively understand how multiple operators' services and products are going to be apportioned to the right carrier. And it is of significant importance to be able to apportion net values instead of running individual transactions by each customer.

In essence, this exercise is not simple. A case in point would be the clearing house concept in the airlines industry through a trusted intermediary. Here the airlines industry has achieved a settlement system where all airlines can sell products and services of their partners in a "code-sharing" agreement. They do not have to settle this account by account, but rather at a certain predetermined time they settle the entire agreement that they have. Likewise, the other code sharing agreement participants would do the same.

This is the type of settlement, and in the transit industry terminology "apportionment", that needs to be considered. Hence in the E2E mobility scenario, we need to have the products and services paid for and utilized, accounted for by each service provider and the money allocated to each one. Financial systems thus would need to act not only as a revenue accounting system, but ensure that they settle accounts accurately with partner organizations involved in the provision of products and services as well.

Mobility Diagnostics

11

Barbara Flügge

Abstract

To capture the entire momentum of Smart Mobility a holistic, mobility targeted analysis is a key instrument for decision makers and influencers. These days, technical advancements offer analytical and methodological procedures for real-time calculation and a digitally enabled predictive discourse on mobility matters. An increasing number of data sources and data volumes emerge. The large field of mobility targeted analysis we refer to as Mobility Diagnostics. We have encountered already analytical streams in the context of traffic data driven analysis (so called Smart Traffic). In the area of service oriented analytics, Service Diagnostics is playing a key role.

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11.1 Traffic Data Management

With respect to traffic data management the potential for Smart Mobility triggered analytics is huge. The rise of big data and real-time processing allows us to derive traffic

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management related benchmarks. The most relevant *Key Performance Indicators* (*KPIs*) and who they are serving are depicted in Table 11.1.

Table 11.1 Data diagnostics examples with relevance to Smart Traffic

ID	Smart Traffic analytics detailing	Service bundling with	Applicability especially for
S1	Traffic Monitoring		City, region
S2	Traffic Abnormal Discovery		City, region
S3	Temporary Zoning Control Plan for City Event		City, region
S4	Entry Control Policies	S5, S6	City, region, district, event, campus
S5	Vehicle License Control Policies	S4, S6	City, region, district, event, campus
S6	Congestion Charge Policies	S4, S5	City, region, district, event, campus
S7	Incident Prioritizing		City, region, district, event, campus
S8	Operations planning and operational research for emergency vehicles and police cars		City, region, district, event, campus
S9	Event triggered operations planning		City, region, district, event, campus
S10	Equipment information browsing for police officer's equipment		Public security personnel
S12	Driver Analysis		Fleet manager
S13	Commuter Insights		City, region, district, event, campus
S14	City related traffic management and traffic bundles	S8, S9, S10, S13	City, region, district, event, campus
B1	Operations monitoring and alert system		City, region, district, event, campus
B2	Resource management planning and imbalance management for means of transport dependent on traffic volume		Bus
B3	Bus planning simulation		Bus

Table 11.1 (continued)

ID	Smart Traffic analytics detailing	Service bundling with	Applicability especially for
B4	Public transit planning for commuters		Bus
B5	Bus service level analysis		Bus
B6	Bus ticketing analysis and pricing strategy		Bus
B7	Bus lane setting and what-if analysis		Bus
B8	Estimated time of arrival for buses		Bus
C1	Taxi capacity analysis		Taxi
C2	Tariff planning and service pricing for taxis		Taxi
C3	Taxi operation monitoring	B1	Taxi
C4	Taxi Dispatching and Guidance		Taxi
C5	Taxi station layout planning	B3	Taxi
C6	Emergency Management for Taxis		Taxi
C7	Taxi driver productivity and business compass	C3	Taxi
M1	Metro passenger evacuation management		Metro
V1	Visualization schemas		All

Example for Smart Traffic Applications The company SAP drives a number of projects in European and Asian cities with respect to Smart Traffic:

> "As cities grow fast and face challenges in terms of resources and infrastructure, they need transparent, collaborative and innovative technology to help them prosper. […] this technology shows how Big Data-driven insights based on real-time traffic conditions and predictive analytics can help cities run smarter. Smart traffic control shows how optimized traffic light controls and additional car lanes help avoid rush-hour traffic congestion. Congestion indexes and speed controls based on data from RFID, GPS, cameras and induction loop technologies provide pictures of real-time traffic issues and compare conditions with other cities and city sectors. Origin-destination analysis compares travel behaviors between city sectors, areas, streets and multimodal travel." [146]

One of the advantages of Smart Traffic is the identification, analysis, and visualization of personae dependent KPIs. Big data applications are applicable due to a high number of

access points and data volumes, and serve the segmentation of KPIs according to city district, means of transport, and time and date for example. Being faced with an infrastructure burden and high maintenance efforts, the analysis of digitally connected vehicles allows us to derive resolutions in infrastructure planning [147].

With respect to requirements that personae have, bus operators seek resolutions, for example when to plan for a new bus line and how to get bus riders on board for the change. Another issue to be resolved is knowing the number of travelers that will be affected on board and to estimate the profitability of a new bus line.

In the context of customer service, operators seek to predict the number of people that are waiting to board at subsequent stations and to what extent the transit operator should increase or decrease the frequency of its assets. One key area that benefits from Smart Traffic is the design of service level agreements for one operator and the coordination among multiple transport operators. On the advantages of digitization, a benefit is the digital capture of service level agreements and their compliance checks.

11.2 Service Driven Analytics

How service oriented KPIs are being distilled and evaluated is the subject of the following example. The example illustrates the scope of service analytics in the field of cycling. Where two-wheeled means of transport are augmented technically with sensors or tags, the earlier introduced Smart Traffic KPIs (see Table 5.3) can be applied to bikes, e-bikes, and scooters, too. In cases where two-wheel means of transport are not captured within the traffic flow analysis or where cycling related traffic situation analysis does not take place, the following considerations might be useful.

Example: Service Diagnostics for Bikes
Overall, a mobility driven analysis for a city or region reveals insights into the optimization potential for the cycling community: firstly concerning the utilization of the given infrastructure and secondly concerning the increase of traffic safety for cyclists. Performance indicators play a significant role for decision makers and layout planners. Likewsie, can service designers benefit from performance indicators in the form of gaining insights and hints on adapting existing and designing additional services? Table 11.2 compares both viewpoints.

11.3 Intersection Analysis and Relevant Action Items

What is the benefit of a holistic view of cargo movements and mobility consumption? The so-called intersection analysis aims to distill those conditions from any potential ones that harm cargo related traffic flow in a critical segment or corridor of the observed transport route network.

Table 11.2 Mobility analysis of the traffic infrastructure with respect to cycling

Mobility services for cyclists	Performance indicators for the bike
Accident prevention analytics and measures	Average cost/damage per accident
Accommodate bike lanes to usage pattern	Average cycling speed
Accommodate bike lanes to usage pattern	Average trip duration
Accommodate bike lanes to usage pattern	Average trip length per person
Promote bike usage, provide incentives to cyclists	Bicycle use in relation to total modes of mobility
City planning: adapt infrastructure to demands	Bike lane percentage per district in relation to total street space
City planning: adapt infrastructure to demands	Cycling kilometers per year
Accident prevention analytics and measures	Frequency of accidents
Improve navigation, speed and enhanced safety of cyclists	GPS coverage for mobile navigation systems
City planning: adapt infrastructure to demands	Length of bike lane network per city
City planning: adapt infrastructure to demands	Level of stress (accessibility)
City planning: adapt infrastructure to demands	Number of bike racks
City planning: adapt infrastructure to demands	Number of bike racks on busses
City planning: adapt infrastructure to demands	Number of bikes per 1000 people
City planning: adapt infrastructure to demands	Number of intersections
City planning: adapt infrastructure to demands, Investment advice	Number of public bike share stations
City planning: adapt infrastructure to demands	Number of public shared bikes
Steering of traffic flows, improve safety of cyclists	Peak times for cycling activity
City planning: adapt infrastructure to demands (designated areas)	Percentage of people cycling for fun
City planning: adapt infrastructure to demands	Percentage of people cycling to work
City planning: adapt infrastructure to demands	Square feet of space per cyclist (level of service)
Steering of traffic flows, intelligent routes	Waiting time at traffic lights

Table 11.2 (continued)

City planning: adapt infrastructure to demands	Waiting time in relation to time spent cycling
Insurance companies, risk and premium calculations	Average cost/damage per accident
Intelligent routes	Average cycling speed
Intelligent routes, city planning	Average trip duration
Intelligent routes, city planning	Average trip length per person
Planning of bike lanes	Bicycle use in relation to total mobility modes
Planning of bike lanes, insurance companies	Bike lane percentage per district in relation to total street space
Planning of bike lanes	Cycling kilometers per year
Insurance companies, risk and premium calculations	Frequency of accidents
Intelligent routes	GPS coverage for mobile navigation systems
Planning of bike lanes, insurance companies	Length of bike lane network per city
Insurance companies, risk and premium calculations, planning of bike lanes	Level of stress (accessibility)
City planning: adapt infrastructure to demands	Number of bike racks
Procurement of public transport provider	Number of bike racks on busses
City planning: adapt infrastructure to demands	Number of bikes per 1000 people
City planning: adapt infrastructure to demands	Number of intersections
City planning: adapt infrastructure to demands	Number of public bike share stations
Demand analysis, planning of bike stations (location, quantity of bikes)	Number of public shared bikes
City planning: traffic lights, intelligent routes	Peak times for cycling activity
Bike lanes outside the city in recreational areas	Percentage of people cycling for fun
City planning: adapt infrastructure to demands	Percentage of people cycling to work
Accident prevention analytics and measures	Square feet of space per cyclist (level of service)
Accommodate bike lanes to usage pattern	Waiting time at traffic lights
City planning: intelligent traffic lights and routes for mobile navigation systems	Waiting time in relation to time spent cycling

Table 11.3 Usage scenario intersection analysis

Elements	Detailing the key elements
Addressees	Regional and/or intersection related transport road network analysis for the cargo business
Motives	Being dependent on third party incidents that occur in the neighborhood and lead to higher traffic volume and congestion in own municipality
Value Drivers	Optimized traffic flow management Reduce traffic load Reduce air pollution and noise Foster service provisioning of regional providers
Owner	Regional and municipal government
Personae	Hub operators such as ports and cargo terminals Navigation providers Providers of external infrastructure (surface, soil condition, bridges, streets, etc.) Resource providers Service providers for drivers, vehicles, vehicle components, production, repair, re-utilization and maintenance System integrators Technology providers Telematics providers and enablers Territorial communities Transport network providers Urban layout planners and community authorities
Market Offerings	Data dashboards Forecasting traffic flow and traffic situation
Degree of Deployment	Established: Phase 1, Phase 2 First deployments: Phase 3, Phase 4
Roadmap	Phase 1: Analysis of current and projected traffic volume Phase 2: Matching result with other and field trial data Phase 3: Transferring results into service design Phase 4: Considering the design and establishment of a personae driven data portal

Applying the significant design elements, the usage scenario with respect to mobility turns into the following, as outlined in Table 11.3.

The roadmap for the intersection analysis consists of four phases:

Phase 1 Phase 1 starts with an analysis of current and projected traffic volume. The key activities are:

- Assessment of current volume and classification of freight moved through the region
- Identification of hubs and analysis of freight movements within the targeted corridors
- Agreeing upon and determining the critical performance indicators as to why a certain corridor is mostly affected by cargo traffic, by freight volume and/or by diverted traffic
- Identifying the key success factors for urban hubs to optimize space, infrastructure measures such as road maintenance, bridges, commuter lanes, and any other public and private service provisioning
- Conduct of field test(s)
- Drawing conclusions about maintenance efforts for streets and bridges, commuter lanes, and others.

One of the key prerequisites to drive Phase 1 is access to data. For any of the individual efforts it is recommended you design a digital worksheet that lists the known data sources. Expanded by and enriched with further data that are sourced from government and other data providers the analysis continues.

Phase 2 The value proposition for any participating stakeholder presented by an innovative urban traffic and transport management system is subjected to Phase 2. It covers the first round of analyzing the cost-benefit effects and the framework for Return on Investment (RoI) calculations. Depending on the progress in the field test and the accessibility of data, an analysis of costs versus reduction in congestion takes place, too. Cost types include costs for smart traffic solutions, infrastructure efforts, and further design and deployment efforts. Next to congestion reduction, secondary benefits that affect business entities and constituents will be observed where possible.

Phase 2 compares the outcome of, or observations and the impact in, one field test on other urban hubs. In case communalities have been identified, further field trials make sure that the efforts are on the right track and reveal additional parameters and dependencies.

Phase 3 All parameters and results are depicted in a service-design driven manner. Thus service relevant roles and responsibilities are studied and documented.

Phase 4 Phases 4 focuses on the need, how-to and design of parameters for one commonly used data portal. Here we will be investigating the value of open data and the potential obstacles of using open data, private data, and/or user generated data. In the market you find terms such as Data Dashboards and Open Government Data Lab. In most cases there is a willingness to share data from a public provider's point of view. One of the prominent examples is the portal from Transport for London (TfL) [148]. Another example is the recently founded VAO GmbH, a traffic information portal for Austria [149]. Those reflections about open access, free-of-charge, and right to re-use go hand in hand with the construct and conduct of *Data Gates;* or as we call them *Trust Gates*.

Trust Gates Trust Gates, hence gating systems, are in use to control the provisioning and sourcing of data in accordance with a classification system along private, confidential, access driven, and publicly available lines. Trust Gates operate through identification and authentication, payment terms, billing and usage, reporting, and governing trust. Codes of individual and business conduct monitor compliance and govern which data are being published, anonymized, or not published at all. The depicted scenario is also applicable to passenger transport.

Part III

The Future of Mobility

Building Blocks of Intelligent Mobility

12

Barbara Flügge

Abstract

Usability and success of Smart Mobility go hand in hand with an over-arching framework that takes all relevant aspects into consideration and is able to facilitate the process of identifying and applying strategic, functional, and technical building blocks. The Building Blocks of Intelligent Mobility (BIM) give orientation to service consumers, decision makers as well as business and government contributors along the multi-diverse and multi-dimensional complex of Smart Mobility. Contained in a BIM catalogue, each of the BIM is now introduced and structured. Among further elements the following four, namely the ecosystem-driven approach, the assignment of use cases, the personae-driven path, and the Smart Mobility role model are key contributors to the Smart Mobility Procedure model.

Contents

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The extensive display of usage scenarios and examples in Chaps. 7 and 8 sheds light on distinct viewpoints on Smart Mobility and its functional as well as technical applicability. The ecosystem design parameters, the personae approach, and the *role model* of the *Internet of Services (IoS)* serve as the contextual glue.

Motivated by deep-dive investigations and projects, a proposition is now made for the construct of Smart Mobility applications and services in the form of the so-called *Building Blocks of Intelligent Mobility* (*BIM*). The format to contain the BIM is referred to as the *BIM catalogue*. The four layers *Smart Services, Smart Data, Smart Products*, and *Smart Spaces* give orientation and serve as a technical and functional frame.

Technical and functional accomplishments would not be sufficient or scalable without decision making capabilities, a sense for innovation, and the claim raised to ensure mobile future generations in a sustainable, fair, efficient, and growth oriented manner. Therefore, we added the layer *Program Management*. Based on our experience, a strategic and project oriented sequence of actions is a key and critical success factor for successfully deployed Smart Mobility. This set of criteria and the layer model therefore form the Smart Mobility *BIM* as outlined in Fig. 12.1. Each of the elements that are part of the *BIM catalogue* is now introduced. They serve as the foundation for any Smart Mobility undertakings. There might be additional elements or future, not-yet-captured elements. Those can be added to any organization's specific initiative.

The elements have been elaborated on in a systematic manner. If necessary, they are deployable in a custom fit and staged order and do not necessarily require a full suite deployment in the first phase. Each of them is now introduced and described, element by element:

- Smart Mobility Program Management according to Sect. 12.1
- Smart Services according to Sect. 12.2
- Smart Data according to Sect. 12.3
- Smart Products according to Sect. 12.4
- Smart Spaces according to Sect. 12.5.

12.1 Smart Mobility Program Management

The *Smart Mobility Program Management* (see Fig. 12.2) embraces the well-known project management relevant tasks. Next to them are addressed those tasks that ensure the strategic embeddedness of Smart Mobility initiatives within an organization and its ecosystem.

Smart Mobility is not a one-way street or a solo effort. Leadership from the top management signals its backing through sponsorship and support. Leadership is multi-faceted and could be the top management of a commercial enterprise, the departmental leader of a community, a city, a province or a ministry, an innovation office, or the designee of a company, for example.

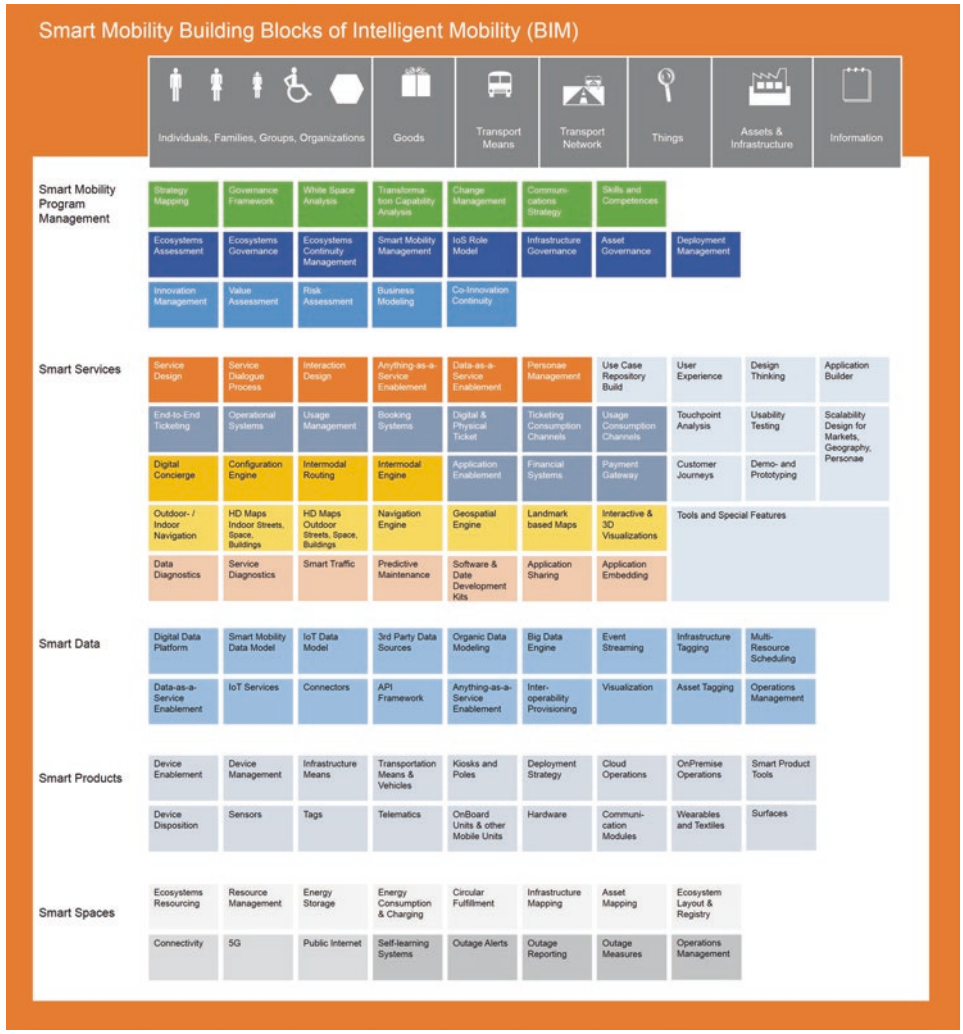

Fig. 12.1 Smart Mobility: Building Blocks of Intelligent Mobility (BIM) – the catalogue

Sponsoring refers not only to the sponsoring of budget or issuing funding programs. It embraces the provisioning of expertise and know-how, access to subject matter experts, contacts within the ecosystem, and facilitating business and governmental partner involvement. Any Smart Mobility engagement is characterized by access and use of data. Next to engaging collaboration partners from strategic, functional, and technical stakeholders it is highly recommended you engage the legal ombudsman and data security engineers from the very beginning.

Strategy Mapping One of the cornerstones of strategy thinking is strategic impact assessments and *white space analysis*. They result in identifying a new business segment and its influence and impact on an organization's structural, economic, functional, and

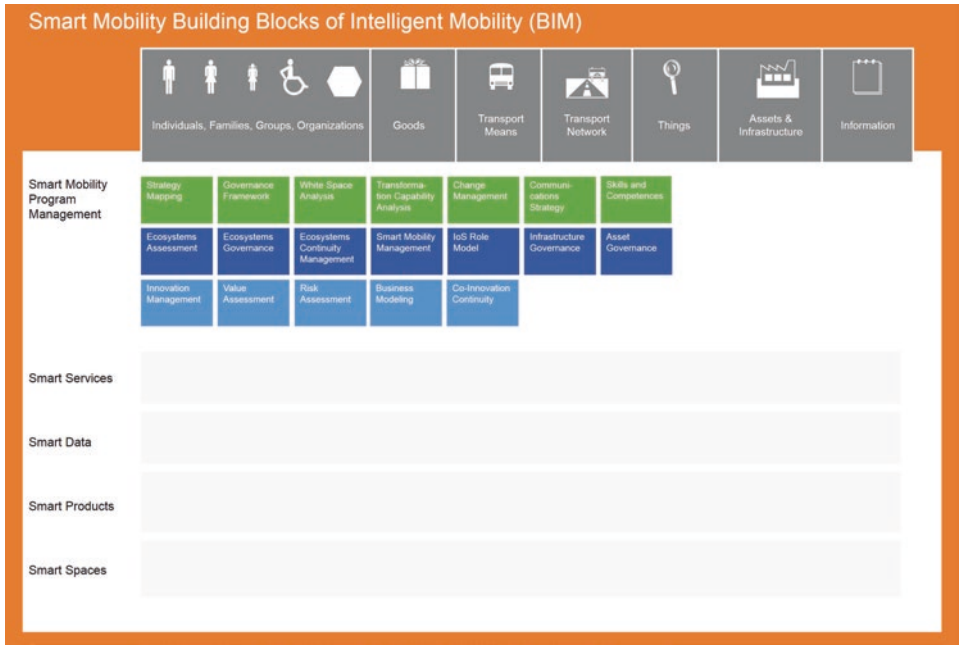

Fig. 12.2 Smart Mobility Program Management

societal set-up. Here we apply an approach that is grounded in the findings of Kaplan and Norton [150] and results in so-called *strategy maps*. The *strategy map* is defined as "a comprehensive description of an organization's strategy". It provides a checklist for a strategy's components and interrelationships.

Strategy Mapping underpins the alignment of Smart Mobility initiatives with other ongoing and/or planned initiatives to ensure the long-term strategic positioning of an entire organization or of one of its divisions. Transformational undertakings with technological characteristics, a high degree of interconnectedness with the population, and to be revealed benefits demonstrate their capability in assessing the need for strategic adaptation. The deployment of a piloting project or a field trial serves to reconsider the strategic targets and reveals the necessary steps for a long-term process of adaptation.

Change Management is another key element next to strategic thinking. Job profiles, competences, training, and self-improvement accompany the employees being employed by a government institution or a private company. Independently from the usage volume/test size of a field trial or a long-term targeted initiative, project initiators need to define a communications strategy and an information panel to embrace the project participants and the population. The population is thus an inherent part of the project.

The governance framework, another key element of the Smart Mobility program management pillar, takes into account the governance of guidelines and policies and a meaningful implementation alongside the project and beyond.

Ecosystem Assessment, Governance and Continuity Management The analytical foundation of ecosystems was depicted in great detail in Chap. 3. To ensure a meaningful and successful design of the Smart Mobility undertaking, the continuous traceability of the applied and/or targeted ecosystem is a key activity. One the one hand, it serves as a communication vehicle for the participating parties and stakeholders. One the other hand, ecosystem continuity management results in a more and more complete depiction of the relationships of the participants within the targeted ecosystem, in alignment with other ecosystems and even within an organization.

The ecosystem assessment refers to the study of the location, such as a city, an economic zone or, for example, an industrial area and its participating members, interactions, the local advantages, and location relevant services. It serves furthermore as a catalyst to derive potential and deployable use cases for the targeted and involved stakeholders and industries. In addition, the ecosystem assessment triggers business model relevant questioning.

Another key activity within the ecosystem assessment is the identification of roles, responsibility, and positioning options for stakeholders. Figure 12.3 outlines the corresponding personae management within the IoS role model.

Depending on context and the individual character of the observed location, further techniques and methods could be applied.

Infrastructure and assets in the context of Smart Mobility are technological elements as well as constructional elements. It is recommended that you target Smart Mobility

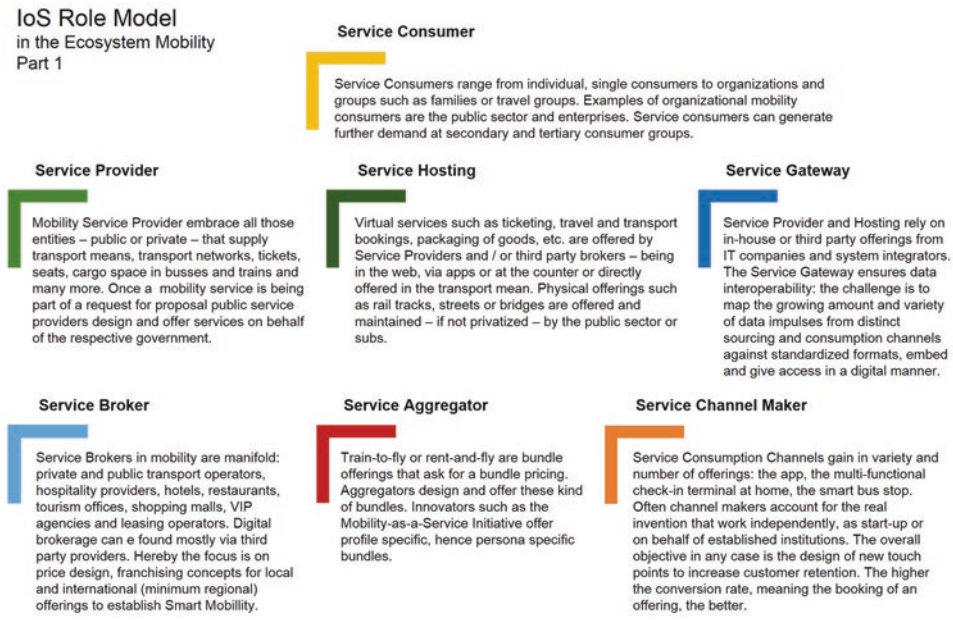

Fig. 12.3 Smart Mobility IoS role model

related assets and infrastructure holistically in so-called *cadasters*. Cadasters are a kind of registry that contain and describe all mobility relevant assets (e.g. streets, bridges, facilities, light poles). They should be defined independently from the current organizational alignment and ownership in city government and maintenance departments. Especially in communities, cities, and regions unnecessary discussions usually take place about who is responsible for what. A Smart Mobility undertaking, as any other ecosystem targeted undertaking, asks for transparency and the willingness to share and update information and data among the participants and addressees. In the future we expect that existing role models give way to a contextual assignment of roles and responsibilities instead of a hierarchical or an assignment characterized by separating public and private roles and responsibilities.

Innovation Management and Value Proposition No doubt, Smart Mobility is one of the most wanted innovative themes that offers a broad range of discovery and invention outcomes. Creativity and design of Smart Mobility offerings play an important role, given the reach of its assets and services towards distinct consumer groups. The same accounts for business modelling. The later aspect targets the evaluation of qualitative and quantitative criteria of Smart Mobility offerings and their pricing strategy. In the markets, movements such as *Business Model Innovation (BMI), digital business modeling,* and *business model generation* opened up the discussion among distinct organizations and encouraged the sharing of commercial considerations. Any of the movements aims to define the *unique selling proposition (USP)* of a product or service to outperform known and unknown competitors and derive a suitable and promising calculation schema.

Especially in Smart Mobility app offerings the calculation schema is driven by volume, meaning the size of the targeted user community. Pricing wise most of the observed Smart Mobility apps are free of charge to attract a reasonable number of users. Profitability and economic capacity build rely on chargeable add-on services that amplify the initial offering.

A common pattern in the field of innovation triggered initiatives is the acquisition of public funding. Another element concerns the set-up of coinnovation projects in collaboration with representatives from business and research institutions as well as mentors and business angels. Regardless of the applicability of public funding and research budget, and the overall project organization, it is recommended you set up a coinnovation continuity program. This concerns the ongoing exchange and sign off for the relevant steps to be taken for market entry, further field trials, and the expansion of service offerings.

One of the observed mistakes is the launch of coinnovation projects or hackathons that succeed in the first round, but miss the efforts to continue. We come back to this phenomenon by introducing a continuity-triggered involvement throughout the Smart Mobility Procedure Model (see Chap. 13).

12.2 Smart Services

Within *Smart Services* there are six key areas (see Fig. 12.4):

- Service design
- Launch and conduct of use cases and a use case repository build
- Ticketing concerning mobility related services and other kind of services
- Digital concierge and intermodal routing
- Outdoor and indoor navigation
- Mobility diagnostics.

Alongside the definition of the layer model, *Smart Services* contain service and solution triggered tools. Furthermore, the entire *solution lifecycle management* takes place within Smart Services.

The following depiction of Smart Services is dedicated to introducing key features, functions, and tools for successfully deploying Smart Mobility. It does not serve as an architectural model or technical schema.

Fig. 12.4 Smart Mobility services – an overview

Service Design *Service design* embraces all necessary tasks and activities to define elements and parameters of Smart Mobility offerings in an optimal and adequate manner. The identification and invention of applicable services is taking place in the context of interaction design. Any activity, task, or request can be offered as service these days (aka Anything-as-a-Service). This could be an individual who accompanies a patient to the hospital, the offer to review all necessary travel documents and filling in the necessary forms, or the offering of a private car owner to use his car for a maximum mileage per month in a pre-defined time window.

The variety and multifaceted nature of services is what we refer to as the *Anything-as-a-Service* phenomenon. A similar effect is encountered with the variety and multifaceted nature of data. Under the assumption that the user provides the unconditional acceptance to release usage insights as well as accepting the bundling of usage-related data with publicly available data, a data-as-a-service movement in the field of mobility is emerging.

To be successful good service design embraces the addressees and answers the question about who is taking over which role in which time and process segment. Therefore, personae management is part of this building block.

End-to-End-Ticketing *End-to-end ticketing* or *one ticketing* targets the connectedness of the entire travel chain in a digital format. The requirements for and functioning of *smart ticketing* that have been covered in Part II play a significant role in pursuing the digital connectedness of means of transport on-site, cross-regionally, and internationally, and the corresponding services with one ticket and one payment.

This area is often declared as one of the most challenging building blocks of Smart Mobility. Depending on the scope of Smart Mobility, proprietary IT solutions, standard applications, public and/or privately issued services are in use. Intermodal routing that embraces two or three means of transport does exist already. The current discussions target the connectedness and intelligent use of further means of transport and alternatives, as well as accompanying the traveler digitally. The digital companion we refer to as the Digital Concierge.

Digital Concierge Similar to the functioning of a sixth sense, the *Digital Concierge* operates through a number of algorithms and data status monitoring. The heart of the Digital Concierge is the autonomous, unsolicited interaction with the user. The user, depending on a traveler's profile, is the person itself and/or the proxy. All relevant tasks and activities, alerts and notifications, incidents and bookings, and travel alterations are bundled and operate in a pre-conditioned format.

Following the exemplified intermodal travel schema from Sect. 8.1.4, the Digital Concierge captures, in step 1, all preferences of the traveler and his travel conditions in a *mobility profile* (see Fig. 12.5).

The identification, calculation, and presentation of alternative routing options for the traveler are subject to step 2 (see Fig. 12.6).

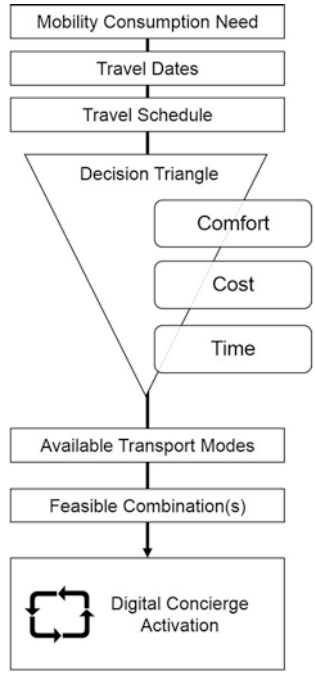

Fig. 12.5 Ecosystem Mobility – intermodal on the road – step 1 – alternative routes for one trip <door-to-door>

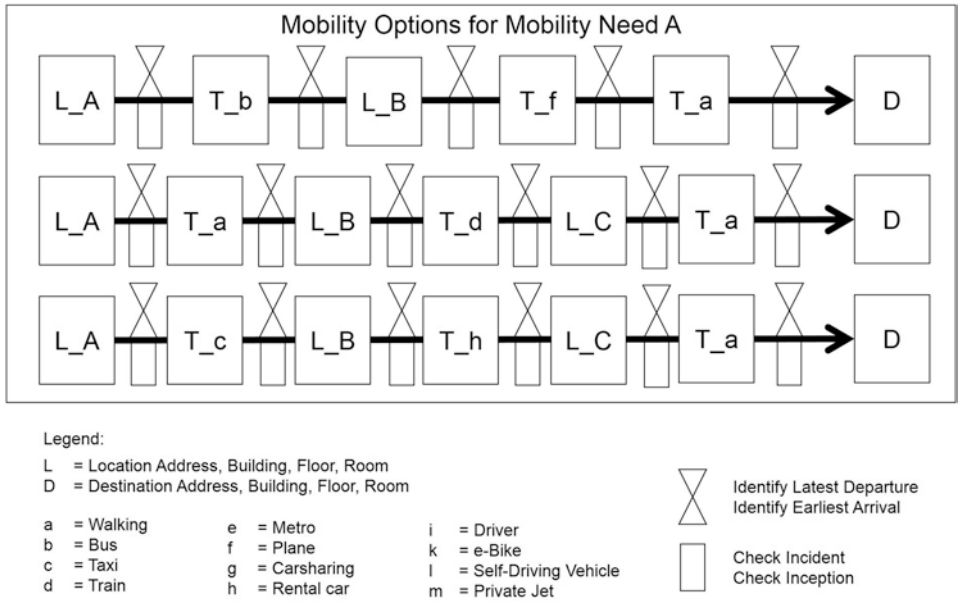

Fig. 12.6 Ecosystem Mobility – intermodal on the road – step 2 (extract) – alternative routes for mobility need A

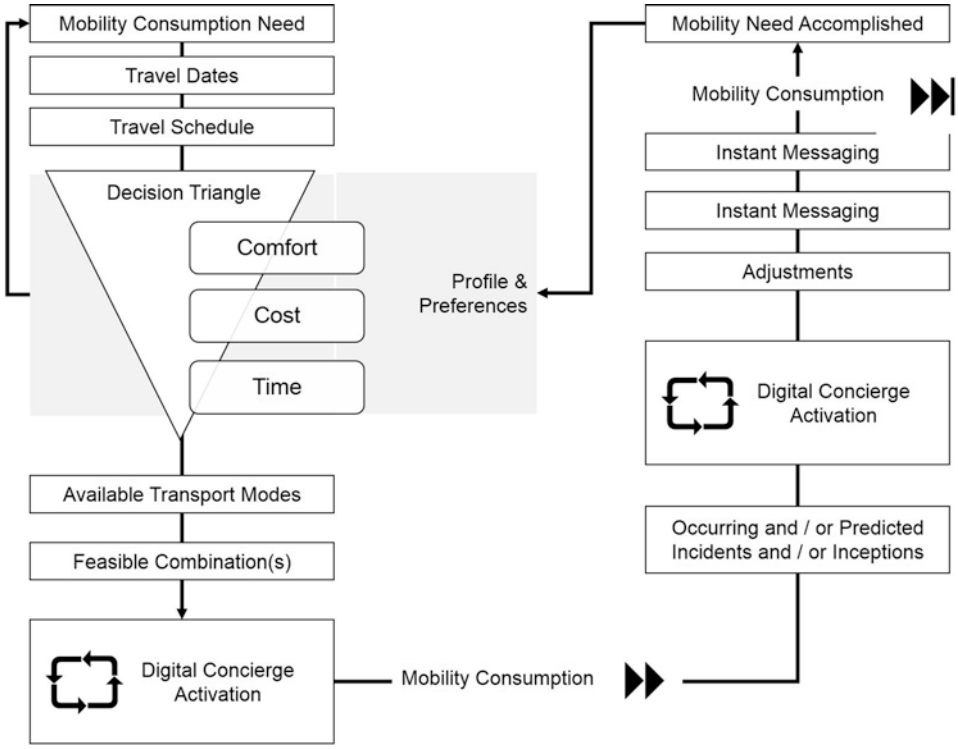

Fig. 12.7 Ecosystem Mobility – intermodal on the road – step 3 (extract) – alternative routes for one trip <door-to-door>

Within step 3 the Digital Concierge accompanies the traveler along the entire journey (see Fig. 12.7). The same accounts for the proxies in case they have been defined and configured for the traveler.

The Digital Concierge ensures a flawless and smooth travel experience, regardless of the type and impact of incidents or exceptions. Even more, the Digital Concierge supplies the traveler with social and business contacts in a purpose driven and theme oriented manner. The Digital Concierge links in where social networks often end for travelers: experienced and inexperienced travelers expect to receive theme and purpose driven guidance and suggestions, and moreover the chance to turn the trip where possible into a positively surprising experience before, during, and beyond travelling.

Outdoor and Indoor Navigation The digitization of buildings and the increasing capture of internal pathways and spaces are judged as groundbreaking as the digitization of streets and road networks and the resulting business segments of map providers and information service providers.

The map is the clue to better orient pedestrians and to bundle road related services for autonomous driving. The map is the digital base that gives optimal orientation, seeking geographical entries and exits, or proposing an elevator or escalator nearby, following the Digital Concierge's recommendation.

In addition, landmark mapping is a critical BIM, too. External landmarks whether they are signature buildings, sites, and orientation points such as well-known fashion stores, supermarkets, or top spots all accommodate a traveler's need to orient himself in an unknown territory externally as well as in internal spaces.

The entire field of outdoor and indoor navigation concerning Smart Services is interacting with the *Smart Spaces* area of the BIM. A detailed depiction of navigation trends and requirements can be found in Chap. 9.

Mobility Diagnostics Next to Big Data proceedings and the supply and processing of data sources of diverse formats is as essential, further BIM is the provisioning and use of software relevant development kits (*Software Development Kits, SDK*s) and data related development and processing kits (*Data Development Kits, DDK*s). Pre-configured entry gates will offer access to data source providers and data streamers to issue further application processing. Service providers could, for example, rely on tools for data quality checks, data assurance and security measures, as well as tools to remove error prone, outdated, and irrelevant entries.

Data influence the logic and scope of the perceived prediction to target mobility services. One application area is the matchmaking of the itinerary of a spare part with the specialist and the to-be-prepared targeted operating site with onsite personnel, pathways, and available time slots for the exchange.

So-called in-app offerings, where an application is being called in within a running operation, benefit from continuous data analytics processing. Referred to as *application embedding* the system knows which applications and services should be offered in parallel to the started ticketing purchase. Data thus link applications and serve as the glue binding distinct providers, to the benefit of the consumer.

Next to application embedding, a consumer is empowered to use his applications and services while switching devices. This kind of *application sharing* is relevant to a traveler when starting an operation at the desktop and seeking to continue when exiting the office and entering a taxi or train compartment that is being reserved for company employees, and offers access to the company's virtual private network.

Already to date, data are being offered as a critical resource to give credit to newly established business models and facilitate disruptive offerings. One example is the transit travelers' behavior making use of public transport. Another one is booking an annual subscription for family car-sharing. Data triggered services resonate through the build of data capacity and behavioral reasoning in the phase of free of charge offerings and the transformation into data-injected predictions in the market expansion phase. At the point of having enough capacity, a second transformation step happens: the chargeability of add-on

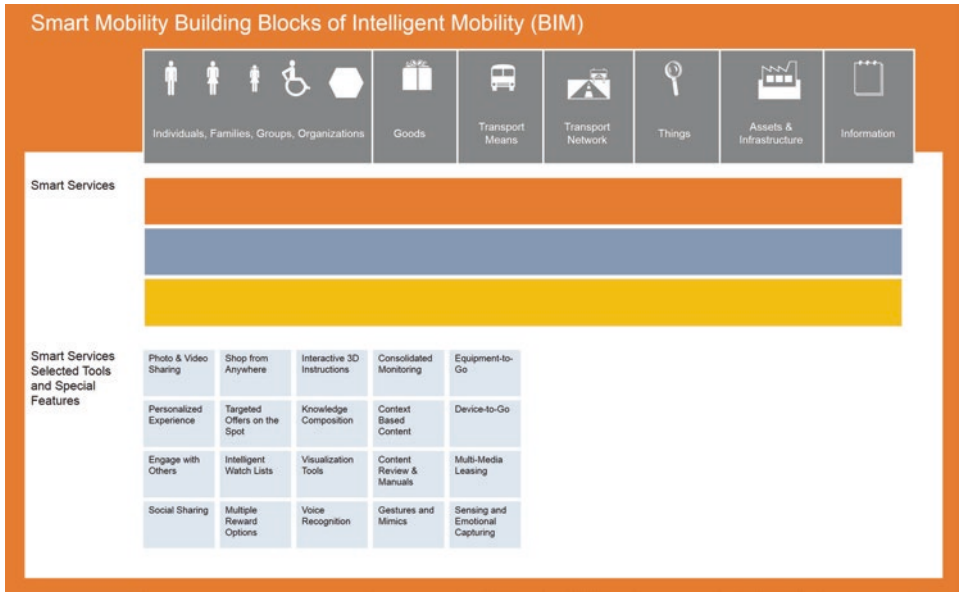

Fig. 12.8 Smart Mobility services – selected tools and features

features. To what extent will the business model reasoning change once the consumers as ultimate data providers ask to get reimbursed for the provisioning of behavioral statistics? This question remains pertinent to the pressing aspects of sustainable business modeling.

Selected Tools and Special Features In this category, as outlined in Fig. 12.8, a number of tools and functions are clustered. Those stand for a plethora of offerings for private consumers. More and more these offerings find entry in the business environment.

12.3 Smart Data

The *Smart Data layer* (see Fig. 12.9) comprises data provisioning, data assurance, and analytical offerings as well as data hub design and data hub operations. Next to these elements the Smart Data layer is the home of the *Smart Mobility data model*, organic data modeling, and the tagging of applied infrastructure and assets.

The *Smart Mobility data model* unifies all personae, things, means of transport, routes, and new forms of information and data carriers that will merge into Smart Mobility processing. The development of using new forms such as wearables or textiles, and the resulting new kind of data mediators, force the dynamics of the data model.

With respect to tagging, you need to decide how long a thing or an element needs to be registered and administered. Starting with a size of one hundred million tags for one

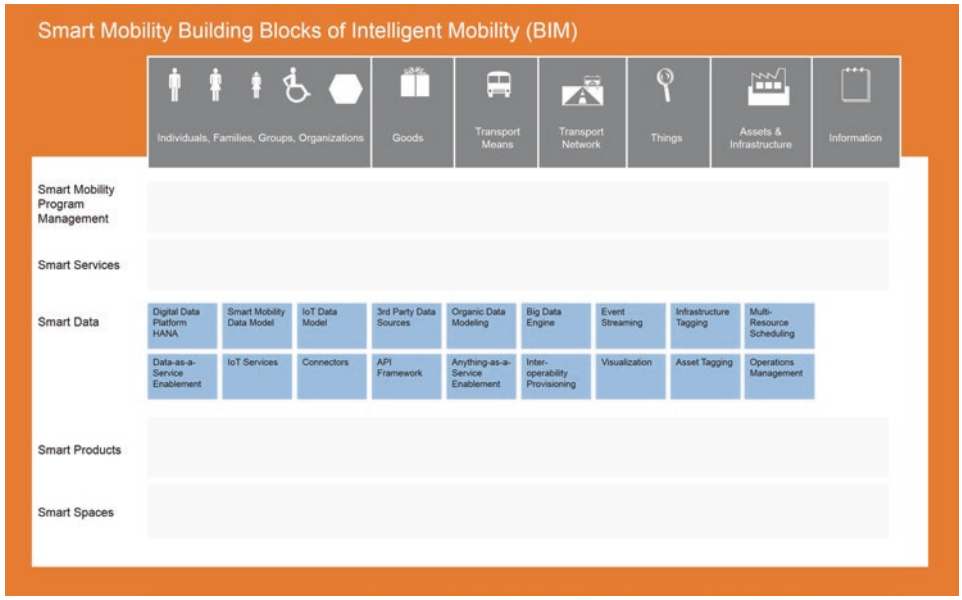

Fig. 12.9 Smart Mobility Data

ecosystem and the shelf life of one medium, through changing habits a discussion around de-archiving registered things has begun. It concerns questions like: Does de-archiving become part of the governance framework of businesses? Should all registered assets become replicable, retraceable, and evaluable over months and years – in relation to the company's internal and legal frameworks?

12.4 Smart Products

Within *Smart Products* (see Fig. 12.10) all physical products that contribute to an ecosystem functioning are digitally captured, categorized, and administered in the form of a *cadaster*, then evaluated and maintained. Examples of physical products are means of transport, traffic lights, light poles, bridges, and parking garages. In addition to the product related capturing of products, further characteristics such as frequency of use, construction condition, and contextual use should be added. The last one refers to the role the product plays in the context of mobility: being a facilitator, being a navigation element, or being for example a product-in-flux that changes its condition based on utilization and the means of transport. Similar to the described contextualization of products, the augmented asset capturing applies to the physical road management and transport related system such as streets, railways, water ways, and air space. The last one tends to be looked at from an airport functioning perspective. Another viewpoint is emerging through the use of air space in cities.

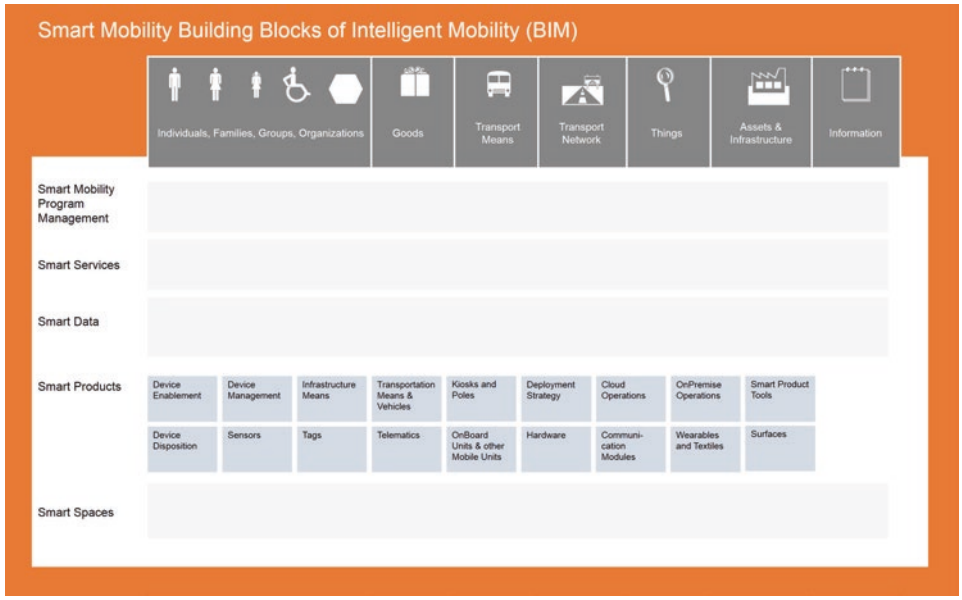

Fig. 12.10 Smart Mobility Products

Devices and communication media such as onboard units in vehicles and telematics are part of Smart Mobility products, too. Furthermore we add sensors, beacons, wearables, and textiles. In the near future, further connected things and chained elements will expand the registry of Smart Mobility. The latter aspect asks for an open and adaptive management of the cadaster.

Next to device management, device enablement and maintenance tasks such as exchanging data and information providers account for the removal of outdated and unnecessary elements.

12.5 Smart Spaces

The mapping of physical and digital spaces and its management is subject to *Smart Spaces* (see Fig. 12.11). Smart Spaces embrace all elements that were assigned to Smart Products, Smart Data and Smart Services as well as resources such as energy, water, and connectivity.

Here we introduce the concept of *ecosystem resourcing*. Ecosystem resourcing denotes the process of equipping the habitat with life essential, operation relevant, and functional resources. Thus the process of turning the habitat into a self-contained functioning system is factored in.

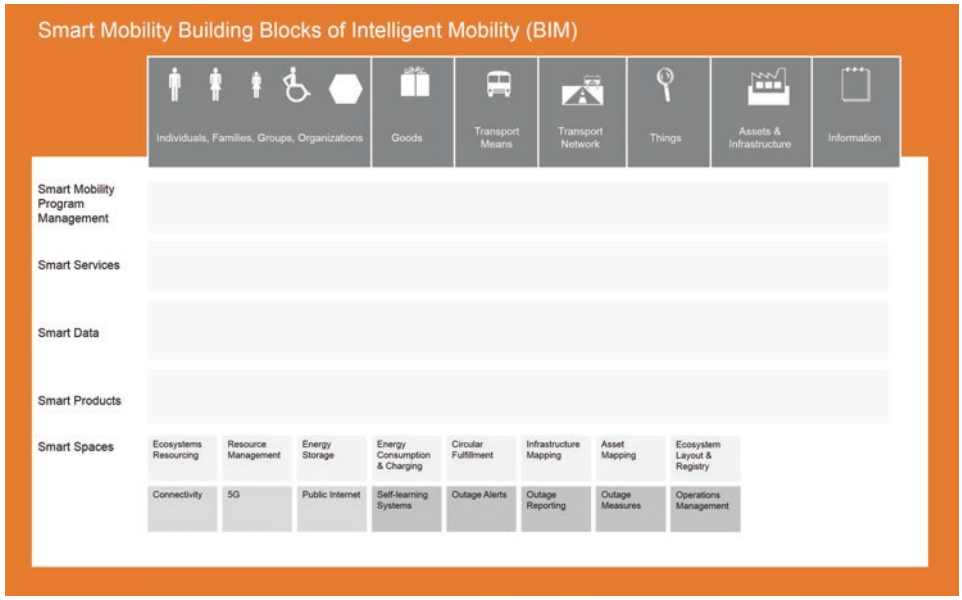

Fig. 12.11 Smart Mobility Spaces

In the case of missing resources or backlogs in the supply and distribution chains resulting from contingency measures or natural disasters, the risk increases for the individual. Smart Mobility offerings function only with premeasures and operation concepts that are in place to combat connectivity outage in the field of telecommunications, energy provisioning, or climate related interferences.

The Smart Mobility Procedure Model

13

Barbara Flügge

Abstract

Aiming for a successful transformation of opportunities and constraints into real benefits the Smart Mobility Procedure Model serves entire organizations, decision makers, designers, and promoters with a blueprint: six potential entry points support Smart Mobility initiatives. Entrepreneurs and solution providers have a different starting point and needs than government institutions and individual contributors. The Procedure Model takes those distinct viewpoints into consideration through checklists, hands-on material, and questionnaires. It applies the Building Blocks of Intelligent Mobility (BIM) that are the subject of the previous chapter. Moreover, it proposes a model to ease the discussion about institutionalization and juristically triggered aspects.

Contents

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B. Flügge (ed.), *Smart Mobility – Connecting Everyone*,
DOI 10.1007/978-3-658-15622-0_13

Successfully deployed Smart Mobility offerings go hand in hand with a structured and systematic, but nevertheless, design-oriented process. Motives to engage in Smart Mobility are manifold. One is the need to combat congestion and emission issues. Another is the economic need to streamline investment decisions and attract companies and personnel into the region, and launch a commuter friendly and cargo driven intermodal program. We thus sort the motives along six fundamental themes:

1. Exploring new business opportunities, assessing existing business models and/or your own position in the context of mobility.
2. Reviewing, expanding and extending your own BIM in terms of potential market offerings.
3. Initiating and deploying Smart Mobility once the decision has been made.
4. Conducting a fitness check for your own ecosystem that outlines the degree of being prepared with respect to Smart Mobility.
5. Elaborating business opportunities to position your own technology and innovations to get involved in innovation projects and determine the market access potential.
6. Conducting a context check to compare the readiness of your own ecosystem with one or multiple ones. The context check is applicable to any BIM, subject, or theme.

The *Smart Mobility Procedure model* fosters the structural and methodological discourse along the above listed themes. The model defines sequence and options to apply the *BIM*. Company-owned and cross-organizational elements can be sorted and added where feasible and useful.

According to the above chosen listing, the addressees and entry points for any of the six themes are as shown in Table 13.1. Nevertheless, initiators and interested groups in Smart Mobility might start differently and choose another order. This is purely driven by the maturity of your very own Smart Mobility engagements.

Table 13.1 Smart Mobility Procedure model – entry points

Chapters	Entry point	Addressees
13.1	*Explorative phase*: exploring new business opportunities, potential positions, and business models	Companies Public authorities
13.2	*Sound check*: map, adapt and expand own BIM solutions with Smart Mobility related criteria	BIM service providers for technology, services, and business processing
13.3	*Initiation phase* and Kick-off: decision has been made to execute and deploy Smart Mobility project(s)	Government owner Private businesses Consortium triggered co-innovation Project management Mobility managers

Table 13.1 (continued)

Chapters	Entry point	Addressees
13.4	*Fitness check*: compare your own mobility capability with other locations	Public sector entities Interest groups Project managers Mobility managers
13.5	*Market access check*: identification of potentially new markets and bundling possibilities for your own offerings	Inventors Entrepreneurs Start-ups
13.6	*Context check*: comparing your own with third party ecosystems	Publicly funded entity Privately funded entity Project managers Mobility managers

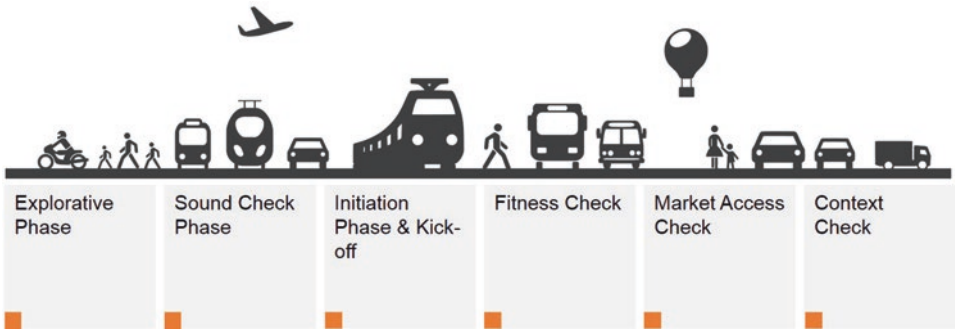

Fig. 13.1 Smart Mobility Procedure model – entry points

In the following, a detailed description of the relevant activities for each of the entry points is provided according to Fig. 13.1.

Those BIM elements that are mission critical are outlined graphically for each of the six entry points in the subsequent sections. Apart from that the entire blueprint, the BIM as such, facilitates and supports the undertaking of Smart Mobility.

13.1 Explorative Phase

When considering Smart Mobility driven projects and efforts, the *Explorative Phase* is a good entry point (see Fig. 13.2). It is this phase's main objective to gain insights into Smart Mobility, launch ideation contests, and gather ideas from an organization's environment, its ecosystem, and its employees.

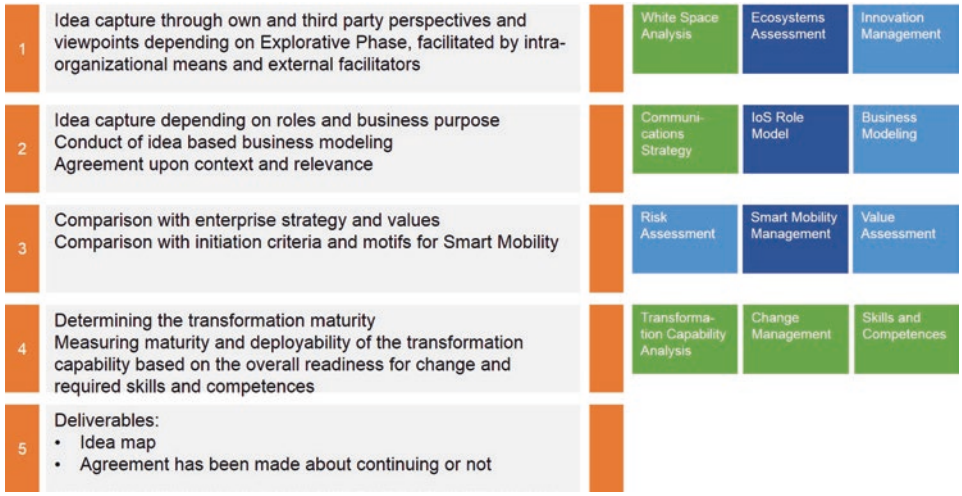

Fig. 13.2 Smart Mobility Procedure model – explorative phase

In this phase, project managers, team members, and experts apply intra-organizational and external creativity methods and techniques such as Design Thinking or Service Design. Those are applicable in a considerable low effort starting with a two-days workshop.

Results typically range from idea maps, game planes for organizational and transformational requirements, up to a transformational checkpoint and the resulting to-be-agreed-upon next steps. The transformational checkpoint governs firstly the issue and extent of a change management program and secondly the scope of skills and competences for Smart Mobility in relation to planned user groups and divisions. Thirdly it governs the nature of the Smart Mobility undertaking, for example through proof of concepts, before-after analysis, and the deployment planning on a local and regional scale. One further determinant, fourthly, is the decision about the involvement of external business partners and clients.

With respect to *business modeling* it should be noted that the first modeling is conducted under certain assumptions. Assumptions relate to primary and secondary business partners, the high level design of an offering for existing and future market penetration. The use of the *IoS Role model* sharpens the eye for connections, intersections, dependencies, and unknown territory in conjunction with further participants and influencers in the observed or targeted context. Modeling takes place in a staged approach. There will not be one single *business model*. It is expected that per role and positioning a minimum of one business model is identified.

13.2 Sound Check Phase

Existing mobility related solutions providers and service providers use the *Sound Check Phase* to reconcile their offerings with respect to the BIM elements. The necessary steps are depicted in Fig. 13.3.

Each of the steps of the sound check are illustrated in Fig. 13.4.

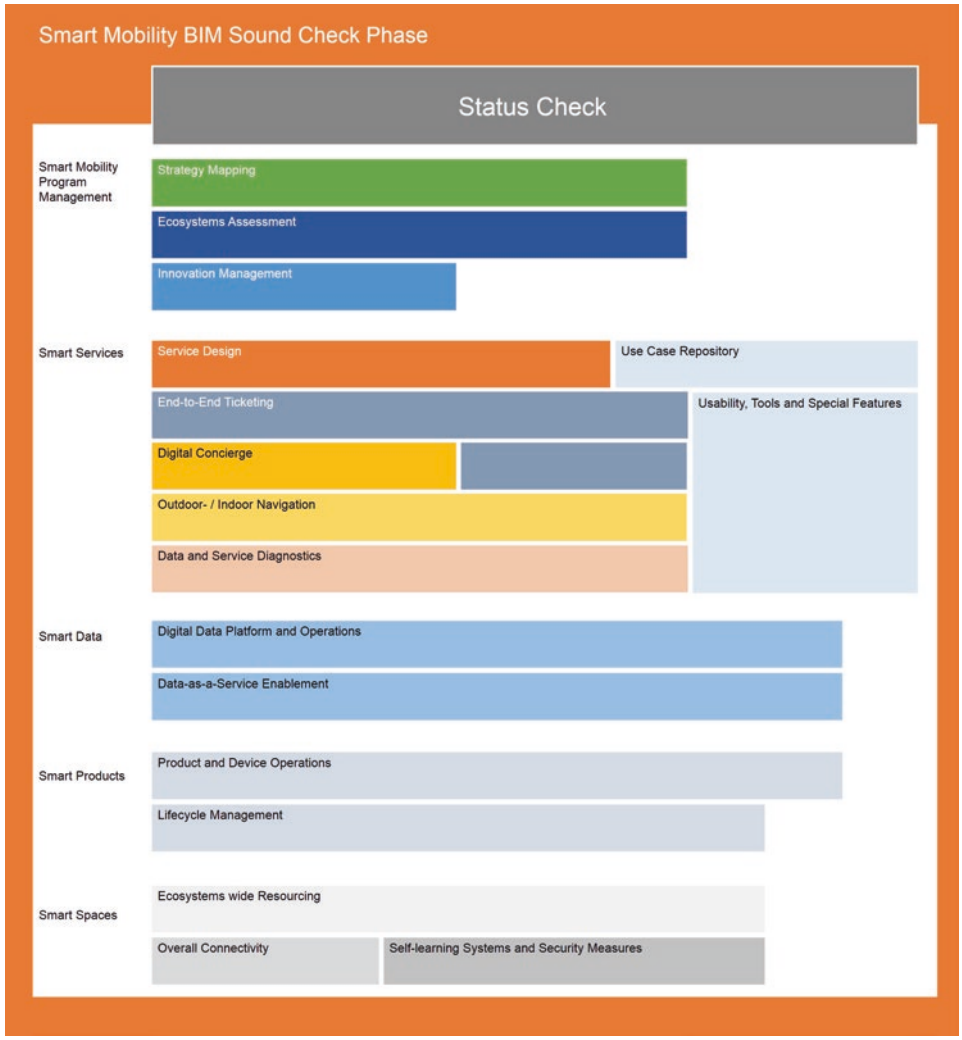

Fig. 13.3 Smart Mobility Procedure model – sound check phase – overview

13.3 Initiation Phase and Kick-Off

The degree of successfully deployed Smart Mobility initiatives correlates with the willingness to innovate and the willingness of the decision makers to deal with innovative, yet disruptive, offerings. These offerings can be of a functional and technical nature. In addition, they target the status quo of organizational and operational structures of business and government entities. Not only in Smart Mobility, but in all other contexts that target individual consumers and multi-industry ecosystems, the need for change and the willingness to embed change from the very beginning turns projects into successes.

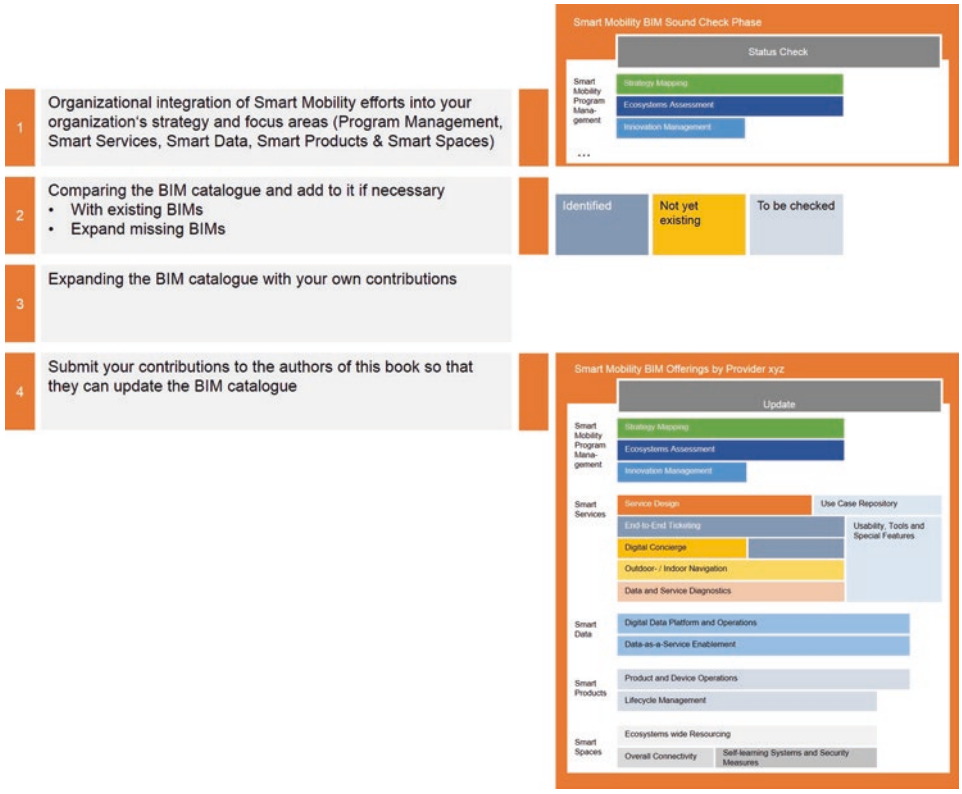

Fig. 13.4 Smart Mobility Procedure model – sound check phase – detailing

One further measurement of successfully launched initiatives is the willingness of organizations to not only test innovative offerings in a field trial, but institutionalize them within their organizational boundaries and beyond in the contextual ecosystem.

The *Initiation Phase* is illustrated in Fig. 13.5.

Checklist to Prepare Smart Mobility Projects The overall starting point for Smart Mobility projects is the agreement of the to-be-tested use case(s). Once the selection has been made, the action items as listed in Table 13.2 take place. Those assure the development of a common understanding on key parameters, the evolvement and ultimately the sign-off of a jointly agreed decision paper to initiate the project, starting it and tracking each of the corresponding statuses and to dos.

Change Management – Preparatory Steps for Organizations and Ecosystems Targeting a high probability of successfully deployed innovation in organizations and ecosystems can be measured by a number of parameters. The following elaboration and suggestions are the result of a longitudinal study and cross-regional and cross-industry assessment [66].

We distinguish two fundamental evaluation streams. Firstly, the organizational capability to cope with innovation and its operational impact. Secondly, the capability of an

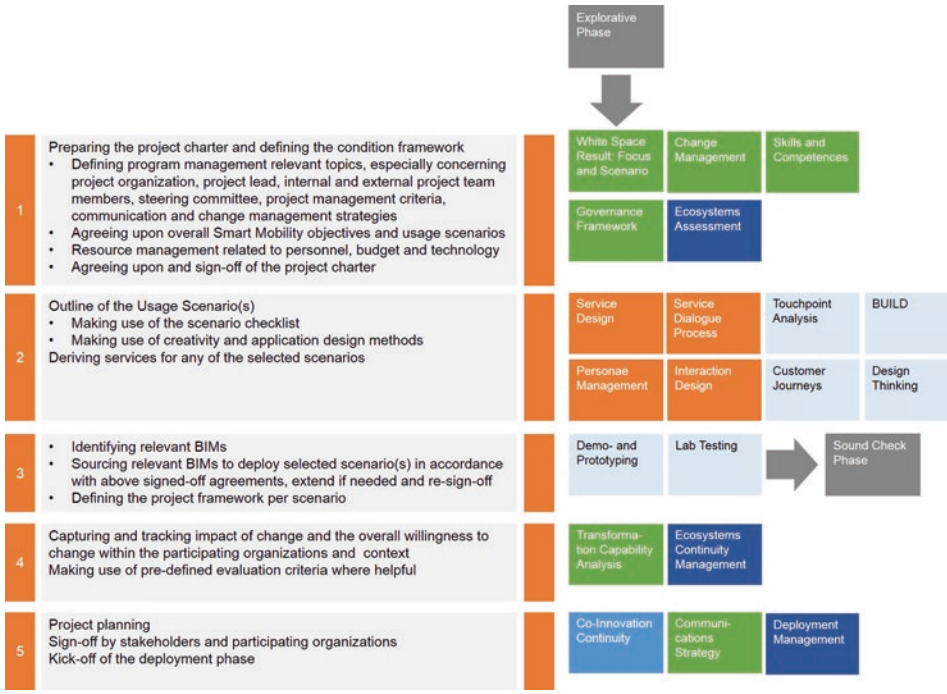

Fig. 13.5 Smart Mobility Procedure model – initiation phase and kick-off

innovation to connect ecosystem participants and members. The organizational evaluation criteria that have been observed throughout a series of projects are outlined in Table 13.3. The table serves as a working tool for project teams to track the status of their very own Smart Mobility projects.

The ecosystem wide connectedness is measured by the criteria outlined in Table 13.4:

Table 13.2 Checklist for preparing a use case related to Smart Mobility projects

ID	Checkpoints	Status[a]
1	Use case based project initiation	
1.1	Use case description	
1.2	Description of the addressable/to be addressed ecosystem(s) following the Smart Mobility program management activities	
1.3	Description of the value network following the Smart Mobility program management activities	
1.4	With regard to Smart Services, relevant BIM Which BIM are being applied?	
1.5	With regard to Smart Data, relevant BIM Which BIM are being applied?	

Table 13.2 (continued)

ID	Checkpoints	Status[a]
1.6	With regard to Smart Products, relevant BIM Which BIM are being applied?	
1.7	With regard to Smart Spaces, relevant BIM Which BIM are being applied?	
2	Business modeling with regard to Smart Mobility program management activities	
2.1	Elaboration of the Value Proposition Which benefits are achievable for customers by using the offered Smart Mobility solutions? How is the customer being supported to pursue his own duties?	
2.2	Addressability and characteristic of the targeted personae Which personae are being identified as Smart Mobility customers? Throughout the conduct of a personae driven analysis to which degree does the previously conducted value proposition assessment change? Does it require adjustments and if so, which ones? What kind of relationship is required and from whom, to offer Smart Mobility to the above identified personae? What kinds of relationships towards further personae are required to reach out to the original identified personae and customers?	
2.3	Checkpoint on benefits and usage effects based on the personae related assessment Will the value proposition differ for individual user(s) and user groups? To what extent does it differ? Are distinct effects on usage expected based on the personae driven assessment? If so, which ones? What are the quantitative and qualitative advantages of the targeted service?	
2.4	Service deployment Sketching of revenue streams, initial and recurring costs in addition to pre-investments and financial efforts for project funding	
2.5	Sketching of quantitative and qualitative value streams Which trends are known and not yet known? How will/could markets emerge based on the targeted deployment scenario?	
2.6	Trends and market development Who is the service provider of which of the BIM? What are the condition frameworks for test, usage, and deployment of the BIM? What other kind of research initiatives take place next to Smart Mobility? Is there an opportunity to combine research initiatives with your own undertaking? Where and how can you and others benefit? Which contributions are being expected from you and others?	

Table 13.2 (continued)

ID	Checkpoints	Status[a]
2.7	Legal aspects What kind of legal aspects need to be considered in the area of data security and data privacy, cloud computing, cyber security, liability, and usage rights amongst others?	
2.8	Societal aspects Which impact does Smart Mobility have on the society and the population in the observed context? Impact areas related to human-machine interaction, competence building and enrichment, further focus on establishing knowledge workers and hiring data scientists that focus on ecosystem related analytics and data-as-a-service offerings	

[a] Status management and updates are part of the project's preparatory, conduct, and post-deployment phases.

Table 13.3 Organizational change management capability

Evaluation	Evaluation criteria in detail	Evaluation result[a]
Checkpoint on organizational footprint	Description of company profile: organizational structure and legal entity characteristics (public authority, private business, research institution, other), size, strategic pillars and business segments, targeted reach such as geographies, markets, consumer and business segments, vision and mission statements, competency profile, competition Description of strategic positioning Transformation capability related measurements are in place Description of the decision making process within the organization Hierarchical *embeddedness* of strategic projects Handling of change management processes in the past Listing successfully deployed change management and/or innovation initiatives in the past 5 years	

Table 13.3 (continued)

Evaluation	Evaluation criteria in detail	Evaluation result[a]
Measuring an organization's willingness to innovate	Evaluation takes place along the following measures: – Innovation may exceed expectations of original ideas and scope – Innovation follows an organization's system of values – Innovation is driven by the requirements of future consumers and/or users – Highly complex innovation with regard to understandability, traceability, and the ability to be replicated – Innovation leads to band wagon effect in other organizations – Innovation is perceived as technological novelty – Innovation is testable prior to deployment – Other participants and user groups are given the opportunity to replicate the innovation	
Degree of influencing the workforce	Evaluation takes place along the following measures: – Positive effect of innovation – Innovation is being accepted hesitantly – Innovation is being rejected – Motives for degree of acceptance are captured along socio-cultural, demographic, and other factors	
Innovation related sourcing process	Sourcing process is being measured by: – Criteria that influence the sourcing of the innovation and/or sourcing of innovation critical components and assets as outlined in the *BIM catalogue* – Identifying the degree of an organization's dependency on the innovation – With regard to the perceived value that is being generated by the innovation for the organization – With regard to securing the competitive advantage of an organization – With regard to securing the future position of an organization in the active and planned ecosystems	

[a] The evaluation and the evaluation results are part of the project's preparatory, conduct, and post-deployment phases.

Table 13.4 Ecosystem dependent change management capability of an organization

Evaluation	Evaluation criteria in detail	Evaluation result[a]
Degree of institutional linkage	Assessing the legal and political condition framework of an organization in the observed ecosystem Degree of dependency of an organization on institutional elements of those geographies that are subject to the organizational footprint (e.g. country, community, city, and further ecosystems)	
Economic contribution of the organizational innovation	Organizational contribution and influence on economic and socio-cultural evolvement of those geographies that are subject to the organizational footprint (e.g. country, community, city, and further ecosystems) Note: a high degree is accelerating the acceptance of the organizational innovation at state and local governmental institutions and administrations Preparatory steps to predict relevant measures such as cost-benefit analysis, return on investment ratio and further economic and ecosystem relevant key performance indicators Degree of practicability to apply the perceived innovation in the public sector Identifying adjustment needs and potential of the perceived innovation to foster the acceptance	
Degree of connectivity among the participating members of an ecosystem	Conduct of a connectivity analysis Identifying the degree of connectivity dependent on observed and targeted personae	
Contributing to informal networks and initiatives	Interrelationships of organizations in ecosystem related informal networks fostered by the organization's Corporate Social Responsibility (CSR) program and local activities with respect to research, education, and social welfare	

[a] The evaluation and the evaluation results are part of the project's preparatory, conduct, and post-deployment phases.

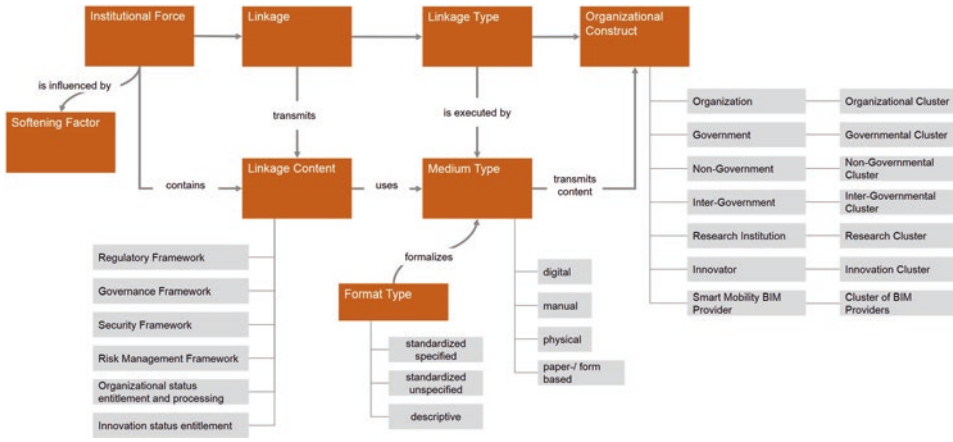

Fig. 13.6 Procedural steps to facilitate compliance checks in and among organizational constructs

Introducing a Procedural Model to Facilitate Compliance Checks Within and Among Organizational Constructs The following model has been elaborated to explore the *embededdness* of IT standards in European Union directives and to foster the transition of embedded IT standards in the dedicated legal frameworks for each of the EU member states [66]. The model aims to ease the depiction of dependency factors when a huge number of participants comes into play in a legal environment such as the European Union. The schema in Fig. 13.6 shows the basic model. The assessment of the participants followed the connectedness analysis as outlined previously. A detailed elaboration took place for each of the participants. The detailing of the schema has been conducted in close alignment with the participants and is depicted in Fig. 13.7.

13.4 Fitness Check

Trainers that regularly subject athletes to a fitness check are similar to the individual judging a *Fitness Check*. Checks are based on common, conventional, and recommended measures from physicians and subject matter experts. Moreover athletes rank themselves and get ranked following a set of local, regional, and global standards. Further criteria depend on the form of sport and the athlete's profile. Common questions are covered such as asking for how long the athlete is active in that sport, his exercise program, and his routines when doing sports. Further checkpoints are about the goal plan and individual objectives that might not have been considered in the current plan.

Conducting a fitness check for an entire ecosystem is much more complex. A search on key terms such as mobility, urban mobility, intermodal traffic management, and others results in a large number of parameters that might be applicable for a *Fitness Check*. Not all of the parameters are comparable or useful in an ecosystem wide context. Furthermore,

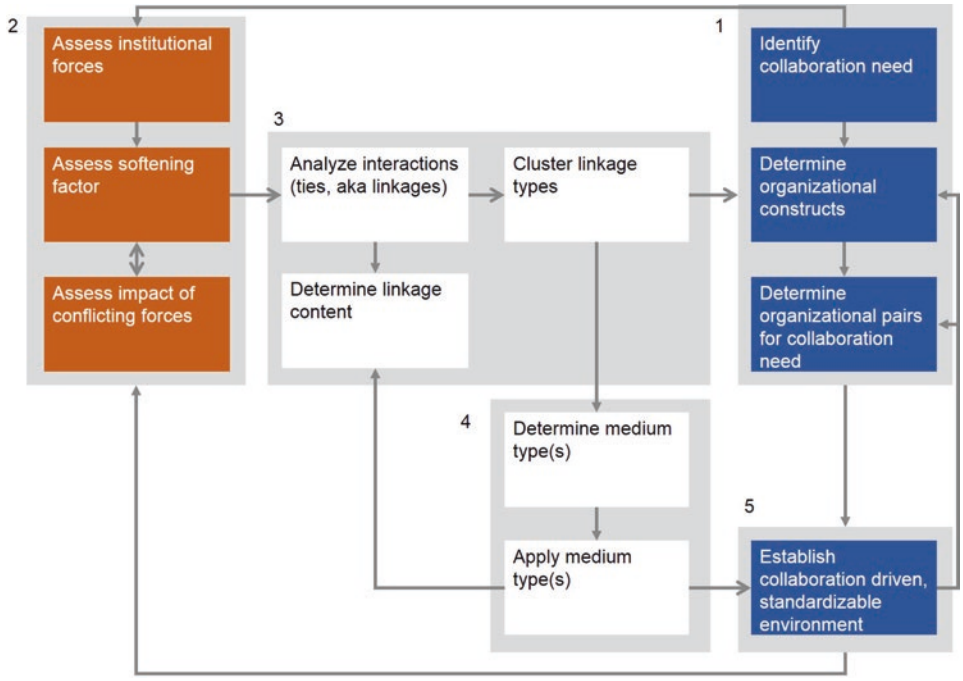

Fig. 13.7 Investigating the impact of innovation on jurisdiction

even the key terms are applied differently and are not clearly defined. With respect to metrics, those are subject to a number of distinct resorts, distinct media, and are often maintained separated from each other. Even more, once maintained the digital media differ in scope, quality, and actuality. Therefore it turns out to be a tedious effort to transfer the figures from separate systems, align, and adjust them in a semantic unique manner to derive one comprehensive mobility metrics foundation. The metrics we introduced in Part II promote a method to conduct a location, yet ecosystem embracing, KPI management. Big data tools and modern diagnosis methods lead these efforts.

Overall there is a lack of consideration of the local status quo of urbanizations and ecosystems: the *habitat's profile*. A location's key elements such as those depicted in Fig. 13.8 are of great help. The habitat's profile presented here is applicable to any location that considers Smart Mobility.

Once these elements are assessed among the group of stakeholders and Smart Mobility initiators, the first relevant step is made! What follows is an agreement about the criteria that serve as the basis of comparison. That agreement is made between the stakeholders and drivers of the project. It is recommended you identify comparable ecosystems and mobility relevant environments (see Sect. 13.6). The shortlist is a result of mapping the ecosystem's profile against others. It is also useful to look at the ecosystem's ranking in the local and national indices. Concerning urban settlements, one approach is taken by the

Fig. 13.8 Smart Mobility Procedure model – a habitat's profile

Smart Cities index in the USA, another one by the so-called Zukunftsatlas (Future Map) in Germany that compares cities, even villages, and regions along smart city related segments such as Smart Mobility, Smart Environment, and others [151].

Overall a mapping of one ecosystem to others should be conducted based on population, reachability in the hinterland, and events. Events are a good characteristic for Smart Mobility to assess the quality of mobility functioning in cases of peak usage of means of transport in relation to predicted and unforeseen travel. Thus mobility related measures include the profiles of previous attendees, the size of the event and its overall profile, the price range of the tickets, and the mobility related habits with respect to arrival and departure retrieved from previous events. In a Smart Mobility and *one ticketing* environment, the business traveler, for example, is being guided towards an interesting event, receiving the registry invitation pre-prepared, and a mobility and lodging inclusive offering through the *Digital Concierge*. Event organizers can count on achieving a higher number of attendees without engaging themselves in direct sales efforts. Hospitality providers will benefit from better occupancy rates through short-term bookings. The same accounts for hospitality service providers as well as further kinds of event adjacent services in the field of tourism.

All other actions that are part of the *Smart Mobility Fitness Check* are outlined in Fig. 13.9.

The fitness check is also a good instrument to assess the before/after situation with respect to the mobility project (see Fig. 13.10). The assessment compares as-is with regard to the optimal transport operations. As baseline serves the mobility service portfolio that has been agreed upon in the strategic alignment process and the identified roles and responsibilities (see Sect. 13.1). The real challenge is the definition of the ideal mix

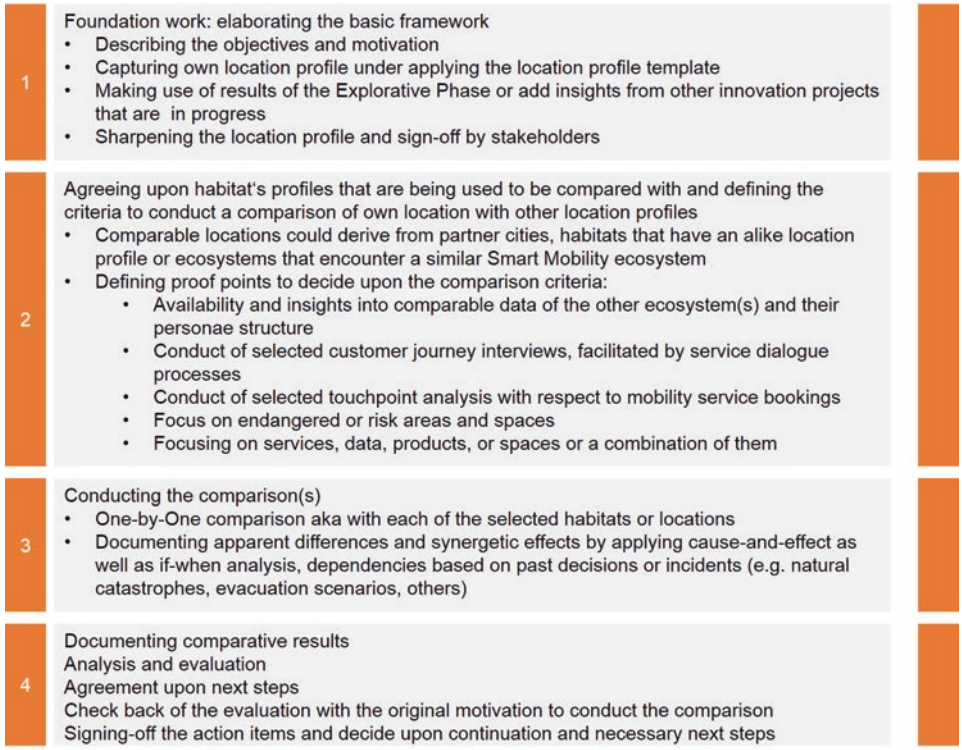

Fig. 13.9 Smart Mobility Procedure model – fitness check I

of public, private, and shared-economy driven mobility service offerings. The *IoS Role model* and the connectedness analysis are the ideal set-up to derive the ideal mobility mix on the one hand and explore further alternatives in a creative conceptual space on the other.

Furthermore, stakeholders should not hesitate to explore those alternatives by inviting representatives from other ecosystems that have been identified as role models and/or comparable ecosystems. The alignment with Smart Mobility project teams and mobility managers is useful to exchange knowledge and align or even conduct Smart Mobility field trials jointly. A continuous knowledge transfer facilitates even more the build and extension of skills and competences driven by a collaboration-based set-up.

13.5 Market Access Check

Looking into the emerging number of innovation triggered market entries, conducting a *Market Access Check* has become increasingly popular in recent years. An entire section in Chap. 15 is dedicated to the trends in innovation management.

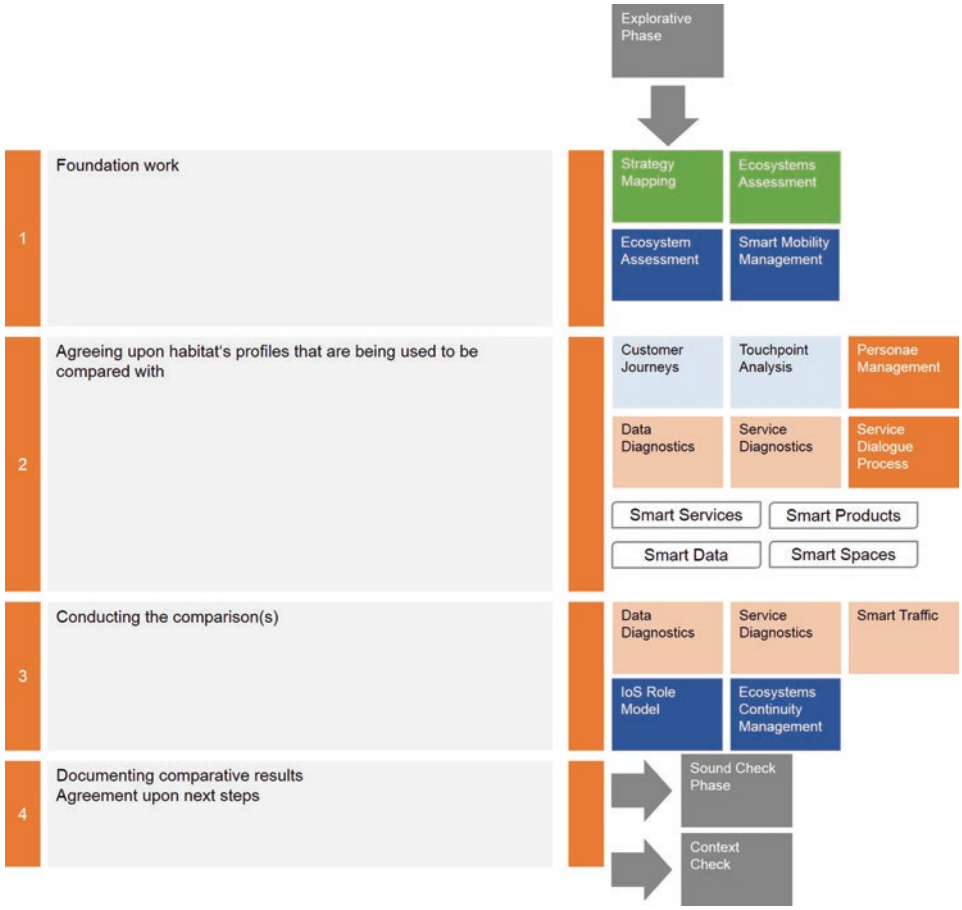

Fig. 13.10 Smart Mobility Procedure model – fitness check II

Innovators and entrepreneurs pitch their offerings in competitions, hackathons, and workshops issued, for example, by financial investors. The issuing entities are not necessarily only companies and private institutions. It has been observed that the public sector through local government itself, associated interest groups, and research institutes triggers innovation projects. Likewise, the innovators and entrepreneurs gain access to potential customers and have the ability to interact directly and countercheck the projected market acceptance.

It has never been made so easy and low cost to get access to test communities. Compared to market studies and consumer tests conducted by institutional providers, the hackathons and pitches provide a perfect field of opportunities next to access to testers: checking the viability against the competition, comparing your own approach with others, and even more relevant turning the participation into a social selling opportunity and getting

access to former pioneers that are now joining advisory boards and acting as business angels and mentors. One the other hand, the industry leaders and stakeholders in public and private entities benefit from a collaborative, co-innovation flavored setting that eases the engagement of constituents.

The conduct of a market access check is outlined in Fig. 13.11.

To identify in which area and direction the considered innovation is heading, it is recommended you apply the *BIM* structure (see Fig. 13.12) and watch out for functional or technical closeness of other offerings. The BIM Catalogue serves as a checkpoint to consider add-on elements or look for useful tools and methods.

The conduct of market access checks is driven by viability tests. *Viability* is one of the key elements of the design thinking method. Here viability relates to usability of an innovation or solution or service. Usability is twofold and targets the economic benefit and the consumer oriented benefit. The more refined the detailing of the to-be-tested offering, the more market driven and realistic are the outcomes of the test.

In an ideal setting the first prototypes are introduced to a test group. Prior to the test, the test organizers define the usability requirements and the test cases. The nature of use cases is subject to the scope of the planned offering. In any case it should embrace design, touch points and omni-channel deployment modes. The test results then are a critical source

Fig. 13.11 Smart Mobility Procedure model – market access check I

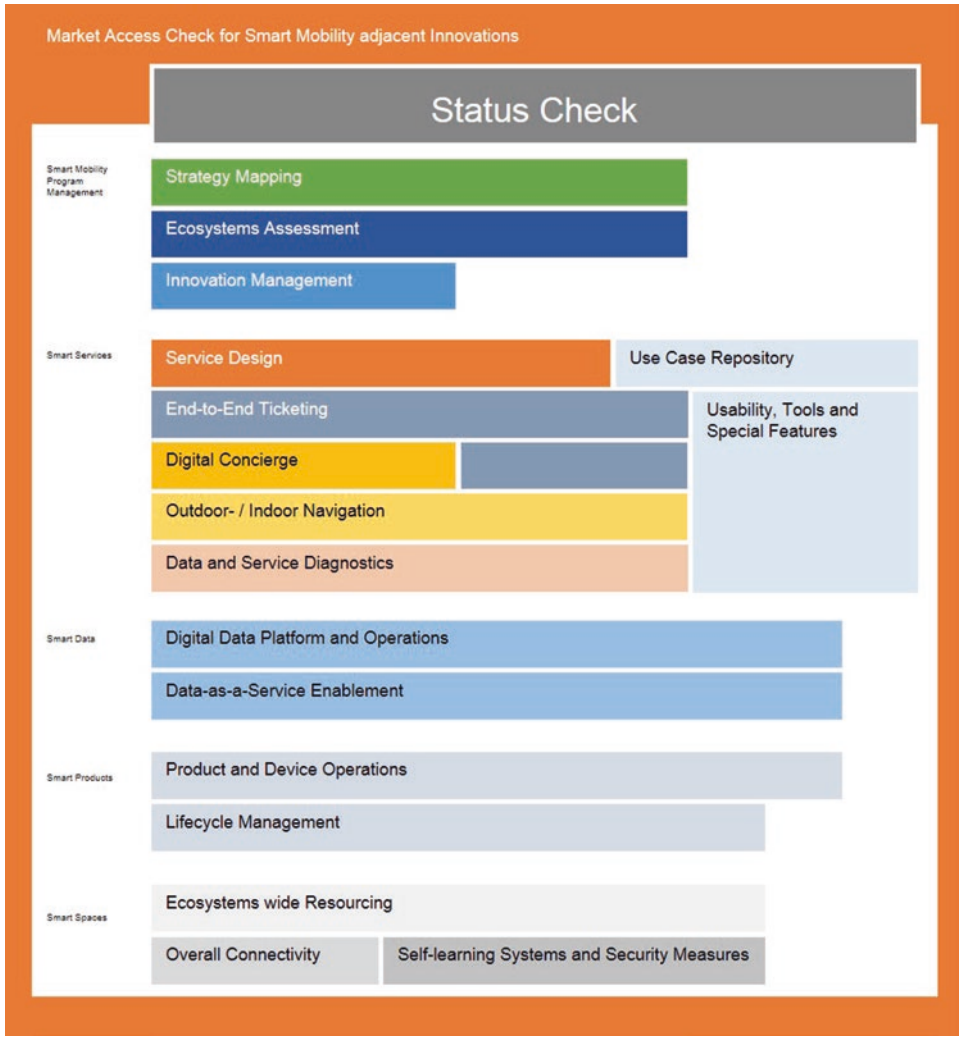

Fig. 13.12 Smart Mobility Procedure model – market access check II

of information for the development and design team and lead to a further iteration of the development and design. In the next test cycle, personae and targeted user groups are introduced to the offering.

Business model testing is conducted by inviting further experts. They are being asked to assess the identified business model(s) and economic conditions, outline pitfalls, and advise on the go to market and market expansion. More often experts are being invited that are subject novices and come from distinct industries and contexts.

Once the test cycles have been conducted to a satisfactory degree, evolving and refining the solution further, the first larger investments approach. With respect to fixed costs, those

account for workforce and production efforts. It is no surprise that the first changes take place in the start-up management. Shifts in functions and roles are driven by upcoming communication and business development needs. To prepare a market access check it might be worthwhile to take a look at one of the largest facilitators for product build and testing: the so called Komponentenportal of Romy Campe [152]. It was founded in 2012, motivated by the book of Prof. Faltin [153]. To date it offers more than 70 software components and tools.

13.6 Context Check

Subject to the *Context Check* is a comparison of your own ecosystem with other ecosystems. An own ecosystem refers to the ecosystem in which the initiator of a Smart Mobility offering is active, leading, and/or governing. The initiator might be a public sector entity, a *Chief Digital Officer* or the Mayor himself. The assessment starts with the profiling of your own ecosystem. The relevant action items are illustrated in Fig. 13.13.

The checklist in Table 13.5 focuses on the conduct of the analysis of the connectedness and the resulting comparison parameters. Based on the chosen scenario and use case, the detailing of the connectedness proceeds.

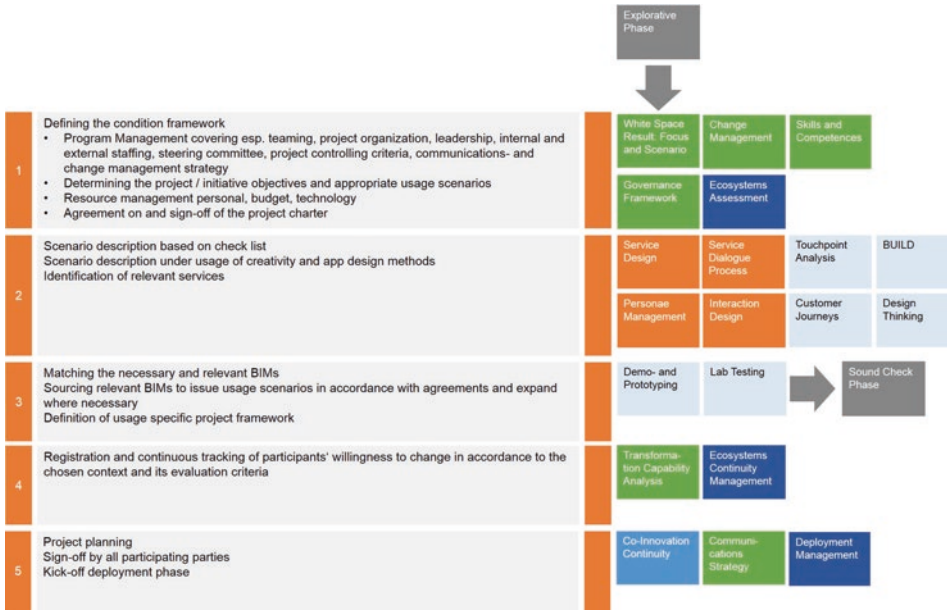

Fig. 13.13 Smart Mobility Procedure model – context check

Table 13.5 Checklist for the conduct of an analysis of connectedness

ID	Checkpoints	Further tools and methods
1	Setting the stage: when you think about the motive to issue a Smart Mobility project, you already consider or have considered a certain context, for example, city center logistics, migration to autonomous parking in the city surroundings, or diminishing the congestion in the early working hours. So, what does your current business network look like?	Smart Mobility Ecosystem
1.1	Please determine your business partners as well as customer and supplier relationships with your organization and amongst each other. Business partners are defined as customers, suppliers, entities that you are collaborating with, adjacent business and government institutions, service providers that act to date independently from your company focus, and organizations that are mission critical to run a business or authority.	Smart Mobility Ecosystem Personae-driven analysis
1.2	Visualize your business network.	Smart Mobility Ecosystem
1.3	Checkpoint: is it necessary to add further user groups? Please identify and list these user groups and describe the interactions they might or will have within your network.	Personae-driven analysis
1.4	Which of the identified personae are addressable by what kind of services?	Interaction Design
1.5	Conduct an overview of the service provider, service consumers, and further clusters of participants.	IoS Role model
1.5.1	Please mark in your business network layout resulting from 1.2 and 1.3 the service related business partners as well as the interactions they have within the network.	
1.5.2	Which network participants are mostly relevant for service sales?	
1.5.3	Which network participants are mostly relevant for service development?	
2	Do you have first cross-organizational process flows in the form of sketches and documents, and that depict the process of service sourcing up to the point of digital and/or physical service delivery and deployment?	Service Design
3	Which skills and competences are being expected from you and your business partners to sustain in-services trade?	BIM Smart Mobility Program management

Table 13.5 (continued)

ID	Checkpoints	Further tools and methods
4	Now, choose another context – a context you might have prioritized lower than the above one or a context that you scoped out because of certain conditions you considered complex! Another way of finding another context are partner cities, cities that are comparable with yours or the city you operate in, based for example on comparable size and number of inhabitants, based on a high degree of innovation empowerment, or based on recently launched Smart Mobility initiatives.	
4.1	Similar to the sound check phase, conduct a comparison of your and their BIM. It is recommended you follow the structure of the BIM catalogue.	Sound check phase
4.2	Do you encounter alike initiatives in the identified ecosystems that are suitable for yours? Which are the key differences to your initiative? What are the key drivers and benefits of the other initiatives?	Sound check phase
4.3	With regard to KPIs, the most burning drivers and improvement areas you find in your very own context: based on your context what are the top 10 KPIs you like to focus on?	Mobility Diagnostics
4.4	Based on the outcomes of the action items from 4.1 to 4.3 you will now be able to conduct the Explorative Phase in a much more focused manner and aligned with your needs.	Explorative phase

The connectedness analysis and the supplemental tools and methods evolved through more than 200+ projects and contexts. Both of them will give credit back to the project teams as they allow an integrated view of personae and services.

Reference Architecture: Smart Mobility

14

How Cloud Based Smart Mobility Applications are Technically Architectured

Nicolas Liebau

Abstract

In this chapter a cloud based reference architecture for Smart Mobility is described. Smart Devices send data to applications in the cloud. The core cloud components are described and references to known products are given. From the cloud application the data is then forwarded to the user's mobile front ends.

Contents

14.1 Architecture Overview

For the implementation of Smart Mobility applications cloud based architectures are predestinated. Different parties deliver information to such applications. Also, several parties use information about those applications. As the data for Smart Mobility can

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adopt the characteristics of Big Data [154], storing multiple copies of the data per party is economically not meaningful. Cloud based architectures are suitable for a 'data hub'. Figure 14.1 depicts a reference architecture for cloud based Smart Mobility applications.

At the lowest layer there are the information sources, i.e. smart devices, people who are carrying or wearing such devices, and external information sources, like a weather report service. This information is delivered to the cloud (depicted in the middle of Fig. 14.1) where it is processed into results. The results are then delivered to the end user devices; they are consumed by the user (e.g. via the browser or an app on a smartphone). This layer is the top one shown in Fig. 14.1.

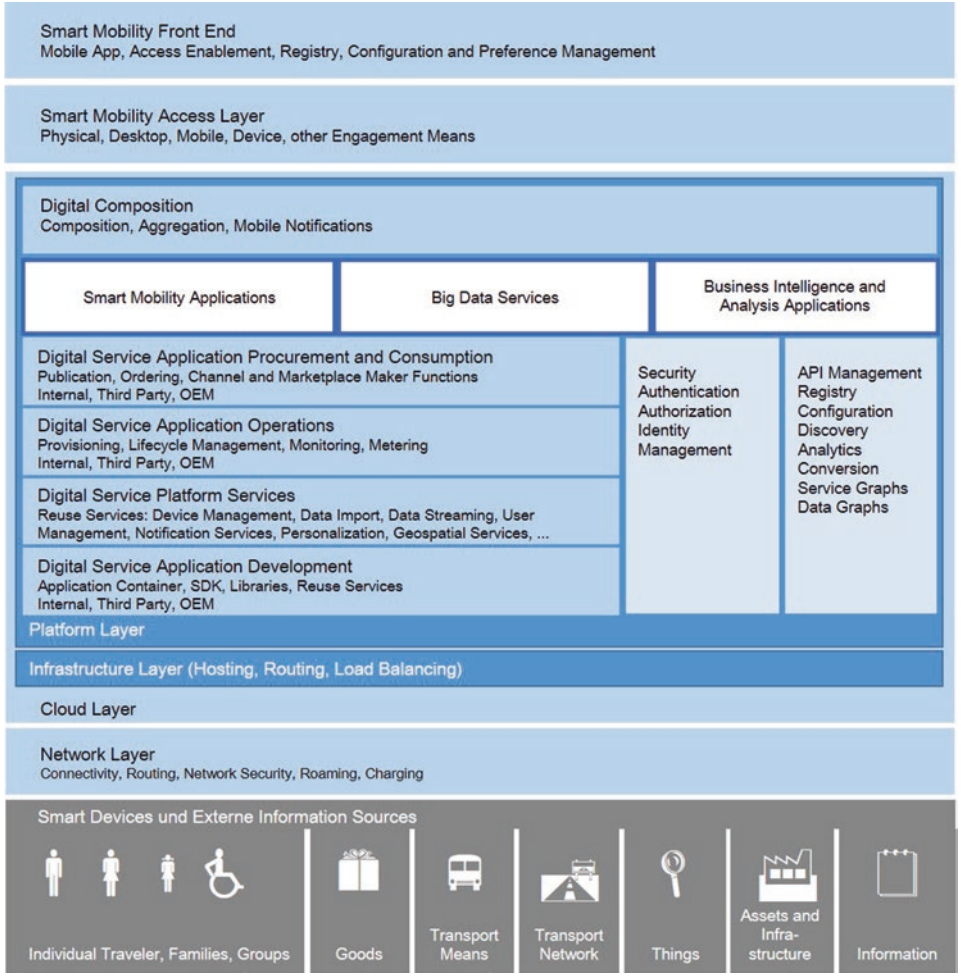

Fig. 14.1 Reference architecture for cloud based Smart Mobility applications

14.2 Network Layer

The information sources deliver information to the cloud. The network layer is responsible for transporting the information. It fulfills the routing functionality so the information is delivered to the correct destination address. For this, wired networks, wireless networks, mobile networks, or a combination of these can be used. The network layer can be further structured according to the Open Systems Interconnection (OSI) model of the Internet [155].

Challenges here can be costs for data transmission (e.g. if mobile networks are used), reliability of the network connectivity, and security. For securing the information an end-to-end encryption should be applied from the device to the application. For example, if a mobile network is used for the data transmission, the wireless distance is encrypted on the network layer; the remaining distance is not. Therefore, the information should be encrypted additionally on the application layer, for example via https [156], TLS [157], or VPN [158].

14.3 Cloud Layer

The cloud layer is structured into the infrastructure layer, the platform layer, and the application layer.

14.3.1 Infrastructure Layer

The infrastructure layer provides in the cloud the required processing and storage resources. This layer is also called the 'Infrastructure-as-a-Service' (IaaS) layer. The infrastructure layer is accessible via Application Programming Interfaces (APIs); with computation nodes and storage reserved and provided for the cloud application. For example, a service with 8 CPU cores, 12 GB RAM, and 5 TB hard disk storage can be ordered. Well known alternatives for those APIs are Amazon Elastic Compute Cloud (EC2) [159], Microsoft Azure Virtual Machines [160], and OpenStack [161].

When you select a cloud provider pay attention to a high-performance infrastructure layer. As mentioned before, Smart Mobility applications potentially show big data characteristics; i.e. potentially Petabytes of data need to be stored. Such amounts of data cannot be moved any more easily via computer networks. The data become "immovable property" like the data center itself. Therefore, it is important to choose the right partner.

The infrastructure layer should have a sufficient network connectivity to the Internet and should be extensible in the future. A lead for a good location is the geographical proximity to one of the large Internet exchange nodes like the DE-CIX in Frankfurt, Germany.

The provider should have designed the infrastructure in a saleable manner, so that storage capacity can be extended seamlessly. Also it should be possible to temporarily

book additional infrastructure resources and to get billed based on usage. This is important for data analytics, for example, to find new predictive models in the application or to train such models.

14.3.2 Platform Layer

The platform layer of a cloud provides the application containers and services required for developing and operating applications. This layer is also called 'Platform-as-a-Service' (PaaS) layer.

14.3.2.1 Digital Service Platform Services

In comparison to the IaaS layer, in the PaaS layer it is defined which platform should be running on a server. That is, should a web server be installed or a database? Other application containers running on a server (called server nodes) can be Java,.Net, node.js, Hadoop, etc. Pay attention that the PaaS layer offers your planned containers. For example, today SAP HANA is only available at some PaaS providers apart from SAP; further the available size might be limited. An example for an OpenSource PaaS is Cloud Foundry [162].

Apart from the basic application containers, a PaaS offers many superior services; this can be, for example, services for connecting and remotely managing Smart Devices (Device Management) like SAP HCP IoT Service [163] or Amazon AWS IoT Services [164], data import services like connectors to external information sources and databases like the OSISoft PI to SAP HANA Integrator [165], data streaming services like Apache Storm [166] or Apache Spark Streaming [167], data integration services like SAP HANA Cloud Integration [168], data science services SAP HANA [169], R [170], or Apache Spark [171], portal service like SAP Hana Cloud Portal [172], user interface frameworks like SAP UI5 [173], and services with and on top of geographic maps like HERE [106].

In summary, you find here all the data services and smart services a cloud platform offers to the application developer. The developer composes the application with those services and develops the missing functionality using the application containers. If the PaaS does not provide a required service (e.g. Apache Spark), then the application developer deploys this service on his own on the respective application container. All services offered by the PaaS provider are also operated by him.

Of course, services that are installed or developed by the application developer also need to be operated by him. More about operations can be found below under 'Digital Service Application Operations'.

14.3.2.2 Digital Service Application Development

For the development of applications, first an Integration Development Environment (IDE) is required. Examples are eclipse [174] or the SAP Web IDE [175]. Inside an IDE the functionalities of the platform services required to develop the application are delivered via Software Development Kits (SDKs). With this an IDE marks autonomously errors

in the source code. Furthermore, check tools (e.g. for security validation like Cross Site Scripting [176] and code injections [177]) are essential.

Services for source code management like GitHub [178] allow collaborative development and the administration of different versions of developed components in a clearly arranged way. For the compilation of the final software, build tools like Maven [179] are provided.

14.3.2.3 Digital Service Application Operations

When the application is ready to be developed it must be tested and then provisioned to the productive landscape. For this the PaaS must provide services for the deployment of the different application components; here, for example, Jenkins [180] is used. Tools (e.g. for translating the application into different languages) are also important.

During the lifetime of the application errors (bugs) will be found that need to be corrected; for this a hot-fix process is required. For new versions, patches must be installed.

While the application is being operated productively it must be monitored. For this, important messages and errors must be logged and the status of each component must be monitored. In the IaaS, performance indices must be provided like CPU utilization, RAM utilization, etc. Application health checks must be included. Warning messages get generated if the runtime of a specific procedure exceeds a specific threshold or if a certificate will expire shortly. The performance indices and the warning messages are summarized in an operations cockpit. Form here automatic actions can be triggered to correct errors.

Furthermore, an important aspect for billing customers, is the metering of the used resources of the IaaS, the PaaS.

14.3.2.4 Digital Service Application Procurement and Consumption

This layer is not directly related to the architecture of an application: however it is essential for its successful sales. For sales a ‘store’ is required that is used to offer an application to the market. This is an ‘application store’.

First the application must be published, so customers can find it and order/purchase it. Different channels should be supported through the application store – direct sales and indirect sales via partners who receive the provision.

When a customer has purchased a Smart Mobility application this layer is responsible for requesting the provisioning the application to the customer from the Digital Service Application Operations layer. As cloud applications are often priced based on the usage, metering information provided by the Digital Service Application Operations layer must be used, so the charge to the customer can be calculated. With this all the different layers are closely coupled.

14.3.2.5 Security

Security is a functionality that has to be considered end-to-end across all layers. In Identity Management the users and their digital identity attributes (like keys, passwords, authorizations in the form of assigned user roles) are managed. Those attributes are used to

authenticate users. When a user is authenticated the assigned user roles are evaluated in order to authorize him for transactions.

Important protocols in this area are SAML [181] for web-based authentication in browsers and oAuth [182] for authentication with APIs.

14.3.2.6 API Management

As a cloud application is composed of many components that are communicating via interfaces (APIs), the management of those APIs is extremely important. Over time, components are further developed, enhanced, and with it their interfaces change. Dependencies need to be recognized, so that changes in an interface can also be adapted in the calling and receiving components. Therefore, APIs must be managed along the complete lifecycle with the steps registration, configuration, search, analysis, and translation. For the analysis, tools like service graphs are helpful: these depict the relationships of services within an application. Further data graphs help to trace how data flow between services. A well know API management tool is apigee [183].

14.3.3 Application Layer

At the application layer the Smart Mobility application is located. Also the application itself should provide interfaces so it can be extend and connected to other applications like Business Intelligence.

Important here is the integration with Big Data analysis tools like Apache Spark or R. Data scientists must be enabled to work efficiently with such tools so that they can find new patterns in the data. Those patterns can then lead to new functionality in the application or even to new business ideas.

14.3.4 Digital Composition Layer

In order to allow that many users can consume the Smart Mobility application in a scalable manner, the data used by the application must be composed in such a way that computational effort and network traffic is minimal when sent to the users. If thousands of users simultaneously access an application, performance issues can occur. Therefore, direct access to the application database should be avoided. Therefore, in this layer data is replicated, aggregated, composed, and provided to the end user devices via load balancing mechanisms.

In order to directly send information to mobile devices like smartphones, special mobile services are required. Mobile devices basically have, through their SIM cards, a firewall integrated: this does not allow any traffic initiated by the cloud to reach the device. In order to send messages to the device, Apple [184] and Google [185] provide special services for smartphones.

14.4 Smart Mobility Access and Smart Mobility Front End Layer

The results of a Smart Mobility application are sent from the cloud via the network or Internet to the receiving device. This can be a desktop computer, smartphone, or a smart device with actuators.

At this devices are running browsers, apps, or other programs that accept the information, render the user interface and communicate with the Smart Mobility application. Also those apps and programs potentially must be installed and managed, for example via regular automatic updates. Of course, the users or programs must authenticate and authorize themselves in order to ensure end-to-end security.

14.5 Conclusion

The description of the reference architecture reveals that the development of a Smart Mobility application can be complex. Many different functions and components need to be considered. Thus, when selecting the cloud environment it is important that the different layers are well integrated. This reduces the effort required for the initial application development inside the IDE, the operational efforts, and the lifecycle management efforts of the application. This should be considered in your cost calculations. Also you need to reflect, that you not only need different landscapes for development, test, and operations; you need further landscapes for performance tests, a correction landscape for hotfix creation, and a landscape for testing those – and probably further ones.

Part IV

Recommended Actions and Future Directions

Getting Started!

15

Barbara Flügge

Abstract

Smart Mobility is a chance for local ecosystems to foster mobility efforts and make use of methodological basics, techniques, and tools such as the Building Blocks for Intelligent Mobility (BIM) and a field-tested Smart Mobility Procedure Model. How do Smart Mobility initiatives find entry into daily business activities? Which follow-up measures could be derived based on a number of projects and hands-on experience? This asks for a pragmatic optimism! What it is means is the cultivation of a practitioner oriented approach with the assistance of innovation empowerment, creativity, and an interest in a solution that fits all participating parties. It might not be the best-in-class solution that is applicable and deployable, rather the one that allows a participatory construct, offers benefits, and approaches the final goal of Smart Mobility in digestible steps.

Adding to the presented cases and examples and their assortment along the *Smart Mobility Procedure Model* and *BIM*, the following explanations are dedicated to introduce new perspectives, propose practical transformation needs, and recommend follow-up measures.

The discourse on optimal mobility offerings is directly linked with the demand for everybody's right to mobility. To turn this demand into reality, the following action items are considered:

- The strategic impact of Smart Mobility offerings on ecosystems is targeted towards the needs of personae and things

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- Deploying *seamless mobility* through a solution portfolio that is accessible to everyone for door-to-door mobility
- Making use of modern and innovative information systems and communication technologies to transform critical and effort limiting events into a compelling positive experience throughout a *digital sentinel*.

The study of influencing factors that lead to an increased usage and acceptance of Smart Mobility offerings is part of any Smart Mobility initiative. Instead of the product "bus taking" or "taxi riding" the service mobility and the mobility business process are being leveraged. Facilitated by adopting the viewpoint of a persona and environmental encountering, the context, Smart Mobility operations depend on the collaborative end in a cross-organizational, mobility-related business processing and monitoring activity. Those "public processes" that are commonly managed amongst service providers and operators are a result of three observations:

1. Mobility driving business processing is increasingly characterized by a greater and more flexible individualization of requirements.
2. Connecting the connectable, meaning interweaving things, information, and needs in a digital manner to derive benefits.
3. The vehicle transforms into another form of habitat, living and work space. Autonomous driving is opening up a whole new set of possibilities and freedom for mobility consumers.

Granting innovation as something good asks not only for a systematic approach, but also for forward thinking, designing, questioning, and innovation triggered discussions. A new thinking model is required in the same way as the exploration of new role models and evaluation schemas and solution offerings. The following statements hopefully encourage readers along the upcoming chapters:

- In the near future, there is no need for bus schedules or nervous checking at the bus stop for near time services or bus line switches.
- Parking in the city center becomes obsolete – the autonomous driving car picks me up at home for my shopping tour and the purchases will be delivered by the department store to my home.
- The newly made available space due to the discontinuation of parking garages will be transformed into recreation areas, community and communication spaces, and will serve as innovation hot spots.
- Mobility management is driven by the mobility needs of an entire work space or living area instead of isolated mobility fulfillments through one service provider being of public or private origin. A budget dedicated to mobility is being crowd funded regardless of its source from institutional, company, or private sources.

Getting Started! The right attitude in the form of a pragmatic optimism will serve Smart Mobility projects well, adding to the methodological foundation of the *BIM* catalogue and the Smart Mobility Procedure Model. A few effective measures are recommended to take into consideration:

- Make use of innovation wisely.
- Take advantage of the new service paradigm.
- Consider the new roles and concepts that are offered through technical advancements and human creativity such as the *sharing economy*.
- Measure your transformation capability and make use of it. In the remainder of Part IV each of the measures are being introduced in detail.

Making Use of Innovation Wisely

16

Katrin Redmann

Abstract

Digitization and globalization are moving on with more and more speed. Therefore each player in the market is asked to produce and even better create more new prototypes in shorter periods of innovation. And these innovation projects have to be executed in time and to high quality. The usage scenarios and approach that are the subject of this book give practical hints in order to provide the essential innovation impulse. Everyone is invited to rethink his own area of innovation.

Who is the inventor? Who initiates innovation? In relation to the usage scenarios and examples from previous chapters it has been revealed that each member of an ecosystem is enabled to set the initial starting point for an innovation process, independent of the organizational goals, the company size, or the number of initiators. The parties are pursuing their own interests nevertheless. The following three perspectives shed light on the multi-dimensional perspective on innovation:

- "Innovate or Die" (Bill Gates): Companies have to stay innovative to stay on top of the market. They rely upon internal and more and more external innovation programs.
- "The moment it starts, hell breaks loose" (Guy Kawasaki): Entrepreneurs and start-ups are looking for freedom for the real big idea or have at least a plan in which product area innovation is expected. They leave their company/employer, start working at universities, or follow their own path.

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- "Innovation takes twice as long, costs twice as much, but finally pays off many times!" (Peter Schwab): Programmed or planned innovation and researched innovation are two characteristics of publicly sponsored research. Public authorities give investments annually and the European Union is a sponsor of a huge amount of research during the past decades.

In academia and in the start-up scene innovation goes disruptive. In the past, in a corporate business environment, the players were more concentrated on isolating innovation projects and keeping research teams themselves. Corporations tended in the past to position innovation only in research and development departments. The argument behind this was of an operational nature. On the one hand, the allocation of and clarity about a research budget made it obvious what to expect and in which area. On the other hand, necessary investments in product management got allocated for technical efforts, research lab operations, and/or equipment provisioning for engineers. Strategically, companies set the objective to focus and deploy in a predefined time frame a certain prototype, invent a new material or textile, or conduct a research study for a product.

The tremendous speed in testing, design, and market launch throughout the enhanced development in the information technology and communication sectors – themselves having been a result of innovation – provided a huge freedom to create new ideas. Innovation freedom nowadays concerns feasibility as well as creativity and financial aspects. Companies create virtual worlds in order to get the same intense innovation eruption as in the start-up scene. They establish innovation spaces (physical or virtual) or invest in their proper start-up programs or single ideas [186].

At the same time, universities began to sponsor and mentor certain student teams or PhD students from their own start-up or entrepreneurial courses. You can see, since the 1990s, sponsoring initiatives such as from ETH Zürich to support systematically the innovation spirit of their students [187]. The foundation of its Technoparc enables the university to support students by giving them innovation support for research projects, using business angels for the founding and setting up of the innovation process. Career counselling, venture capital, and last but not least mentor programs to find the right supporter for each start-up, are part of the service portfolio.

Often we encounter a combination of research project, start-up initiation, and mentoring to achieve market potential. Diversity by all means plays a mission critical role: the more diverse the team members' profiles with regard to culture, function, working experience, gender, and age the more creative and promising the collaboration and perceived outcomes.

Design Thinking Design Thinking is a method, tool kit, and a philosophy for thought, life, and work. Design thinking gives room for the analysis of challenges as well as room for solution finding. By diving deeply into the given challenge, the work groups accomplish a well-founded base for the prototype. The quality is then improved by on-going iterations. This process sharpens the prototype. It is ideal if the experts or input providers in the research phase give feedback on the final prototype.

Research Projects at Universities Universities are also driven by competition and need to communicate their strengths. Therefore, it is most important that innovative and successful research projects are initiated and hosted. Among the universities some of them now offer innovation curricula. Studies in entrepreneurship become more and more significant and are integrated in the academic offering. In this context, industry or technology driven practice-oriented projects gain in importance. Companies contribute as sponsors or project team members in research projects. Ideally, innovation projects run for a shorter time than the length of the study. The opportunity of being engaged by a company before finishing studies is there. Alternatively students decide to start up their own companies and continue with them after finishing their academic careers.

Release of Running Attributes In innovation management the key performance indicators are transmitted from one industry or company to a completely different industry, company, and target customer group or company size. This exercise provides a lot of ideas and innovators gain knowledge about their customers' behavior and market mechanisms. This is based on one rule: "fail early and often". You need a couple of pilot projects to discover high-priority industries, determine the go-to-market approach and adapt the market strategy over time.

Institutionalize Innovation Within Organizations

Innovation Networks
Innovative networks are founded by a mix of very heterogeneous participants. They are different concerning hierarchy and business units and vary in their strategy to dissolve company limits to create bridges between politics, business development of cities, and educational, cultural and administrative facilities. Examples are *Start e.V. Heidelberg*, founded and run by the university and urban administration of Heidelberg or *Gründermagnete*, the head organization of entrepreneurship associations and institutes spanning 120 German universities.

Social Networks
Social networks such as Twitter, Facebook, Instagram, or WhatsApp allow access to new catalysts. Leveraging each and every network and combining those with individual strengths reveal chances to accelerate speed, reach, and selling into new target groups.

Integration of Innovation in Running Businesses and Customer Relationships
Idea competitions facilitate a systematic and targeted selection of innovative ideas or prototypes. Depending on the offer and usage, coaching is offered and discussions about feasibility and viability get started.

Innovation in Practice As for any other innovation area, in Smart Mobility gathering the ideal combination of existing ideas and elements is an art in itself. Not every innovation

guarantees a major success. Some of the innovations demand a disruption in mind, a change of viewpoint, or researching new target or user groups. Young bright minds and mentors help to sharpen individuals to gain a new ideas pool for Smart Mobility and new impulses.

Open up a new playground where risks are pursued and welcome is subject to a number of innovative corporate companies and the founding ethos of nearly all start-ups. The biggest chances are gained by those that break free from encrusted patterns, starting to freely move in creative spaces and confronting, in time, the viability of new ideas with experts.

Smart Mobility is an area where the reach of the offered solution and its transferability into other contexts are key success factors and the subject of viable innovations. The majority of the budget is allocated to infrastructure (Smart Products) due to the efforts in remodeling and new set-ups of traffic grids and networks, sensor technology, tagging of buildings, and fixed assets, among other "to dos".

On the other hand, ideas that cause a huge community effect, such as ride sharing apps [112] and the smart phone fix on a bike that is affordable for small budgets, stand for extremely outstanding innovations and creativity. In the latter example, innovation is co-founded in so-called innovation hubs. Innovation hubs are local facilities where the innovators work together to exchange, create, and prototype new ideas and products.

One interesting question is whether companies can produce new ideas and store them. There are indeed latent ideas in heads, drawers, and production areas, sometimes even ready as producible prototypes. In this context, a sign of corporate leadership is to free up space and time for employees and trust them by opening up funds to unlock the innovation warehouse and to test.

Successful areas of innovation include *Dreamiconvalley* [188] in Austria, global start-up networks, and the *Future Lab* of Prof. Faltin, as well as *Entrepreneurship Summits* in Berlin and Vienna.

The Employee in the Spotlight of Innovation Management How can employees contribute continuously to innovations projects? Where and how can they engage?

There is a variety of models like intrapreneurship, extrapreneurship, entrepreneurship and entrarteship. Intrapreneurship takes place within a company to motivate employees and enrich a company's innovation portfolio. Examples are #Innotakeoff @ SAP [189] or studies such as design and innovation management at the Academy for Fashion and Design Munich/Berlin [190].

Extrapreneurship means that employees are released from work to conduct the founding of a start-up externally with a guarantee of returning to the company. The advantage here is that the knowledge is kept within the organization. In case of failure, employees return to their company but piggy-backed with an enriched mindset, and new intellectual approaches and methods.

In entrepreneurships innovation projects go external. The intention is to free up innovators from traditional process tasks, common structures and hierarchies and turn the newly released energy into creativity.

Entrarteship is an interesting topic – also for the authors of this book. As artists are permanently in a creation and innovation mode, judging about success and the value generated is apparent throughout the created artwork itself. It can also be very difficult to determine and market the value of the creation. Inspiration is being provoked by diving into a completely contradictory experience world. Sources for innovation and creativity triggers might be travel, theater, sports, meditation, or positive experiences next to art. One of the key challenges for artists is the determination of the financial value of the artwork, to set the initial price, and the pricing strategy in the long run.

The Role of the Venture Capitalist The actual venture capital community is targeted mainly at the financial support of a start-up that has started with its first product and sales successes. The start-up often then needs investment for go-to-market activities and reaching new target groups. As venture capitalists turn their focus more on the second or third phase the question about seed-funding remains unanswered for entrepreneurs: Who will invest in an early start-up in this risky start phase? One key success factor is the personality of the founder(s) where master and PhD students establish contacts via their professors and mentors, often during their studies, to find trusting venture capitalists and supporters for later on.

New Projects – Find Them and Place Them in the Market How do you acquire new projects? There is no general rule that fits this goal. The majority of projects begin by an intelligent collaboration network in combination with the right communication at the right moment. New plans and projects can be compared with germ cells. They grow with the right care and treatment and evolve into mature undertakings.

From a certain maturity degree onwards, it is vitally important to staff innovation projects with the right skill sets in a receptive environment. There is no recipe and no guarantee that the scouting and staffing turn out right. To encounter the best fit, for example in the case of mentor empathy, some luck is necessary to be successful in the matchmaking exercise.

Sustainability as a Unique Selling Proposition Sustainability is a concern and a market differentiator at the same time. As a unique selling proposition (USP), a lot of start-ups use resources from emerging markets. They directly integrate social projects in their portfolio. They receive contributions from emerging countries and give back value to the people living in those countries by providing an employment infrastructure or by co-financing or facilitating (social) aid projects. In addition, there are global competitions for student entrepreneurs at universities that focus on sustainable innovations. One example is the Global Entrepreneurship Summer School [191].

Considering growth predictions, cities and urban living environments will be formed mostly in emerging and developing countries. Competence build via the above outlined aid projects and the discourse of sustainable matters driven by growth, is still missing resources. Low-income countries should be placed high on the priority list of innovation discovery.

Mobility is of specific interest and relevance because of the increasing growth rate of cities in emerging and developing countries and yet projected congestion and pollution issues.

Co-Innovation Projects Companies play an integral part in fostering inter-organizational collaboration in the field of innovation and mobility. In the past, companies focused on profit maximization and operative margins. Often innovation initiatives had a year's shelf life and focused on revenue objectives. Creative heads became rare and if apparent those employees rather quit the internal innovation trajectory and oriented externally to find an entrepreneurial ground.

How collaboration and joining forces can successfully work and which methods and techniques are appropriate have been introduced and described in Parts II and III of this book. One example of the value added by collaboration for all participating members and co-innovators is the smartPORT logistics initiative at the Port of Hamburg. This involves:

- Focusing on the connectedness of mobile and desktop users such as technicians, onsite staff, dispatchers, auditors
- Use of intelligent matchmaking and data diagnostics
- Deployment of governance frameworks in a mobile environment and diminishing risks by avoiding misinterpretations and lack of knowledge.

Build trust, show transparent values, and follow the needs of everybody involved. Efficiency in small spaces and accuracy in logistics, these two are the guiding ideas of this project and main elements of the *Smart Logistics initiative*. Another factor is the ecosystems approach. The consideration of entire business networks with 900 or more participants reveals often smaller, isolated players working on their own. Also it becomes clear who will play which role and how the different players act on the spot. With respect to personae-related process management the following examples demonstrate the multi-usage of a collaborative approach:

- For freight center, storage, and warehouse operators the aim is to increase turnover and re-use of assets through timely and adjusted throughput of goods
- For shippers and freight forwarding businesses the focus is to get access to traffic and infrastructure data, ease communication and interaction between mobile personnel and dispatchers, monitor own and third party licensed fleets, and shorten waiting times within the distribution chain and at the terminals
- For city and industry zone planners the benefits are threefold: an increased and targeted use of road networks, an optimized and efficient use of the existing space, and being able to offer add-on community services and apps.

Further examples can be found in many other exciting locations such as mid-sized cities, rural areas, airports, the city next to a port, and the logistics center or campus for future orientated learning and further education for students locally, virtually, and within companies.

Legislation and Innovation Especially in the context of Smart Mobility, autonomous driving and Mobility-as-a-Service, legislation-related questions are more and more discussed: What is possible and what should be allowed? Innovation projects show the possibilities of testing technical challenges in a test scenario without any legal risk. An ideal base for such a test scenario is the collaboration with letters of intent agreed by local business partners and public communities and municipal administration offices of cities.

On the other hand, field tests in a real regional environment or in the middle of a city allow the inhabitants, interest groups, and other interested persons, as well as associations and investors, to gain insights in technical design, user driven processes, and innovation designs. Work groups like the Roundtable of the German Ministry of Transport and Digital Infrastructure, the Project 'Z' in Austria, or selected test series of car and technology manufacturers such as Audi in US residential areas and outskirts show how innovative, real, and at the same time disruptive proof of concepts are made feasible. The conscious selection of a city, a region, or a country in recent projects demonstrates that innovations cannot be stopped or diminished, but only transferred to a more convenient and prepared location.

A New Service Paradigm

17

Barbara Flügge

Abstract

From product to service – this transformation towards service orientated offerings and placements has, for quite some time, been part of our daily lives. Be it the online shopping for groceries, the extension of an insurance policy, or the booking of a hotel that has been offered to us at the airport upon arrival. As private consumers we are the experts in service thinking. Within a second we recognize a mismatch of quality and price. Our perceived and actual behavior turns into signals for any service provider and moreover our judgment via digital feedback and rating systems decides ultimately if the provider is still in the market the next day. Similar to consumer-oriented service-driven offerings, service thinking and service-based offerings are needed for Smart Mobility.

Contents

The increasing number of car-sharing providers, the innovation empowerment of companies, and the growing formation of interest driven communities correlate with the ultimate drive for change in one part of our society.

It is not always the best *business model* or economic principle that determines for or against a succeeding service. Often business modeling has the effect of decoupling the elements and conducting backward engineering. This comes into play when business

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modelers seek to dig out the key essential elements of a service's success and its perceived economic success in the market. They might thus overlook the real emergence of a new offering and those motifs that result in a disruptive offering.

A number of the real motifs for disrupting the functioning of mobility – and most likely others, too – can be found elsewhere. It might be the experience of a traveler with a taxi service in a remote or unfamiliar location late at night where the cab driver, despite pre-booking confirmation, has not shown up. How does a traveler cope with the insecurity? Who takes care and feels responsible for ensuring that the traveler will reach his destination? Another example is linked to the experience of car-sharing users who encountered dirty taxis and no shows. Car-sharing users report back on factors such as a higher degree of tidiness compared to that from other drivers and official cabs. Bad experience reports travel just as fast as positive experiences. And the high conversion ratio of positive experiences is certainly a plus in making disruptive models succeed.

Of course the personal experience that drives the consideration of introducing a new service is not necessarily an overall common theme. Another motive for looking for new mobility services is related to increasing air pollution and noise disturbance. Who says that the public city bus cannot run in parallel with cargo bikes and cargo e-scooters for small package handling to avoid separate journeys and increased energy consumption?

Do operators and decision makers in public transport services ask themselves these kind of questions? Of course, the local context might differ and is flavored by past or unconscious misalignments and by an unwillingness to collaborate, where technical and financial means are missing or negligible, or by other local circumstances concerning public sector, citizen and business related topics.

The Mobility-as-a-Service (MaaS) we are introducing is characterized by common sense and knowledge. MaaS is one of the most promising initiatives in the field of Smart Mobility but is still a wrongly interpreted initiative, so that MaaS equates to any service that fits into mobility and movements. An interview we conducted with Hans Arby, the CEO of the start-up UbiGo Sweden [192] and presented below will shed light on MaaS. Right after the transcript of the interview, we derive the business model for MaaS.

17.1 Mobility-as-a-Service (MaaS) from UbiGo's Point of View

The interview was been conducted on February 1, 2016 and is as follows:

Interviewer: Dear Hans, many thanks for taking the time to walk us through the UbiGo initiative and talk about the Mobility-as-a-Service (MaaS) approach you take with UbiGo!

Hans Arby: "You are welcome!"

Interviewer: What are the important considerations for travelers on the road from your point of view – when choosing mobility offerings?

Hans Arby: "My perspective on mobility is not to focus on overcoming a distance from location A to location B. It is more the complete need for mobility from morning to evening, from Monday to Sunday, from January to December – this is what makes you decide to own a car or not. It is a long-term decision with respect to deciding on a car.

The car ownership, not the car use, is the key to re-think the mix of mobility offerings (bus, public transport, bike, taxi, etc.). Car ownership is one kind of 'mobility insurance' and therefore it represents flexibility and availability. When going into new kinds of mobility offerings reliability needs to be offered. Hence, you need to make very good promises so that mobility works for people on the road without owning a car."

Interviewer: How do you think that the individualized traveler profile can be made possible in offerings and through the use of technology?

Hans Arby: "The design of the services and interface makes the difference. Similar to app design the user interface needs to be compelling. We as UbiGo chose to go for a 'mobile phone subscription like' model that allows for flexible subscriptions. Barriers and thresholds need to be low. Examples of thresholds are to stop the service or modify the subscription. Mobility-as-a-Service is about gaining control over the cost and efforts.

You as a user can have different accounts – your private (household related) account, your employer's account (for business trips or benefit packages) – or stores, events and restaurants that wants to embed the trip into their offer, or expose you to ads. You could use mobility for free because you expected an advertisement service while riding a bus or a car.

Once there are fully self-driving cars, then it will be sufficient with these and the 'big' public transport (no regular taxi, rental car etc), making it very easy to be a MaaS-operator. The traveler's profile then indicates how to personalize an offering. And the personalized offering for travelers is then the entry point in winning the customers. If you have not won the customer at that point, then it would be you, the MaaS-operator, that will set the specifications for the self-driving fleet."

Interviewer: What from your point of view is the disruptive experience for drivers with autonomous driving?

Hans Arby: "One hundred years ago adjustments of speed made a driver a good driver. Some don't think that we will want to let go the last bit of control and the prestige of 'owning' the steering wheel. However take a look at how we have welcomed all steps of automation so far! Technical advancements like ABS are not about the real needs of a traveler. The real need is about enjoyment and not stress. With an UbiGo offering, travelers could enjoy driving a luxury car. That kind of car turns mobility into a hobby."

Interviewer: How do you compare autonomous driving with other evolutions?

Hans Arby: "With the technical evolution of the photograph, painting became an art. With e-books, real books will be an art and so forth. And with mobility being an 'automatic service', driving will be an art or hobby. That is being expressed for example by enjoying driving yourself in the countryside. It turns into an 'exceptional experience'."

Interviewer: Is 10 years a decent/feasible time frame to change behavior and to consume mobility as a service?

Hans Arby: "Overall, we have the early adopters and inventors type of people as early adopters of Mobility-as-a-service (MaaS). Actually, six months were enough for most of them to change behavior and continue with their new behavior. But at least 50% needed the UbiGo service to stay with it. Mobility habits are hard to change, almost as hard as changing religion.

Coverage of UbiGo is spread across generations. You can make more money as a combined mobility service provider for those user groups that have a big mobility budget.

Most important factors to make the change happen are 1) city planning – not build, but design on car usage, 2) public transport: make it easier to walk and use public transport, and 3) observe the KPI 'distance used for trips'."

Interviewer: What would you suggest to get mobility providers attracted to an online platform? Which mobility providers do you think should be chosen for the platform?

Hans Arby: "There are (at least) two different models. One that is the platform for an open market with 'all' providers present where users shop around for each trip at the current prices, in which the platform provider takes a percentage on each transaction; or our UbiGo-model where we procure everyday travel volume and re-package it for our subscribers, disconnecting what we pay for the trips from what our customers pay. This is probably the only way you can make enough money to be sustainable as a platform provider. We work with preferred suppliers first, but we will probably add other providers for On-the-go customers.

Examples are as follows:

1) Attract diverse/distinct offerings and suppliers for each of the service providers, such as one taxi, one public transport vehicle, one car sharing company, and one coach operator.
2) Then you can start negotiations if you have one of each category. Conditions and suppliers would change according to the local context.
3) Profitability comes via a transactional business model (e.g. 10 Cent).
4) It is key that the service quality is met otherwise the customers will not come back.

Innovation is not complicated but you need co-innovation, making it possible in the ecosystem to turn into a re-seller. Start with larger hubs and cities, then turn to smaller villages and embed other services like home deliveries. Suppliers could become indispensable to offer new deals."

Interviewer: Is it possible to book and pay for the whole intermodal travel segment from your point of view? What is needed to make it happen?

Hans Arby: "UbiGo plans to have one booking and payment transaction for the users. Three major cities in Sweden are currently in the pipeline and where the distinct mobility providers have been chosen.

The subscription model is a model with one bill for the use of the rental car, taxi and bus. What is being used is a situational choice. You use MaaS without knowing beforehand where to go and when. Anything on top of the subscription fee would be paid in addition.

We don't see ourselves running an operation in every city, rather supporting local operators with a platform model and the experience to run a local service. By doing that, industry standards will evolve for interfaces, etc. and also for enabling roaming functionality.

In order to turn profitable you need to have a good IT platform for settlement, setting up offerings such as business process logistics and the execution of MaaS.

Take the example of a newspaper: You can choose and select what you are reading. The platform for MaaS operations works similarly. You can skip or choose what kind of MaaS components you like to use."

Interviewer: What are your suggestions about integrating real-time data into the traveling process?

Hans Arby: "We are referring to published bus plans, public transport and location of the cars. As said before, we first focus on the economic side, enabling easy access and using existing journey planners, etc. Real-time journey data fall in when you grow by volume.

Real-time data fall in when MaaS grows by volume. Then the MaaS consumers like to check online for all necessary information. Aggregated data can perhaps be sold to traffic management operators. That is the problem: To deploy a real multi-modal, errand-based planner would cost a lot, especially since you have to mix timetable-based services over a whole travel chain, for example 'always available services' such as taxis mixed with limited access service like car-sharing."

Interviewer: To what degree should intermodal travel among mobility providers be coordinated?

Hans Arby: "A decision support system would be needed and this would turn out very costly. You do not need an intermodal travel planner, you need an advanced system. I have not seen anything like this in the market. This would mean you could check availability of rental cars and car-sharing (interdependency planning). Public transport is regular traffic, rental cars and car-sharing are not. The result of combining both turns into a very, very advanced 'travel planner'."

Interviewer: With respect to publicly subsidized services, what is the concession model that is being established with public transport?

Hans Arby: "The concession or re-seller model needs to ensure that the MaaS operator gets a fair margin for the public transport and that users, on average, pay as much as the direct public transport customers. Or the cost gets covered by advertisers, events, etc.

Public and private service provisioning need to be combined. Public transport takes care of their brand when you promise to the users a MaaS. Even though the MaaS operator takes full responsibility for providers and customers, the providers' brand and image are more apparent to mobility consumers when boarding the car.

In addition, a good market can be created if you allow integrators to include public transport offerings based on the travelers' profiles."

Interviewer: Which main challenges do you observe in deploying smart mobility successfully?

Hans Arby: "The absolutely biggest challenge is to get all the local and regional public transport authorities to open up public transport to re-sellers. And this is a policy related and political question that has to be dealt with locally.

The main challenges are to set up the initial offering and to sustain it in the market. The sophisticated travel planner will not be as important, at least not in the first years."

Interviewer: Many thanks, Hans, for your insights!

17.2 Business Modeling MaaS

In Focus: MaaS by UbiGo Schweden What is the *unique selling proposition* of MaaS offerings such as the one from UbiGo Sweden? Hans is talking about the shift from car property towards a purpose driven use of a mean of transport enablement. The perceived additional efforts in advanced planning of daily or purpose driven mobility needs play a minor role, from his point of view. The travelers pay for a portfolio of possibilities in order to consume mobility. Until now the mix of transport means in a MaaS offering is driven by empirical knowledge. The mix comprises the used mileage, the number of hours or the distance that have been covered with public transport. Another pricing determinant might be the size of the household with respect to the number of family members or the number of people that share a flat, or simply the number of people that work in one office, in one building, or in one place. It is not questioned any more whether the offering is being made by an enterprise or the neighbor around the corner that offers his car, or if it is the regional bus that is used for daily commuting or for shopping.

UbiGo Sweden's field trial that took place in Gothenburg, Sweden resulted in a great acceptance by the participating households and citizens. More than 70 households have been participating and seek to make use of the offering beyond the field trial. According to Hans Arby, a 6-month trial period is sufficient to stimulate a change of habits. Interestingly, the age of the users did not matter when it came to the decision to make use of MaaS or not.

Along with the willingness to cooperate shown by public and private mobility service providers, information technology plays a greater role than ever. To offer MaaS in a continuous, ecosystem-wide spectrum the *digital platform* is a key element. The MaaS operator asks the service provider to publish booking, payment and further sources of information and notifications. The last comprises minimum details about usage duration, mileage, and distance. UbiGo Sweden developed a procedure to offer the MaaS consumers access in the form of a digital front end, an app. The ease of use via desktop or mobile devices allows them to plan on mobility consumption before the mobility need. Analogous to Smart Ticketing, the booking and payment for MaaS should be as operable as possible.

With respect to public transport schedules and time slots, UbiGo relies in the first phase of operation on the existing plans published. The inclusion of real-time data and scheduling-on-demand of buses and tramways is currently out of scope. In case real-time dispatching is being considered, according to Hans Arby, an intermodal routing engine is required that matches predetermined operation cycles of mean of public transport with unplanned incidents and exceptions.

The Business Model for MaaS Driven by the Intelligent Transport Systems (ITS) Association MaaS customers pay for mobility per itinerary or monthly depending on mobility usage, distance, or other mobility criteria. The packaging of mobility needs results in a subscription-based model where the MaaS customer pays an amount of money per mobility package. The price for the package derives from the combination of transport means and the number of hours that have been spent on the public bus and the mileage spent in the taxi or a shared or rented car. Thus the MaaS customer gets rid

of individual bookings, payments, and tickets. Opting for a seasonal, monthly or annual ticket, the customer pays only once. In case his business or private requirements change and he requires more mobility, additional services and offerings are charged separately or the MaaS package is modified, and hence he is upgraded. The same applies with a lower demand on mobility, for example through a shift of priorities or lifestyle. Overall, the app driven operation and monitoring of the MaaS booking simplifies the validation process too.

The overall concept of subscription-based payment and service packaging derives from the telecommunications industry. MaaS follows the concept of connectivity contracting. Those offered, for example, a monthly or annual fee including a credit of x number of text messages and a maximum download size. Other connectivity contracts are based on time of usage and pre-selected geographies for roaming or download.

The business model behind MaaS leads to a new set of evaluation and calculation criteria. To argue pro-MaaS the user first takes into consideration his personal efforts in planning, booking and usage authorization, his personal expenses on one occasion, continuous ownership of the car, and his efforts on business and leisure trips. Second, he compares the identified monthly and annual efforts with the offered subscription fee for MaaS. The Finnish representative of the Intelligent Transport Systems (ITS) Association provides details of four MaaS packages (see Table 17.1) [193].

Table 17.1 Mobility-as-a-Service packages

Package	Package elements	Subscription fee
Urban commuter package	Free public transport in home city area Up to 100 kilometers free taxi Up to 500 kilometers free rental car Domestic public transport up to 1500 kilometers	€95 per month
15-minute package	Taxi pick-up within 15 minutes from call to service deployment EU wide roaming for shared taxi at a mileage costs of €0.15 Free public transport in home city area Domestic public transport up to 1500 kilometers	€135 per month
Business package for business travelers – worldwide	Taxi pick-up within 5 minutes from call to service deployment in all European Union member states Free taxi in home city Lease car and road use Taxi roaming worldwide	€800 per month
Family package	Lease car and road use Shared taxi for all family members with a 15-minute pick-up guarantee from call to service deployment Free home city transport for all family members Domestic public transport up to 2500 kilometers	€1200 per month

What are the prerequisites to succeed in the above claimed MaaS schema? Overall, any of the packages and business model metrics, such as service fulfillment in a certain time frame or local, regional and cross-country mechanisms, are subject to an *ex ante* agreement amongst stakeholders and service providers. Most importantly, the approach asks for an *ex ante* alignment amongst organizations and decision makers that have not necessarily known each other or collaborated with each other beforehand. On the operational side, the MaaS logic asks for a collaboration driven and open systems access that must not be targeted to end an organization's boundaries, a city government's or national boundaries, or an information system's boundaries. Thus, isolated operations and private business processing would not only diminish but abort any MaaS targeted attempt.

What is the consumer's viewpoint? Do MaaS offerings pay off? The following comparison of traditional mobility efforts with two of the MaaS concepts as outlined in Fig. 17.1 results in a clear "Yes"! MaaS is paying off! We conducted the comparison as follows. We compared the monthly expense of car ownership and maintenance for a business traveler with the urban mobility related efforts he needs to invest for business travel. Mobility expenses such as flights and long-distance train journeys have been excluded. It takes no more than three day trips within the home city area or abroad to pay off the 15-minute package.

As stated before, a key prerequisite is the pre-alignment and agreement of the individual mobility service providers. That effort might be arguable against the projected income per subscription fee. It might be argued that driven by volume, the business model needs to attract a high number of local and foreign travelers. So why not start with one provider

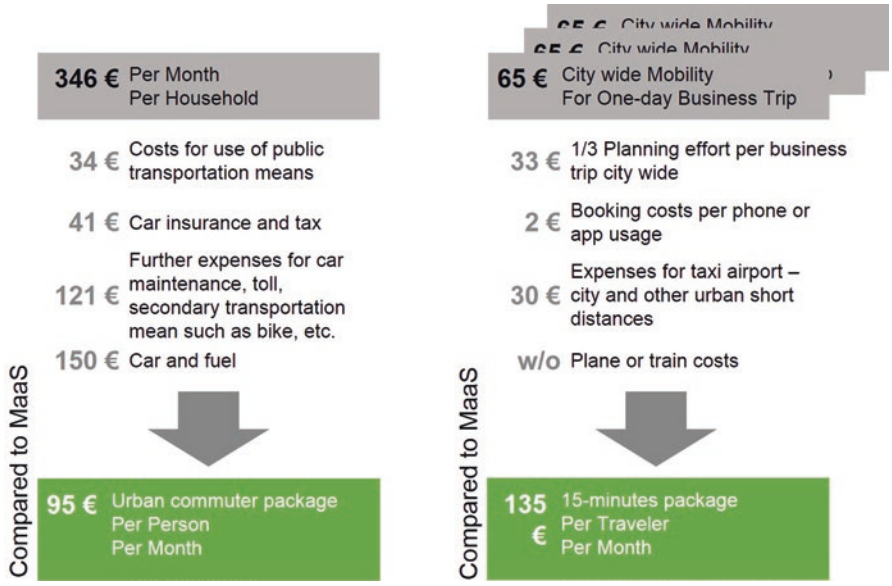

Fig. 17.1 Comparing monthly mobility efforts with the MaaS concept

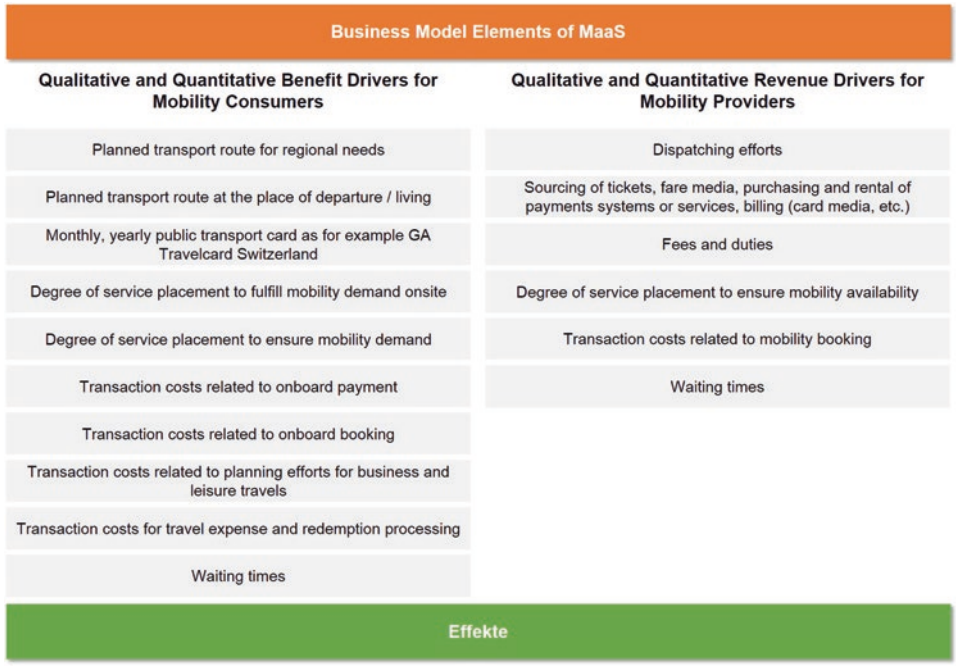

Fig. 17.2 MaaS Business Model Elements

for the local bus, one taxi, and one rental car operator! That should be enough to get the transformation going!

Which business model elements drive MaaS' economic viability? The elements that are depicted in Fig. 17.2 result in the *MaaS Business Model* Elements.

The above introduced business model elements transform into the so-called *effectiveness formula* of MaaS. The effectiveness formula reveals the impact on efficiency gains and business processing efforts for those entities that fulfill the mobility needs. For further details on the impact of the *effectiveness formula* see Fig. 17.3.

How does the service fulfillment process alter through the use of MaaS? MaaS triggers a predictive income of requested transport capacity and fosters the optimum utilization of the appointed transport means. Those that turn into a MaaS service provider, as for example the taxi operators in a highly frequented trade fair district, will be part of the MaaS package for business travelers. The reachability of mobility services accelerates through the size of the addressable consumers: all MaaS subscribers that maneuver in a certain geographical area can be reached with one single message. To best target an ecosystem's traffic sensitive areas and intersections that occur, for example, between public and private transport, MaaS operators make use of geo-fencing. Geo-fencing is the digital process of mapping the ecosystem's layout to mobility needs and then segmentizing (i.e. fencing) it. Geo-fencing is applicable to any ecosystem whether a city, a region, the border

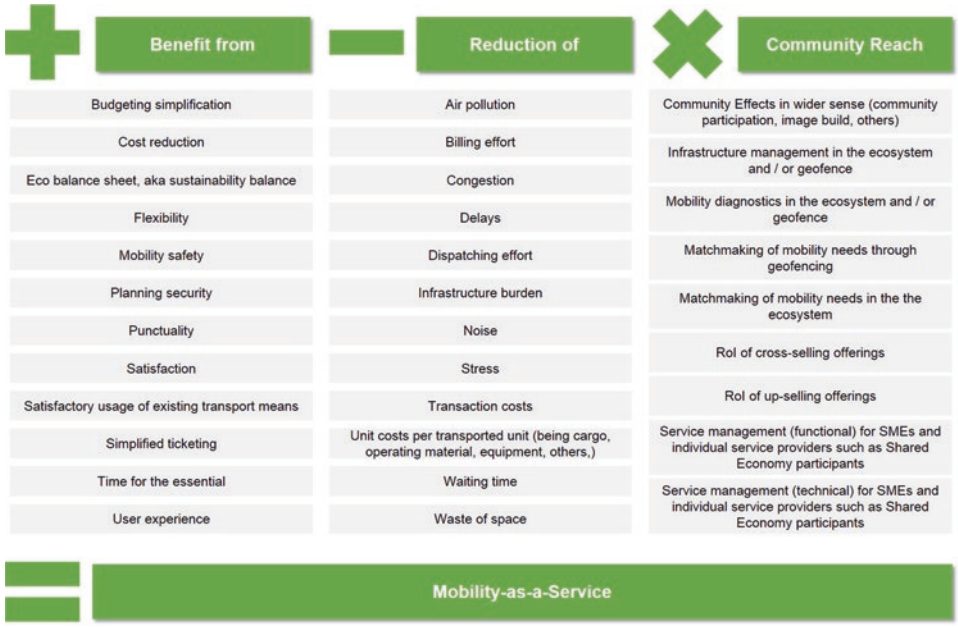

Fig. 17.3 Effectiveness formula of Mobility-as-a-Service

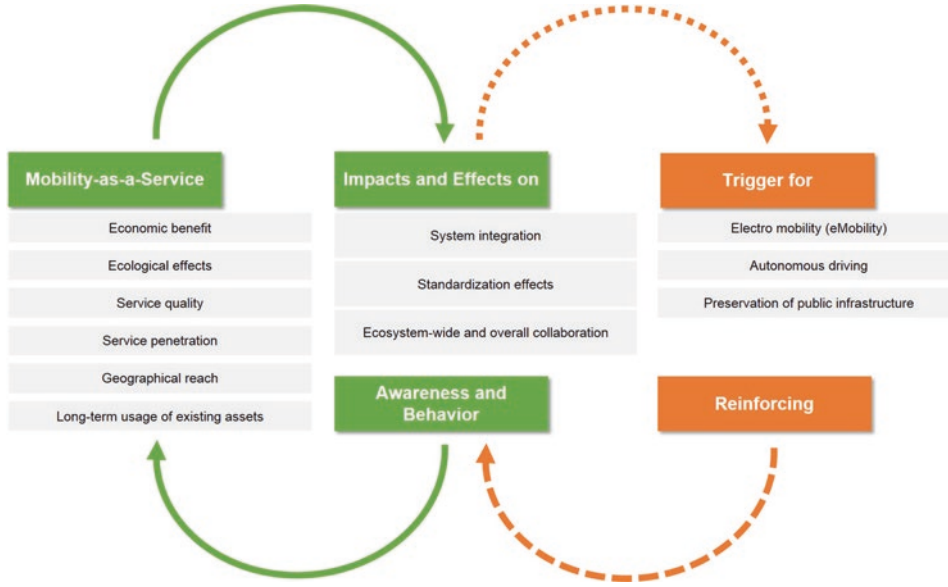

Fig. 17.4 MaaS enhancing the Circular Economy

crossing between two countries, a research campus, or a commuting area that needs to be monitored and used for demand-offer balancing.

Not only do mobility service providers benefit from MaaS. Those that offer adjacent services such as vouchers, hospitality services (up-selling), or travel packages (cross-selling) encounter a market opportunity once they have gained access to the MaaS community. Furthermore, the analysis of mobility needs and the matchmaking between demand and offer can be streamlined and better coordinated. The same is true for the mobility service providers where adjacent businesses need to align with the MaaS operator.

Establishing MaaS throughout an entire community fosters the requirements of the Circular Economy regarding safety and sustainability, as outlined in Sect. 2.8.3. The impact of MaaS is depicted in Fig. 17.4.

A Holistic View of New Concepts and Roles

18

Barbara Flügge

Abstract

Organizations and individuals are asking themselves more frequently which positions they can occupy in the context of mobility enablement and other kinds of intelligent business services. It is not necessarily the offerings of a sharing economy that serve individuals in analogy to their share in a corresponding manner. According to service thinking it takes a willingness to turn the viewpoint externally and put ourselves into the position of other users and market participants to gather opportunities and identify pitfalls. Once organizations are willing to enter this process, they are acknowledged by third parties. Unforeseen opportunities open up, too. Paired with a methodological and structured approach the use of digital services and media lead to chances not only in the observed geography, but even more so in new, yet untapped markets.

Contents

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B. Flügge (ed.), *Smart Mobility – Connecting Everyone*,
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18.1 Targeting Smart Mobility to Connect Everyone

Barbara Flügge

It is the task of industry and government leaders to orient themselves globally and derive local positioning for their own organization and environment. The task is conducted independently of an industrial assignment and is more than ever a task for government administrations, too.

The following example from the telecommunications industry illustrates the stake the industry has in the Smart Mobility movement. Telecommunications providers foster the distilling of local behavior and event triggered service usage through an analysis of patterns of their customers' connectivity streams [194]. More often we experience that distinct *business model* options are being examined that exceed the current focus on connectivity empowerment. In any of the mobility systems on a global scale, connectivity is a key asset, for example for smart lighting where a light pole turns into the Wifi hotspot and app service provisioning.

The *Internet of Services (IoS) Role model* that accounts for the successful deployment of a Smart Mobility application or any further offerings grounds in a common sense among all participants. A Smart Mobility offering resonates through a collaborative and cooperation driven attitude. Isolated offers will not withstand the long term.

In the meantime, those solution providers that dominate the market are ones that create a new service experience through *disruptive* and creative offerings through yet more aggressive market entry strategies. Following the principle of generating and expanding a community of followers, the isolated position is sought, not the collaborative one. Locations that seek and have to positively outperform the competition and that are highly dependent on local industrial and/or educational stakeholders should join forces – following an *ecosystems thinking* attitude.

The advantage of ecosystems thinking for Smart Mobility and any other similar undertakings is that it considers new roles and project initiatives for one location. The *IoS Role model* that has been presented is fostering such an approach. The operability of ecosystems thinking goes hand in hand with knowing about *ecosystems functioning*. Figure 18.1 depicts this approach based on the example of Mobility-as-a-Service (MaaS).

It is certainly a discourse among arguments that gets started: arguments about which roles and responsibilities could, might, and should be taken by enterprises and organizations in the context of safeguarding the local hub economy. Our experience has shown that entities should:

- not consider one role only (singular viewpoint)
- not settle on the present status quo,
- but rather act holistically and therefore kick off a role play with two or three further business partners and customers to determine who fills which role and what for.

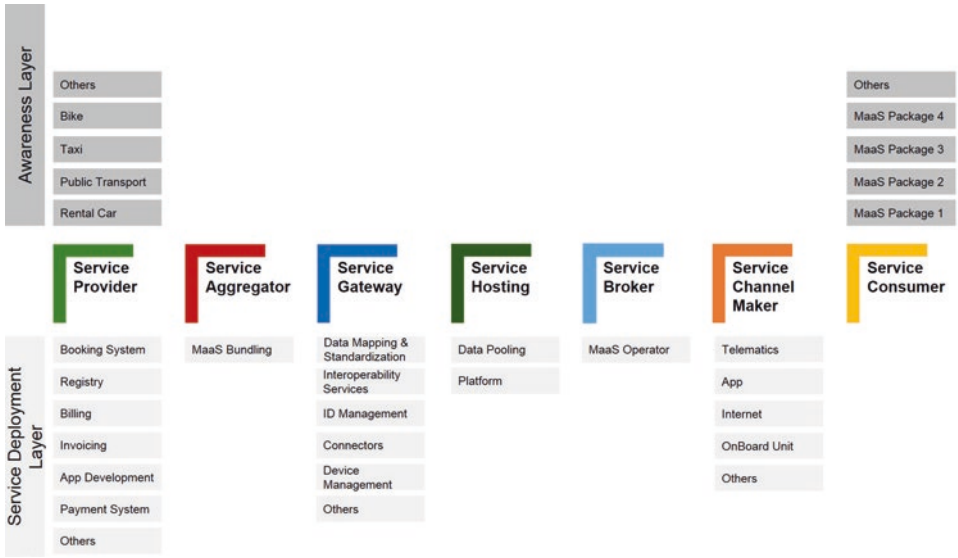

Fig. 18.1 Mobility-as-a-Service: The IoS Role model in practice

That approach is often recommended to take place in our ecosystem assessments – being a preparatory and planning element prior to a project kick-off or as part of a review cycle by which two to three instances facilitate the review of decisions and results.

Figure 18.2 illustrates the outcome of a holistic design and deployment. Here the MaaS elements are not necessarily the only feasible design elements. In fact they act as stimulus

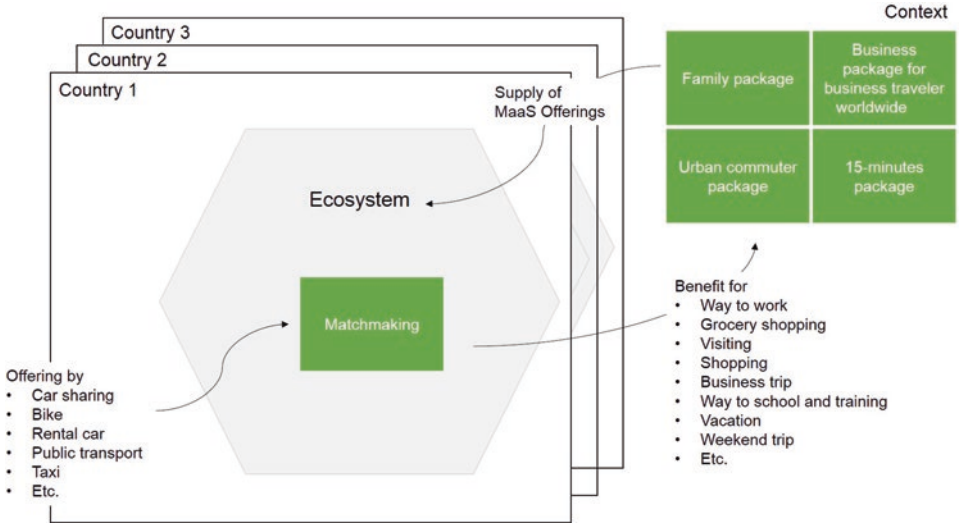

Fig. 18.2 A holistic view of new concepts and roles

and blueprint to think in further layers and connect. The interconnectedness will not stop at decision makers anyway.

With regard to organizational operational structures, innovation undertakings and Smart Mobility shape further new roles. The two key ones that dominate are the role of the project incubator and the mobility manager.

The Project Incubator The *project incubator* is the Smart Mobility guardian of distinct mobility kernels and project inceptions within an organization. He is generating a creative atmosphere and is capable of gathering colleagues and promoters with different viewpoints and opinions to seriously discuss projects and help promote the kernels properly and with utmost respect. Another core competence relates to the matchmaking of founders and mentors, idea generators and idea promoters. In this way, the project incubator works out-of-the-box by intention. He is a forward thinker, so to speak, who is capable of enriching existing mechanisms of collaboration onsite with the ideas richness of individuals, initiatives, enterprises, and research institutions. A project incubator's performance becomes successful once the results of the innovation management become presentable, replicable, and deployable.

The project incubator has an overview of all Smart Mobility related activities as outlined in the Ford Smart Mobility program. That is the only way to avoid duplication and rework, and to accelerate the disposal of ideas that have already failed in other locations or hubs of an organization. Likewise, building a network of innovations becomes easier by comparing your own with other ecosystems. Thus the efforts and acquisition of necessary skills and competences can be shared.

Next to the project management element another core competence of the project incubator is the acquisition of start-ups, entrepreneurs, and innovation departments of enterprises as well as the alignment of these distinct parties.

The Mobility Manager The *mobility manager* sets the ground for all mobility relevant requirements and their fulfillment within an ecosystem and the relevant locations. Driven by the assembly of an ideal location profile, the mobility manager is able to target private and public service offerings in a manner in which mobility is made consumable and financeable. There are ongoing initiatives, as depicted in the example of the city of Gothenburg, which aims for inclusive mobility management. The execution of holistic mobility management depends on the operators, for example, the Swiss Railway Company SBB. SBB is offering, with the GA travelcard, unlimited travel on SBB trains and most other railways. The GA travelcard is purchased on an annual basis and to date permits the use of any means of transport, including trains and buses, and even entrance to museums and public services are promoted. SBB is also offering car leasing through its business segment called Mobility Solutions.

The competency and skills profile of a mobility manager is similar to the one of a Digital City commissioner:

- Distilling the location profile and its mobility needs
- Closeness to citizens
- Leading and mediating distinct interests

- Acquiring new service providers despite distinct business interests or directions
- Projecting the economic, cultural, social, societal, and political location-specific parameters on a mobility triggered requirements profile
- Design of a mobility management roadmap
- Project management, controlling, and steering
- Capable to lead as well as mediate among distinct interest groups
- Aligning with the project incubator and other local initiatives
- Knowledge and experience exchange with mobility managers from other locations
- Continuity management from first set of ideas to the design and deployment of a mobility roadmap.

The Self-Sustaining Ecosystem To become part of an ecosystem and get engaged requires settling an agreement. Regardless of the characteristics of the entity, whether an organization, a manager, or a private household that is about to move into the city, the agreement is made between the entity and the ecosystem.

For any of the entities that reside, move to, or settle within an ecosystem, the negotiation of the agreement is often contrary to strategic, tactical, and individual (personal) objectives. An ecosystem that not only demonstrates but lives inner strength is robust. Signs of robustness are that an ecosystem survives incidents and disturbances such as risks, externally caused adversity, and intervention. Once the ecosystem is anchored in itself, it is capable of running relevant processes and businesses, independently and in a self-organized manner. Especially when it is able to re-condition operational and organizational processes, the ecosystem learns to sustain challenging conditions. Figure 18.3 describes a model to assess the adoption capabilities of an organization within an ecosystem.

When asked for the key measures in order to transform into a *self-sustaining ecosystem* the following two lists are of great help.

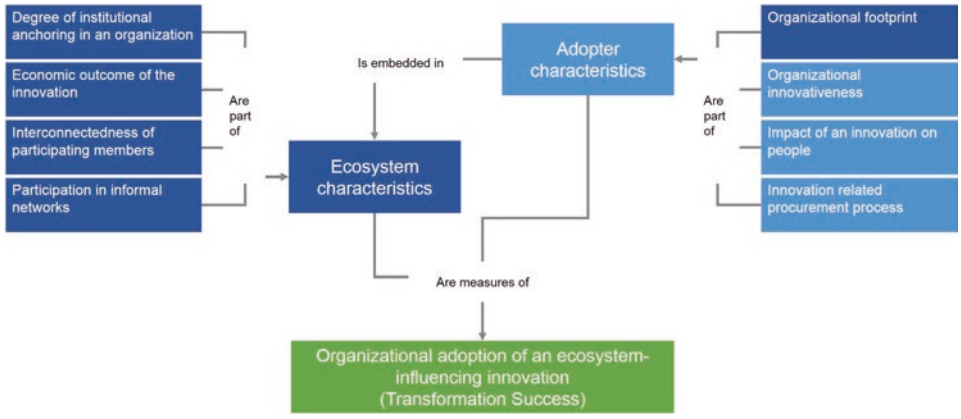

Fig. 18.3 Anchoring an ecosystem-influencing innovation within an organization

Measures to Strengthen the Regional Sturdiness

- Make use of regional business relationships to create innovation clusters
- Collaboratively create an urban and/or regional traffic security registry
- Involve telecommunications providers to outline movement patterns for the city and region with a dedicated focus on known and unknown congested areas; assess duration within the mobile network
- Identify influencing factors to evaluate traffic safety relevant data and business processing as a whole; an example of influencing factors could result from misguided, unnecessary transport and delivery orders
- Broaden your view when assessing the vehicle as an ecosystem of its own that consists of participants, users, components, monitoring engineers, infrastructure assets such as bridges, streets, and surface conditions, as well as climate conditions among other elements
- Conduct user dependent planning, budgeting, and business model simulations
- Create service bundles applying so-called data aggregators (e.g. weather – construction site – shopping peaks – events …) that minimize individual mobility needs and/or that serve drivers and pedestrians in a much more targeted manner and reduce the number of distractions.

Self-Sustaining Mobility Management

- Analyze traffic management and operations units, the public near traffic and regional/cross-regional traffic operators, private businesses
- Investigate further mobility service providers deriving from (Digital) Business Transformation
- Identify influencing factors that result from misguided, unnecessary transportation and delivery orders, ask for passenger travel needs
- Apply a governance role model and adapt the model to map the observed ecosystem; the governance model serves to identify incidents and their impact on insurance and service level agreements
- Deploy MaaS: mobility following consumption and travel behavior on demand.

The Shareholders Much has been broadcasted in the media about the *sharing economy*. Trendsetters that offer their apartment, their kitchen tools, the garden, a tiny compartment for temporary storage, the car, or their driveway. Nearly everybody likes to share and offer and get something in return. Some make a fortune and get co-financed for the recently purchased studio in Berlin; others encounter a monthly scrutiny of their maintenance expenses.

With all due respect to the innovators out there, little has been assessed or done to realize a payback of the transacted profits to the *shareholders*. Looking at *business model innovation*, the shareholder and share provider mostly get neglected. In our *IoS Role model* though the *service provider* is part of the game and the equation. Those that provide the space in the car are service providers that seek to get a substantial share of the profit. The recent incident in Cincinnati asks us to reconsider the concept of the *Sharing Economy*. In the case of Cincinnati, car owners that signed up as Uber service provider experienced a significant increase of revenue share to be handed over to Uber. Not many other

alternatives have left to mobility consumers due to the fact that taxi operators basically got pushed out of the city. A lock-in effect emerged for mobility consumers. The service providers themselves need to decide upon dropping their Uber account or staying with less revenue share than originally planned. Sharing means collaboration and cooperation as it emerged in times of poverty and economic pressure to foster local ecosystems or small and medium-sized enterprises or individuals. Looking into another than mobility industry there are well-functioning cooperatives such as Arla Foods [195].

In the case of ride-hailing in Cincinnati, predatory competition emerged; in other words, an oligopoly was introduced. An oligopoly is defined as

> … a market form in which a market or industry is dominated by a small number of sellers (oligopolists). Oligopolies can result from various forms of collusion which reduce competition and lead to higher prices for consumers. [196]

From an overall perspective and in case of sharing economy offerings, who are the sellers? Is it Uber or BlaBlaCar who brokers a service to the consumers? Are sellers the service providers who sell their services to Uber – being the space, the movement, the car?

What does it take to transform a mismatched movement into a truly ecosystem-like functioning where – as proposed in Sect. 3.3 – all interact with each other and with the environment in energetic, value, and service oriented, textual, informative, and digital cycles?

A holistic view of new concepts and roles is more than ever interlinked with the concept of owning, using, and sharing. Below we look at shareholder values and measurements. With respect to business modelling, we will be assessing, in the near future, insights and concepts to allow a share to be returned back to those that provide the service. We hope to get back to you soon on our key findings.

18.2 Prerequisites for the Digital Mobility Ecosystem

Stefanie Baumann and Michael Püschner

The digital ecosystem revolves around digital platforms that are connecting service providers and their customers as well as manufacturers and infrastructure providers. By means of a centralized and customized interface, customer can access the according products and services. The complex value creation network underlying this structure is characterized by the following features:

Data, the Core of the System Data are developing into the "raw material" with a specific value. Data are the prerequisite for any data-based business model. The concept of open data plays an important role, not least by contributing to adapting our mobility system to the requirements of a changing society (demographic change, urbanization, etc.). The privacy of personal and sensitive data is not incompatible with the use of personalized mobility services.

Information Multiplies In the ecosystem, there is a lively exchange of knowledge and experiences. The mere sharing of information will lead to new solutions and products with added value for the customer.

Universal Access Access is ensured via open, standardized interfaces. Successful interaction of companies in an ecosystem requires that everyone adheres to the same rules. This is made possible by standardized interfaces. Ecosystems are dynamic and not static. In order to function, they must be open for new companies.

Cooperating on an Equal Footing The actions and movements of companies in an ecosystem have the characteristics of an exchange between equals. Hierarchical value chains are replaced by innovative networks, in which all parties concerned benefit from so-called network effects. Traditional roles, like that of the OEM (Original Equipment Manufacturer) change; companies in the ICT (Information and Communication Technologies) sector are gaining in importance, not only in the field of connectivity.

Broader System Boundaries Digital ecosystems do not stop at national borders. In order to create a real added value, large amounts of data are necessary. The cooperation between companies will produce learning effects while also providing for an extension of Smart Mobility services. The future competition will not take place between companies but between dynamic digital ecosystems.

In Germany, the development of a digital ecosystem in the mobility sector has only just begun. A dynamic, multimodal mobility system centered on the interests of the users could entail significant social benefits. Savings on fossil fuels mitigate environmental impacts, thus increasing the quality of life, especially in urban centers. Improved warning systems enhance safety on the roads for drivers as well as cyclists and pedestrians. In particular, the many commuters could save valuable time which today is often wasted in congestions. And ultimately, the personalized request of mobility services will facilitate the targeted provision of matching offers. Examples include barrier-free accesses or pram-friendly station platforms.

18.3 About the Political Framework and the Degree of Freedom for Smart Mobility

Volker Alberts and Barbara Flügge

Besides innovative approaches and field tests, incubators and mobility managers, there is a need to determine the position of the public sector, to classify the consequences of political decisions regarding the transport sector and mobility offers of the future. Where are the chances for a re-alignment of political framework conditions? Is there a public sector influence on innovation? We are interested in the point of view of AustriaTech regarding these topics. The interview, which we conducted with Volker Alberts from AustriaTech [22], gives usinsights. Mr. Alberts works in the area of innovation and eMobility.

Interviewer: Hello Mr. Alberts, thank you for today's meeting! Let us start with getting to know a little more about Smart Mobility as an initiative.

Volker Alberts:

With a pleasure! Smart Mobility symbolizes an integrated mobility approach. On the one hand, it is about everyday routes in the field of personal mobility. On the other hand, it covers topics like freight mobility or last-mile-delivery as well, which are getting increasingly important.

You can also call the consumption of mobility via the use of, for example, flat rates Smart Mobility. It enables a comfortable and booking-free use of mobility offerings for mobility consumers. The user can easily relinquish his registration with car-sharing providers or query the billing of a driven distance.

Interviewer: Regarding the terms Smart Mobility, Intelligent Transport Systems (ITS) and Mobility-as-a-Service (MaaS), aren't they all the same? What are the differences?

Volker Alberts:

The term MaaS is viewed differently on a global level, as well as in the European Union. In the USA, MaaS is often viewed in the context of the telecommunication sector.

Many initiatives in Europe have partially implemented MaaS, for example via "integrated transport systems". Today's offerings are, however, missing transparency in the area of use rates and ticketing for the purpose of a service-oriented payment and proper deduction. Even in Austria, the term Mobility-as-a-Service is viewed as a collective term for innovative mobility services, like car- or bike-sharing. However, MaaS could be seen as the next evolutionary step for ITS.

From my point of view there is a strong analogy between MaaS and cell phone contracts. The example of the retail business Hofer Austria, which is basically foreign to the mobile communications sector but nowadays offers cell phone contracts, shows that it can be one of the mobility providers of the future. This view can also be broadened via different points of view: the dating platform Tinder, Google, and other service providers can be potential mobility providers. The consumer is given the opportunity of connecting his personal interests and expectations to the need for mobility and obtaining a common supply.

Interviewer: How is the status of the political anchoring of MaaS?

Volker Alberts:

Currently there is no concrete ambition to deal with MaaS in the field of transport politics. This means in reverse that without a political ambition, MaaS only reaches a small target audience. These are mostly Early Adopters. Because of the missing political objective target, political decision makers and economic groups of interest, who are important especially for this collaboration-intensive topic, are only partly to be energized.

Interviewer: There are very specific MaaS examples nowadays, like maas.fi [197], UbiGo [117] from Sweden and Smile [198]. Why are the pioneers coming just from the private sector?

Volker Alberts:

In initiatives like Smile, the public sector is clearly in on it. To be successful, projects must not be drowned by inertia. Political framework conditions are inconclusively for the creation of innovation. Innovation outpaces transport politics and administrative barriers in many areas. Revisions of political aims and legal framework conditions are missing in many areas. Legal framework conditions are – unfortunately – aligned to the interests of just a few stakeholders.

Interviewer: Where are the real barriers between political and economic oriented solutions lying?

Volker Alberts:

The supra-national transport-political agenda is defined in the English White Paper on transport [199]. Missions for each state and city derive from this White Paper.

Car-sharing, for example, is not anchored in a transport-political context. Most car-sharing initiatives are economically oriented. The geographical supply of car-sharing companies is determined by operating area and strongly limits citizens in the use of the service.

If there are only economic-oriented decisions made, the operation of a car-sharing system in more peripheral districts of a city makes little sense for the company, regardless of a lack of penetration and a costly logistics distribution.

These days public transport is subsidized. It is supposed to be accessible to anybody. This supply thus exhibits a pay-out capability. There has to be a change in the financing of the public transport sector. For example, if the public transport operator advertises for car-sharing, is this also capable of being subsidized? If car-sharing is subsidized for rural areas, this would have a bigger societal benefit. There would also be a higher occupancy rate expected – for the new car-sharing initiatives as well as for the public transport system.

Interviewer: What are the target audiences and entities within the scope of the public mandate? Does this affect the alignment of the supply?

Volker Alberts:

The target audience for public transport is often viewed from an historic perspective. Often new target audiences are not used or included in the projects.

The breach of old though patterns needs openness and creativity. If they are non-existent on the public sector side and "mature" mobility suppliers, they will be outdated by innovations from start-ups and entrepreneurs. The latter put themselves in the customers' place and examine the individual-related needs. Living Labs and field tests are usual constructs which provide a realistic project approach and involve users, namely from the development up to the testing and implementation of the innovation.

Another open question is what role can be taken by an organisation in the future. The risk for the public sector of missing the moment to use external innovation and transfer it into the political agenda is big. But a few examples, like in the Hanseatic City of Bremen, show that it can happen otherwise. In the case of Bremen [200] a recurring tender for a car-sharing system occurs. The public sector thus puts the order for covering mobility-needs of citizens strategically at eye level.

Interviewer: What is needed to progress Smart Mobility?

Volker Alberts:

New framework conditions and new ways of working together will be important for domains like 1) Traffic management, 2) Sharing Mobility, 3) Connectivity (Cooperative Intelligent Transport Systems (C-ITS), and 4) automated driving.

Area-wide there is a need for:

a) a definition of the transport-political objective target and thereby a strategy at federal and local level, also the definition of goals for and contributions by cities
b) the willingness of the public sector to cooperate with public and private providers of infrastructure and services

c) the design of operator models
d) a data exchange and data harmonization
e) assistance for business rookies to develop services
f) the establishment of Living Labs
g) the positioning and utilization of existing expertise through knowledge exchange
h) the building of awareness for the potential of Coopetition (Cooperation-Competition) instead of competitiveness, as well as
i) the transfer of decision making ability to the municipalities and support of the design capability.

Interviewer: Which focus points are important for the future?

Volker Alberts:

Aspects of transformation like digitization and automation have to be used, to generate a new framework for our transport system.

In the end it is important to not only look at new and additional developments, but also the clarification of things we will not do in the future – what we do today is decisive!

Regarding role models and digitization tasks have to be scrutinized. If the Big Data Scientist together with the digital system overtakes planning and accomplishes planning tasks in a fraction of the current deployed time and qualified employees required, the question regarding competences and jobs for the future emerges. This leaves room for decision-relevant task areas and the focus on highly complex processes. This demands (further) education aligned to the future.

Capacities regarding infrastructure also have to be questioned. Is there still a need for parking garages, is there actually a need for a fleet expansion? Through intelligent disposition and automated driving, vehicle savings of up to 90% in urban areas are possible. However this is only feasible in association with public transport as the backbone and an intermodal power of disposition. The latter is shown by a study using the example of the city of Lisbon!

An isolated consideration along the former division of roles does not make sense. The inclusion of infrastructure, vehicles, data, and new services for a sustainable mobility-ecosystem and therefore also Mobility-as-a-Service is needed.

Interviewer: What a great final review. Thank you very much Mr. Alberts for the interview!

Volker Alberts:

You are welcome!

Organizational Transformation Maturity

19

Heinrich Pfriemer

Abstract

One of the key prerequisites to get started with Smart Mobility is to be clear about skills and competences. The identification of transformation maturity expects firstly to determine relevant external and internal dimensions. Secondly, the competence dimensions are checked against the real-time situation. Once the maturity check is done, the mapping of expectations from perceived to real triggers is ideally a continuous flow of interaction among the participating parties.

Contents

19.1 Conducting Maturity Assessments Based on BIM

A maturity analysis provides insight of the capability level of an organization in executing strategies, methods, and processes. That assessment shows the current grade of institutionalization of capabilities, as the higher the capability level, the easier it becomes for any organization to successfully use and implement strategies, processes, and methods. Such an analysis serves as a snapshot of capabilities and would be completely in vain if it does

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not serve as the foundation for the next steps, which can be derived from the existing need for immediate actions.

Such a maturity analysis is normally conducted on the basis of a specific maturity assessment model. Already at first glance, this is sound foundation in the area of smart mobility is provided by the Building Blocks of Intelligent Mobility (BIM). These building blocks unite the individual actors of mobility with all possible business models and areas of action of smart mobility.

To assess the maturity two axes have to be considered: the subject matter or process areas and the proficiencies or capability levels. The latter will be detailed further during this chapter.

A recommended version of the maturity analysis model during a MaaS project applies the BIM as depicted in Fig. 19.1.

That example illustrates the possessed capabilities, like access to actors, stakeholders, scenario deployment maturity, and executable business models. The standard visualization form is the so-called *heatmap*. The color coding provides all stakeholders with the same overview of known strengths and the detection of neglected or undisclosed weaknesses or blind spots. A heatmap is an easy-to-assess decision making visualization. As shown in Fig. 19.2, the general transformation capability of any organization is independent of a specific application area such as Smart Mobility.

Fig. 19.1 Initial assessment based on BIM

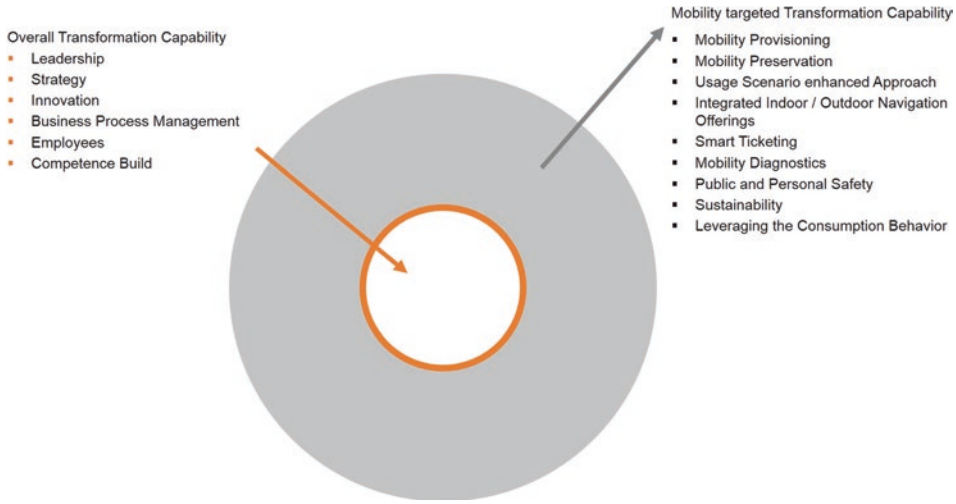

Fig. 19.2 Transformation capability of an organization

The Maturity Assessment Dimensions The measurement of transformation maturity levels serves as the initial situation assessment. As shown in the example of the building blocks above, mobility related dimensions are highlighted (see Chap. 13). The fundamental transformation capabilities of an ecosystem and their contributions to the maturity assessment of an ecosystem are now explained further. The following dimensions are only descriptive and do not claim completeness. They rather should serve as the basis for own-enhanced building blocks within the framework of such a maturity model.

Leadership

Each and every start-up, every cooperative venture, or even the formation of a new network leadership is required and key. Leadership here does not mean micro-management or order tactics. Leadership's first and most relevant task is to guide eco-systems and leadership to success. That comprises a wide innovation potential and the subsequent materialization of smart mobility. It is executed through structured organization-wide strategies under clear innovation management and hand-over to implementation projects.

A further very important leadership task it is to guarantee via executive sponsorship the creation of a compelling need for change and the formation of the "will" to execute such mobility projects. These two facts are mainly deciding whether any transformation is for better or worse. Timely, in-best-case, pro-active decision making and ensuring sustainment of the necessary discipline (when implementing innovations) are further key leadership tasks.

Strategy

The check for the pure existence of a strategy is an important dimension in each and every maturity model. Additionally, the execution and implementation strategy of an

organization is also assessed. Therefore a strategy should be rolled out to the entire organization or network, supported by the leadership, and should be made transparent as far as possible for each and every member. A simple tool, like an "action plan" can ensure that, because only then strategic targets are translated and are accessible for employees, for example. Not many will have access to or read the new strategy papers.

A cross-sectional area, like mobility, demands such a common and mutually shared and agreed understanding. A profound understanding helps each and every stakeholder to act jointly, but also to re-imagine Business Models and ways of interaction.

It is recommended, when several "players" have to work as one network, to invest at an early stage to compare their existing strategies, which will avoid potential conflicts later. This, of course, is pretty common sense, but is quite often forgotten.

Many organizations are currently appointing a Chief Digital Officer (CDO), with the clear mandate to roll out such a digital strategy into the organization and to ensure strategy, supervision, and support. New York City first CDO, Rachel Haot, got a direct mandate from the Bloomberg administration for her execution of a digital roadmap for NYC [201].

The risk of neglecting or underestimating dealing with new ways of strategy, business model focus, and business processes re-imagination is very high. Latest studies show that, within the next 10 years, 40% of all S&P companies will have ceased to exist [202].

Innovation

It is a given that organizations realizing the strategic relevance of innovation for further growth, profit, and competiveness, are stronger at differentiating themselves from their competition. In the context of a maturity assessment, the existence and use of innovation methods and processes are examined, as is the capability to roll out innovation via prototypes and incubators to organizations.

Following Don Tapscott's approaches, the digital economy offers the potential to re-imagine existing paradigms. A kind of best practice approach for many cities, like the City of Amsterdam, is to develop incubators themselves.

For example, Smart City apps are being developed in the Amsterdam Arena Innovation Center [203] with a clear focus on mobility and a real life city in which to run field tests.

The dominant corporate culture plays an enormous role in the successful implementation of innovations. Maturity assessments also give an indication as to whether the current culture allows innovations or they are blocked by the internal corporate immune system. Knowledge of these soft factors, which can become hard show-stoppers, is helpful in determining the right innovation approach.

Business Process Management

A maturity assessment with regard to business process management might sound initially trivial, but not many organizations are really good at business process management. However, gaining a certain level of expertise in that domain provides organizations with a new kind of organizational capability, ensuring a close and continuous business and IT alignment, which provides the potential for an increased and iterative business process

improvement. Therefore organizations with highest scores are furnished with a huge strategic agility, which allows them, if necessary, to refocus swiftly. Taking that into account, they can swiftly roll out new or improved business processes and by doing so implement innovations rapidly. A further positive effect on employees and their qualifications results in the fact that organizations with high business process management maturity are aiming to automate tasks with high transactional volumes and free up their employees for key tasks.

Employees and Competence Building

The digital economy is mainly existing because of knowledge workers. They are the main driver for the earlier mentioned dimension strategy and innovation. Employees of mobility providers are mobility customers themselves and therefore should be, of course, part of the innovation process. Their own experience will lead to worthwhile insights, especially in the user experience. Next to the embracement of employees when posing innovation questions, it is necessary to understand that a continuous learning of methods and techniques is a key criterion in a maturity assessment. Only a pool of 'enabled' employees allows scalability and the roll out of several projects.

Maturity Dimension	Stage 0	Stage 1	Stage 2	Stage 3
Scenario	Little experience	Conceptual	Prototype	Live
Indoor/Outdoor Navigation	Location based maps available	Data for indoor and outdoor navigation exist, but are not yet integrated	Integration takes place in case of events and selected locations	In- and Outdoor Navigation covering entire mobility chain end-to-end (End-to-End Mobility, E2E)
Smart Ticketing	Traditional ticket procurement, sales, and issue processes	Service design and user based service management	Intermodal ticketing and payment	MaaS
Mobility Diagnostics	No diagnostics or assessments of mobility related benchmarks and / or services take place	Mobility provider specific data capturing Transportation mean related analytics	Ecosystem-wide Data capture and analytics	Smart Traffic and Service Diagnostics to foster incident and predictive control
Mobility Provisioning	Regulation based maintenance	Siloed insights and investment in selected mobility areas	Partially regional focus and investment Creation of an infrastructure registry	Ecosystem-wide mobility provisioning and sourcing Digital infrastructure registry
Mobility Preservation	Traditional role model and separation of public and private service provisioning	Smart Mobility Role Model gets established intra-organizational	Smart Mobility Role Model gets established inter-organizational	Comprehensive budgeting and asset maintenance in accordance of a ecosystem-wide mobility management
Security	Regulation based traffic safety, security and evacuation measures	Individual studies with respect to a holistic mobility concept and incident triggered effects	Regional safety concept targeting studied transportation mean and personae	Intermodal trigger traffic safety for all personae in the ecosystem
Sustainability	Punctual assessment of sustainability criteria Regulation based sustainability assessments	Individual studies concerning the influence of intermodal offerings First charging stations for eMobility	Regional sustainability concept Intermodal pilots	Circular Economy based sustainability and infrastructure safeguarding in the ecosystem
Consumption Behavior	Organization triggered assessment	Product triggered assessment	Ecosystem wide assessment	Consumers as designers of the ecosystem
Leadership	Little interest in Smart Mobility	Individual initiatives are being considered	Organization specific mobility initiative(s)	Smart Mobility is a top-level matter
Strategy	Transport strategy exist	Mobility strategy exists, but has not been rolled out yet	Strategy has been rolled out with the organization	Ecosystem-wide strategy
Innovation	Maintain the Status Quo	Local, yet random innovation without organizational support, backbone or initiative	Established innovation processes and methods within an organization	Continuous innovation management for the entire ecosystem
Business Process Management	Processes are being defined on lowest level of interaction	Scenario triggered definition of processes	Organization wide business process management	Continuous process management
Employees and Competence Build	Uncoordinated individuals (departments, employees, initiatives, etc.)	Scenario triggered employee enablement	Organization wide employee enablement	Employees as inventors and actors

Fig. 19.3 Transformation maturity – criteria catalogue

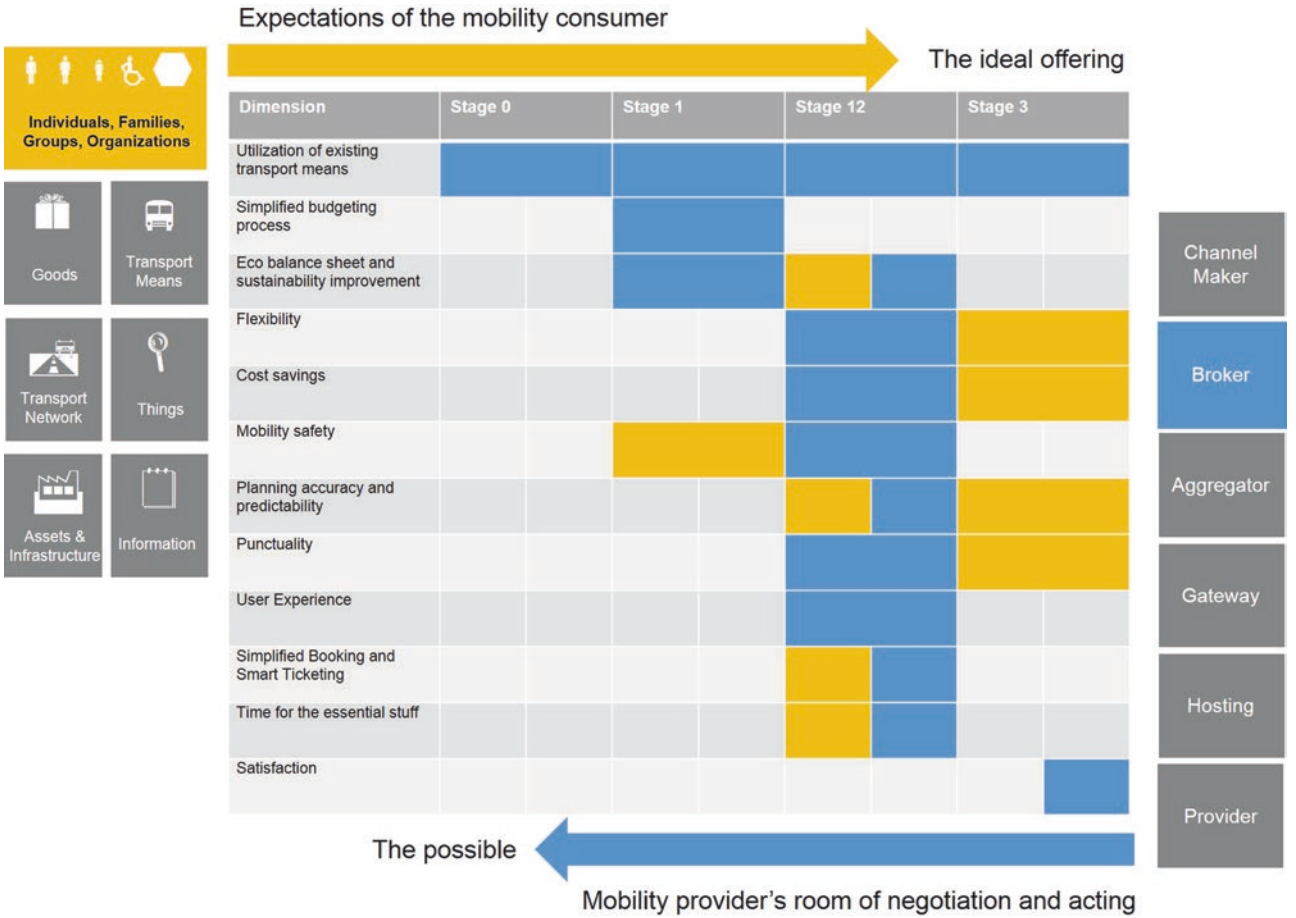

Fig. 19.4 Anticipations in transformation maturity

Those internal dimension aspects provide precious insights of the transformation maturity of such an organization. That approach is also valid for entire ecosystems. Similarly, it is possible to compare the maturity of different departments of an organization.

19.2 Proficiencies of Digital Maturity

The definition of proficiencies of a digital maturity assessment has to be reasonable and logical. From a practical point of view, five levels of proficiency are proven to be suitable. During the design of such a maturity assessment model there should be a focus on a clear understanding and definition of each and every indicator of every dimension.

To achieve a better understanding, Fig. 19.3 provides an example for a potential combination of dimensions and proficiencies. It illustrates a pragmatic design approach for maturity assessments. It clearly has no intention of being complete and should only serve as a framework for your own mobility projects regarding dimensions and proficiencies.

Our project experience shows that it is useful, to evaluate your own project first using such a generic assessment tool. Afterwards, a stakeholder specific proficiency development is triggered, and by doing you need to compare the *effectiveness formula* with the estimated and real outcome. That could look like the one outlined in Fig. 19.4.

Such a visualization not only helps in providing a better understanding of the expectations of service consumers regarding maturity levels but also prepares potential negotiations and trade-offs. It further eases your own course of action, to derive your own need for action, and for the sake of continuous improvement to hand over to start a proper implementation.

Good to know! Please do not stop after the assessment. In most cases, direct improvement steps will be necessary immediately. As a bare minimum those should be bundle into a report and be presented in an executive summary to the CEO or CDO for further discussion.

Concluding Remarks

Barbara Flügge

With this book we started an exciting and multi-faceted journey from socio-ecological to socio-economic aspects of mobility. It was our aim to open up the technological and societal impact of capabilities that emerged through information technology, human creativity, and ecosystem needs in the field of mobility.

The charisma of mobility is doubtless – as it reaches out to everyone and everything through the trajectory of digitization. Our elaborations took place in a descriptive and understandable manner for everyone involved. The Smart Mobility Procedure Model serves as a dotted line and outlines the key activities driven by interest and entry point. The Building Blocks of Intelligent Mobility (BIM) serve as blueprint to foster the identification and design of Smart Mobility relevant elements from a multi-user perspective: strategic, project, or innovation triggered viewpoints are respected as well as start-up or innovator's requests. By applying the Smart Mobility Ecosystem and the Transformation Maturity Assessment ecosystem participants will find a hand to identify the preferred position. Which roles should be occupied, which ones to quit and how to connect the ones that are yet unknown to the others?

As visionary as it is, Smart Mobility is feasible. We as authors are aware of the multi-disciplinary tasks behind Smart Mobility. The public sector and enterprises are confronted with infrastructure and investment decisions that steer today the maneuverable mass of tomorrow. Two key prerequisites are apparent for success the intelligent and creative use of information and communications technologies as well as the conscious alignment of organizational and project-based matters of the respective ecosystem.

By taking Smart Mobility as a competitive advantage that serves your locations and hubs it will trigger a mindset to make all of us aware of further needs. Our society is

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characterized by technological advancements and innovation is highly interconnected with its capacity to anchor technology and innovation in the environment itself. It is the mandate of managers and political leaders to understand the capacity that needs to be built, enhance it, or mitigate it in accordance with an ecosystem's condition framework. Digitization could act here as a decoder of complex cause-and-effect lifecycles among individuals, organisms, organizational constructs, assets, environmental factors, and infrastructure!

We would like to thank our project and business partners and colleagues that encouraged us to make the book happen! We can be contacted throughout our digital profiles at LinkedIn or through the website featuring the work: http://www.digitizingecosystems.com.

Barbara Flügge on behalf of the authors.

St. Gallen, 2017

Glossary and Acronyms

3G Third generation of wireless mobile telecommunications. 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV (source: https://en.wikipedia.org/wiki/3G)

5G Fifth generation mobile networks or fifth generation wireless systems

Acatech National Academy of Science and Engineering

AFIMB Agence Française pour l'Information Multimodale et la Billettique

APNR Automatic Number Plate Reading

AR Augmented Reality

ARTS Advanced Rural Transportation Systems

Autonomous driving Synonym describing the final stage of automated driving by self-driving vehicles

BIM Building Blocks of Intelligent Mobility

Business network One form of ecosystems functioning where the focus on is on business, economic, and political activities involving organizations from public and private entities and their employees

BYOD Bring Your Own Device

CAD Computer Aided Design

Cell of Origin Used to determine a geo position

CIID Copenhagen Institute of Interaction

CLECAT European Association for Forwarding, Transport, Logistics and Customs Services

CNA Calypso Network Association

CPS Cyber Physical Systems

DDK Data Development Kit

Digital Concierge Sixth sense-like application that operates through a number of algorithms and data status monitoring and keeps an autonomous, unsolicited interaction with the user

Digital Mobility Front Office All that are in charge of enabling and fostering digital consumption and service expansion in exchange with the customer/mobility consumer

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Digital moment The moment in which the service consumer expresses his instantly, hence immediately perceived"okay" that the chosen service provider met his expectations and was the right choice

E2E mobility End-to-End mobility

Ecosystems resourcing Denotes the process of equipping the habitat with life essential, operations relevant, and functional resources

Ecosystems thinking A collaborative and cooperation driven attitude of all participants that are part of an ecosystem

eMobility Electronic mobility

EMVCo Consortium formed by Europay, Mastercard, and Visa

Entrapreneurship Process of designing, launching, and running a new business, which typically begins as a small business

Entrarteship Innovation in the field of art and/or design, coupled with the process of designing, launching, and running a new business, which typically begins as a small business

EPA United States Environmental Protection Agency

Galileo European global satellite navigation system

GDS Global Distribution Systems

GLONAS Globalnaja nawigazionnaja sputnikowaja sistema, English: Russian Global Satellite Navigation System

GPS Global Positioning System

GSM Global System for Mobile Communications

HMI Human Machine Interaction

ICT Information and Communications Technology

IFM Interoperable Fare Media

IoS Internet of Services

IoT Internet of Things

IT Information Technology

ITF International Transport Forum

ITS Intelligent Transport Systems, in some references synonymously referred to as Intelligent Traffic Systems

ITSO Integrated Smart Card Organization

KPI Key Performance Indicator

LCC London Congestion Charging

LPI Logistics Performance Index

LTE Long Term Evolution

M2M Machine-to-Machine Communication

MaaS Mobility-as-a-service; MaaS puts users at the core of transport services, offering them tailor-made mobility solutions based on their individual needs and easy access to the most appropriate transport mode or service being offered as a bundle of flexible travel service options for end users

Mobility as a service Mobility as a service puts users at the core of transport services, offering them tailor-made mobility solutions based on their individual needs and easy access to the most appropriate transport mode or service being offered as a bundle of flexible travel service options for end users

Mobility Back Office All that are in charge of physical, infrastructure, and space related, structural, political, and digital mobility-related tasks
NaM New autoMobility, an initiative from acatech
NFC Near Field Communication
OEM Original Equipment Manufacturer
OTA Online Travel Agent
Persona Archetype of a user that comprises alike or similar behaviors of consumers
Physical Mobility Front Office All personae that we encounter along our travels and that ensure the trip's processing and completion
POS Point of Sale
Re-utilization One element of the Cradle-to-Cradle principles
RFID Radio Frequency Identification
RoI Return on Investment
RSS Received Signal Strength
S&P Standard & Poor's (S&P) is an international active credit-rating agency that issues stock exchange indices
SDK Software Development Kit
Self-sustaining ecosystems Self-efficient and effective, independent ecosystems that are capable of surviving
Sentinel Sensing needs (general)
Service Dialogue Process A deep dive and multi-layered diagnosis of the dialogue among service consumers and enablers. The Service Dialogue Process is applicable also to intra-organizational and inter-organizational interactions
Servitization Service-based offerings
Smart Mobility Synonym for Intelligent Mobility and Mobility 4.0
Smart Mobility Ecosystem Complex of roles, services, and linkages of all design elements that take part in the mobility lifecycle
SMEs Small and medium-sized enterprises
Strategy Mapping Strategic enterprise analysis approach based on Kaplan and Norton
SUMP Sustainable Urban Mobility Plan
System-level integration of transport modes Intermodal traffic management for passenger transport
Tagging Characteristic or core element of a persona, service or product that is captured in a digital format and used for linkages with texts, services, products, or other characteristics
TEU Twenty-foot Equivalent Unit
Technical feasibility One of the design thinking elements
Ties Interactions (in ecosystems)
TOA Time of Arrival
UMTS Universal Mobile Telecommunications Systems
Usage scenario Describes in detail how the technologies featuring in the target scenario can be used to good effect in different contexts of users' daily lives; prerequisite to issue field trials and proof of concepts

Use case Synonym for usage scenario; term originally evolved from the act of documenting software requirements in the Unified Modeling Language

USP Unique Selling Proposition

UX User experience

VdV German association of transport companies (German: Verband Deutscher Verkehrsunternehmen)

Viability One of the design thinking elements

Weißbuch White paper series issued by the European Union; the so-called White Paper Traffic was issued in 2011 (http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm)

WTTC World Travel and Tourism Council

Zukunftsatlas Future Map, a tool that is being designed and offered by Prognos Germany that compares urbanizations and regions along smart city related benchmarks

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