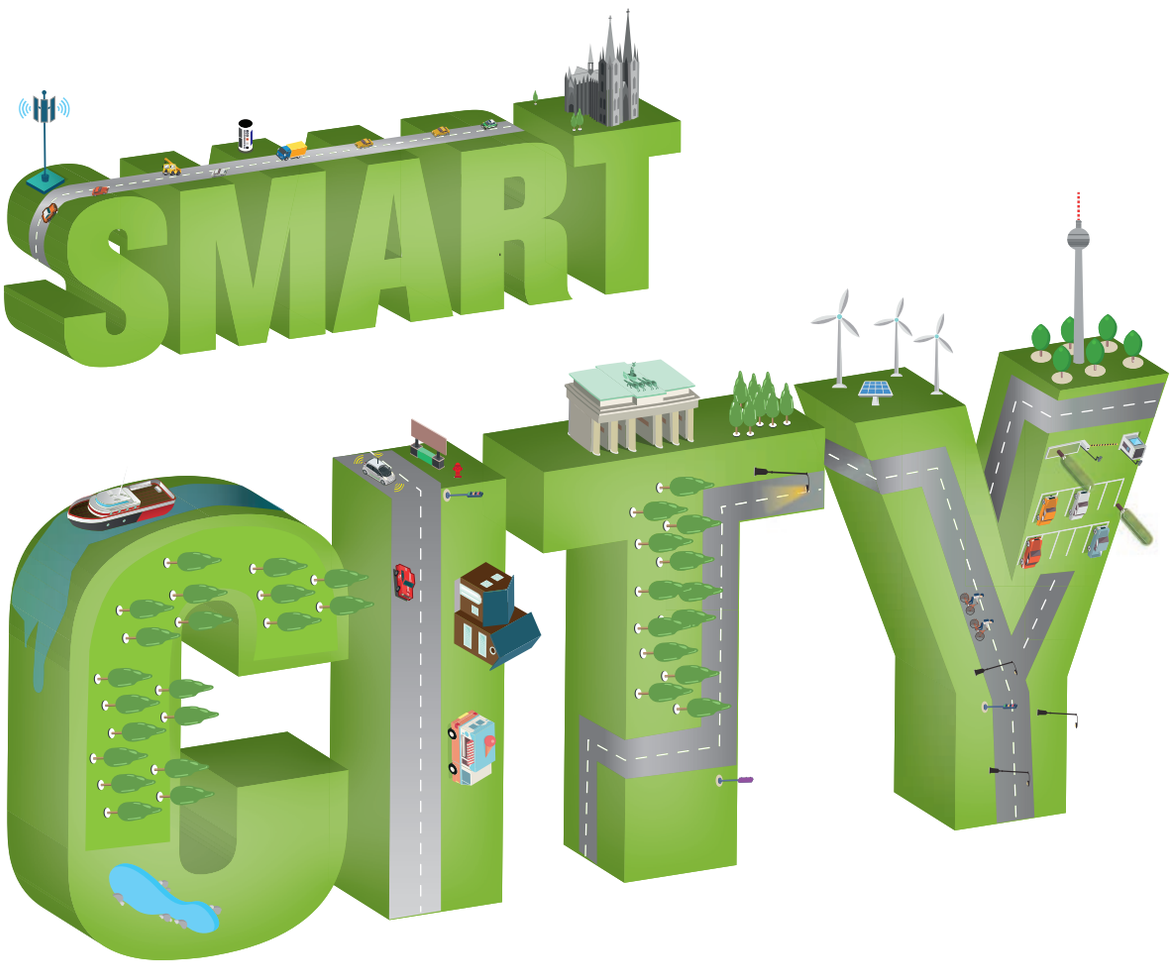
The German Smart City Market 2017 - 2022.

Facts and Figures



Arthur D Little

eco
ASSOCIATION OF THE INTERNET INDUSTRY

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Preface

The “smart city ecosystem” is complex and involves a multitude of participants with different interests and competencies that need to cooperate to be successful. As a result, both companies and cities must follow a clear strategy in order to be successful in this environment. As a strongly growing area, products and services related to the “Internet of Things” in an urban context will gain heavily in importance in Germany as well as globally in the coming years. Growing urbanization poses increasing challenges for cities, which can be most efficiently solved using “smart business models”.

As a globally active consultancy in the area of the smart city, Arthur D. Little therefore helps cities to shape new ecosystems, bring together partners, and make appropriate solutions usable for their citizens. In addition to this, companies from widely disparate industries and technology areas are positioning themselves along the smart city value chain, in order to find their place.

Our study “The German Smart City Market 2017–2022. Facts and Figures” therefore has the objective of clarifying concepts and segments, as well as demonstrating the opportunities for companies and cities in the smart city market. Together with eco – Association of the Internet Industry, we have made it our goal to resolve the complexity of the smart city ecosystem and to present the relationship in an understandable manner. We also provide institutions and companies – for the first time – with concrete figures on the market and competition in Germany. These have been derived out of a wide range of expert interviews and quantitative market modeling, and have been validated by specialists.

We hope that this study enables the reader to better understand the creative scope and possibilities in the smart city market in general and in Germany in particular. The study should motivate entrepreneurs and city decision-makers to commit to success-critical cooperative ventures, in order to get a permanent foothold in the market environment with the help of appropriate partners.

We wish you enjoyable reading and interesting insights and warmly invite you to give us your comments and feedback.

Yours,
Lars Riegel
Principal
Arthur D. Little GmbH

The “Smart City” offers companies from a wide variety of sectors enormous growth potential. This is one of the central findings of our study, “The German Smart City Market 2017–2022. Facts and Figures”, carried out jointly with Arthur D. Little. We estimate an annual growth of over 16 percent for the market, and a volume that by 2022 may well have reached 43.8 billion Euro.

As CEO of the Association of the Internet Industry, I am of course happy to hear such forecasts. Although the smart city is a vision whose realization is dependent on the commitment of all sectors, the Internet is the foundation – and that is what our sector provides.

Without the Internet, there can be no smart city – once again, it can be seen that the Internet industry has long since outgrown its status as a niche industry. The Internet is a fundamental enabling technology for all other sectors. Often we do not notice how important our enabling technologies are until they do not work as expected. In the smart city, this is no different. Given that many changes are taking place behind the scenes, we as normal citizens may at first not even be aware of some improvements in processes.

However, in one area we feel the impact directly – in public transport. Perhaps this – alongside current topics like our CO2 emissions, the diesel scandal and the alternative energy revolution – is also a reason why we, when we talk about the smart city, most often speak about mobility.

In traffic, when nothing moves, it quickly gets very emotional. No one likes sitting in a traffic jam, and it gets particularly unpleasant and stressful when we feel helpless and abandoned. When we think it can only get worse. When we don’t get any information.

Let’s have a look abroad, for example at Dubai. Dubai is in the lead in several smart city rankings. Anyone who, like me, occasionally does business in Dubai, can see very clearly how investments in the smart city lead directly to a considerable improvement in the quality of life.

Those responsible in Dubai have managed, through targeted measures, to substantially reduce the time spent in traffic jams per inhabitant. The result is not only an average of twelve hours per inhabitant per year that are freed up for nicer activities – but also the feeling that someone is taking care of things. That things are getting better.

We are still working on being able to report equivalent successes from Germany. Above all, on standards, on horizontal thinking, and on the preparedness to forego short-term benefits, in order to invest for the long term in a system that will benefit everyone.

However, if we really want to exploit the potential found in this study and implement the associated vision, then that is exactly what we need to do – and ensure the foundations. We need to ensure that digital ecosystems can develop in our cities that allow the solutions to flourish which transform a city into a smart city.

You can learn about how companies and cities can contribute to this development in the study “The German Smart City Market 2017–2022. Facts and Figures”.

Best wishes,
Harald A. Summa
CEO
eco – Association of Internet Industry

1. Introduction

1.1. Summary of Study Findings

Traffic chaos, increasing pollution, and growing costs for retirement provisions are only a few of the problems associated with increasing urbanization and an aging population. German cities are facing growing challenges – the Internet of Things is set to provide relief. Worldwide, cities like Nanjing and Dubai, and city-states like Singapore, are reacting to current problems with concepts to develop themselves into so-called smart cities. Leading international cities place the user at the center of their IoT strategy, among other things to create comfort for their citizens, reduce public spending, and to establish an efficient urban infrastructure.
In the study "The German Smart City Market 2017–2022. Facts and Figures", eco – Association of the Internet Industry and Arthur D. Little have analyzed, based on a range of sources and expert interviews, the status of the smart city development in Germany, and what cities and companies should now be doing in order to position themselves in this promising field.

According to the findings of the study, the turnover of the German smart city market will grow from 20.4 billion Euro in 2017 to 43.8 billion Euro in 2022. This corresponds to average annual growth of 16.5 percent.

Compared with the classic large German sectors like manufacturing and the automobile industry, the enormous potential becomes apparent: Between 2010 and 2015, these industries merely experienced annual growth of, respectively, around 0.5 to almost six percent. The leading smart cities in Germany (Stuttgart, Berlin and Munich) are currently reaching the second of four possible developmental stages. Sustainable and holistic strategies that integrate numerous different smart city offers – from mobility to energy management, and on to security solutions – (still) remain a rarity.

Exactly these strategies are essential for the success of the smart city, opening outstanding opportunities for German companies, including telecommunication providers, energy companies, and software companies to develop new growth areas. But can the German industry, as the world champion exporter and the cradle of "hidden champions", succeed in gaining a leading position in this promising business sector?

What can companies in the Internet industry and other related industries do in order to position themselves in this growth area? Arthur D. Little and the Association of the Internet Industry want to provide answers to these questions in this study.

Status and Complexity of Smart City Solutions in Germany for Companies

The smart city can, according to the findings, be divided into ten market segments, with a multitude of solutions that can increase quality of life and reduce costs. The growth occurs across all segments, although the four segments Transport & Logistics, Communication Services & Network Security, Physical Security, and Building Automation account for more than 65 percent of the entire smart city market in 2017. However, in order to exploit the full potential of the smart city, German cities should follow concepts that center on the cross-segmental (horizontal) smart city platform. This means turning away from a vertical silo mentality of individual portfolios, and moving towards a unified vision and cross-segmental architecture that bundles all urban data, services, and applications, both technically and organizationally, and enables data exchange between them. The city and its citizens benefit substantially from the interplay of the different use cases. International leaders like Dubai are demonstrating how such a holistic approach can improve the quality of life for inhabitants and establish efficient urban infrastructures. German cities should now take the right steps and, beginning with pilot projects, strongly advance the use of new technologies and initiate the transformation to a smart city, in order not to fall behind in international competition and become correspondingly less attractive.
An appropriate smart city concept is becoming an increasingly important factor in the competitiveness of a location.

Hardly any chance of going it alone – Cooperation Between Companies as Key to Success

For German companies, it is also important to benefit from the growth in the market and to find their place in the smart city ecosystem; otherwise, they run the risk of losing competitiveness in the globalized economy.
By "ecosystem", we mean the strategic collaboration of companies to identify the specifications and requirements of a city and to be able to offer products and services as a holistic solution. Large international corporations from the USA and Asia, above all, cover more and more parts of the smart city business with their solutions. Not infrequently, the emphasis here is placed on strategic, long-term partnerships with cities (for example, Cisco and Hamburg) and investments in digitalization projects (for example, the planned 500 million US Dollar investment by Cisco as part of the "Deutschland Digital" program).

Companies should begin to bring appropriate products and services onto the market with test customers and reference projects, to get their chance in the large mega-projects like the ones already being carried out internationally today. eco and Arthur D. Little also forecast a wave of collaborations between widely diverse providers in the German smart city market.
In conducting the study, they identified nearly 50 competencies along the value chain that are necessary to cover the majority of the use cases in the area of the smart city. Even large corporations thus have a difficult time providing end-to-end solutions (from the sensors to the connectivity, and on to application software) on their own. It will therefore be critical to success to find appropriate partners in the complex ecosystem.

Collaboration is necessary across a range of industries and value chains, but also on the same level, to cover all the relevant competencies and capabilities of a smart city solution. For the bundling of resources and for international success, it can also be necessary to create partnerships with competitors. However, this will require new ways of thinking that are currently not in the focus in companies.

Based on the analysis of numerous international case studies on smart cities, eco and Arthur D. Little have identified five critical success factors, respectively, for a city to develop successfully into a smart city, and for a company to successfully position itself in the German smart city market.

Companies are faced with numerous strategic questions

- How big is the market potential for us in the smart city area?
- Which business areas can we position ourselves in?
- What competencies and capabilities do we need?
- What stages of value creation are there in the smart city business?
- Which success factors should we take into account?

1.2. Smart City as Solution to Municipal Challenges

Cities are growing and populations are aging. The associated structural transformation demands approaches to problem-solving that span different topics and different portfolios. The strategic step of developing into a smart city with the help of the "Internet of Things" ("IoT") is seen by many cities as a chance to successfully master today's growing challenges in the future. In the following chart, it becomes clear that smart city concepts can make a substantial contribution towards solving existing and future urban issues.

Interview

With regard to many of the challenges described, Berlin – as one of the smart city leaders in Germany – is taking a holistic smart city approach. This has the objective of using intelligent technology to find solutions to the ecological, social, and economic challenges of the city.

What are the current challenges that the city is facing?

A smart city is a livable city. Clean air, and flexible and environmentally friendly mobility offers are just as important for making a smart city livable as a reliable health system and outdoor leisure activities. Given that the population numbers in cities is growing and society is getting older, the 'management' of a city requires re-thinking. More than half of the world population now lives in cities; and this figure continues to grow.

How do smart city services, with new technologies and services, help you to overcome these challenges? How do you go about it?

The smart city strategy agreed on in April 2015 is a guiding principle for the future of the city and part of the city development concept 'Berlin 2030', which is designed to make the city more economically stable, socially more attractive, and even more internationally recognized. What the city of tomorrow will look like can be experienced in Berlin, for example, at the EUREF-Campus. The premises hosts the largest electric filling station in Germany, the driverless bus 'Olli' transports staff to their office buildings, and wind turbines on the roofs contribute to the autonomous energy supply. The EUREF-Campus had, through these and further measures, already achieved the German government's CO2 climate objective for 2050 back in 2014. The Berlin startup scene is also a strong idea generator for smart city solutions. Mobility concepts are re-thought, tested and implemented – for example, in the area of car sharing.

How important are smart city services for the development of your city?

Smart city solutions are urgently being sought for urban living: The world's mega-cities are growing continuously, and Berlin itself gains around 60,000 new inhabitants annually. With over 3.5 million inhabitants, the city is in worldwide comparison a rather small mega-city, but that means it offers the ideal testing ground for innovations. Particularly in the areas of mobility, energy, and health, new perspectives are being created through the interplay with digitalization.

Dr. Stefan Franzke

Spokesperson for the Management
Berlin Partner für Wirtschaft
und Technologie GmbH

1.3. The Smart City Ecosystem and its Market Segments

FIG. 1

Segments	Characteristics	Example Services	Stakeholders
Transport and Logistics	Transport is gaining increasing importance in the era of urbanization. The use of new technologies in public transport, and the control of traffic on the road, for example through the use of "intelligent traffic lights", contribute to a long-term improvement in transport.	– Parking mgmt., ticket systems & passenger info – Traffic management – Control of vehicle fleets – Carsharing	Transport operators (rail / bus companies, subway networks, city bikes
Communication ervices & Network Security	Secure and fast network connections are an integral component of the cities of tomorrow. They make it possible to protect existing infrastructure effectively against cyber attacks and ensure stable and cost-effective data traffic.	– Network security, Public Internet (Wi-Fi) and fiber-optic infrastructure – Low Power Wide Area (LPWA) IoT Networks	Public institutions, network operators, IT companies, telecommunications providers
Physical Security	The increasing population density in cities makes intelligent security systems essential. Improved physical security in public spaces, for example through smart video surveillance, increases the quality of life for citizens.	– Video surveillance of public spaces – Access controls – Identification management	Police, public institutions, electronics manufacturers, private security services providers
Building Automation	Both companies and private households (smart home) can increase energy efficiency, security and comfort. This occurs through optimized (internal) processes, above all the monitoring, control, and automation of systems in buildings and plants.	– Automatic security systems – Intelligent energy systems – Automated devices	Construction industry, manufacturers of household appliances, electronics manufacturers
Health Industry	The digitalization of processes in the health industry and the communication between institutions like hospitals or pharmacies and the patient are becoming increasingly important. Innovations like telemedicine and mobile health make new treatment methods possible.	- Digital patient files and information - Personal health management (e.g. telemedicine)	Hospitals, pharmacies, doctors, manufacturers of medical devices
Energy	An efficient energy supply ("smart grid") involves the digitalizati-on of the power grid (from power generation to transport, and on to the household). Smart streetlights and electrical filling stations are promising and innovation-driven markets.	– Smart power grid, gas and water networks – Intelligent streetlights – Electrical filling stations	Power companies, network operators
Tourism & Retail	The segment Tourism & Retail includes the digitalization of advertising for retail, as well as the use of intelligent vending machines. For example, innovative advertising using location-based services via mobile devices are gaining in importance.	– Digital advertising spaces – Smart vending machines – Location-based services	Airports, railway stations, retail stores, manufacturers of vending machines
Education	Smart education occurs above all through the digitalization of educational institutions, for example through digital monitors and screens (e.g. whiteboards) and ICT services, from Internet access to cloud platforms, and on to digital educational resources (e.g. audio and video learning tools).	– Digitalization of educational institutions (hardware, software, curriculum content, other ICT services)	Schools, universities
Financial Services	The digitalization of financial services includes both the revenue share of Internet payment processes (e.g. PayPal), and also improved security systems (e.g. remote surveillance around the clock) for cash withdrawals at banks.	– Cashless online payment processes – Security at cash machines	Banks, insurance companies, retailers
Public Administration	Digitalization of public administration will enable more efficient processes. This will be achieved through better control of the administration and the provision of digital municipal services (e.g. making applications and organizing appointments online).	– Digital administration – Municipal services (e.g. online applications, intelligent forms)	Municipal institutions

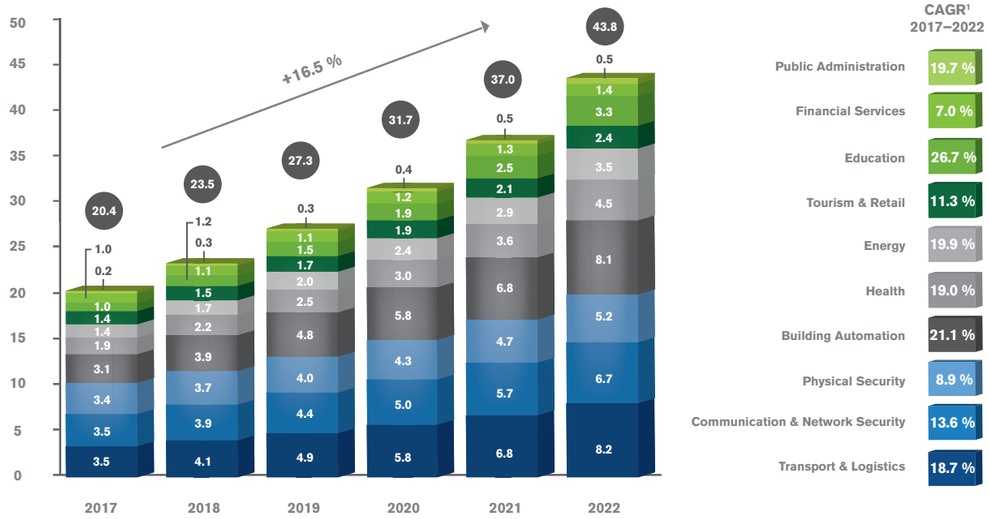
A smart city is a city that constantly seeks to improve the life of its citizens and visitors, as well as the conditions for successful economic trade. It becomes more efficient, technologically more advanced, greener, and more socially inclusive. eco and Arthur D. Little place the emphasis on the promotion of ICT-supported urban innovations. A smart city strategy integrates a wide range of solutions that, in this study, are categorized into ten segments.

2. The German Smart City Market in Facts and Figures

2.1. Revenues and Market Growth 2017–2022

In the area of the smart city, eco and Arthur D. Little expect enormous growth in revenues of 16.5 percent, spanning all ten market segments. However, some considerable differences can be seen in the size and the increase of the segments. Figure 2 clarifies which of the services and segments of the smart city market will receive the most investment from companies, citizens, and the public pocket in the years 2017 to 2022.

FIG. 2 **Revenues and Growth of the German Smart City Market 2017 – 2022 (in bn. Euro)**



Sources: Arthur D. Little, eco
1) CAGR = Compound Annual Growth Rate

The volume of the German smart city market is driven by public as well as private spending and in 2017 already accounted for 20.4 billion Euro. Numerous companies are already very present in the market, including, for example, Honeywell (Building Automation), Siemens (Transport & Logistics), and tech-giants like Cisco.

The market as a whole shows itself to be growing strongly in the period investigated: From 2017 to 2022 eco and Arthur D. Little expect annual growth in revenues of on average 16.5 percent. As a result of this, revenues will more than double by 2022, to 43.8 billion Euro. The market therefore forms a promising business area for companies from diverse sectors. In particular, the winners will be providers of smart city platforms, applications, and services for end consumers.

In contrast, pure hardware and connectivity providers will reduce in importance. However, it is the lack of holistic smart city concepts and the associated entrenched island mentality – both from providers and from cities – that particularly inhibits the cross-segmental market growth.

Important drivers of demand are the expansion of holistic mobility strategies, spending on IT security, strong growth in housing construction, and an advancing wave of digitalization in the health and education sectors.

The five most important market trends are:

Future urban mobility strategies will become established in Germany, similar to smart cities like Vienna and Dubai. The focus is on multi-modality as the fundamental driver – the interconnection of public transport with other mobility offers.

Driven in particular through increasing investment in IT security and network infrastructure, "Communication Services & Network Security" counts as one of the largest segments today and in the future, with approx. 3.5 billion Euro revenues in 2017 and an average annual growth rate of 13 percent.

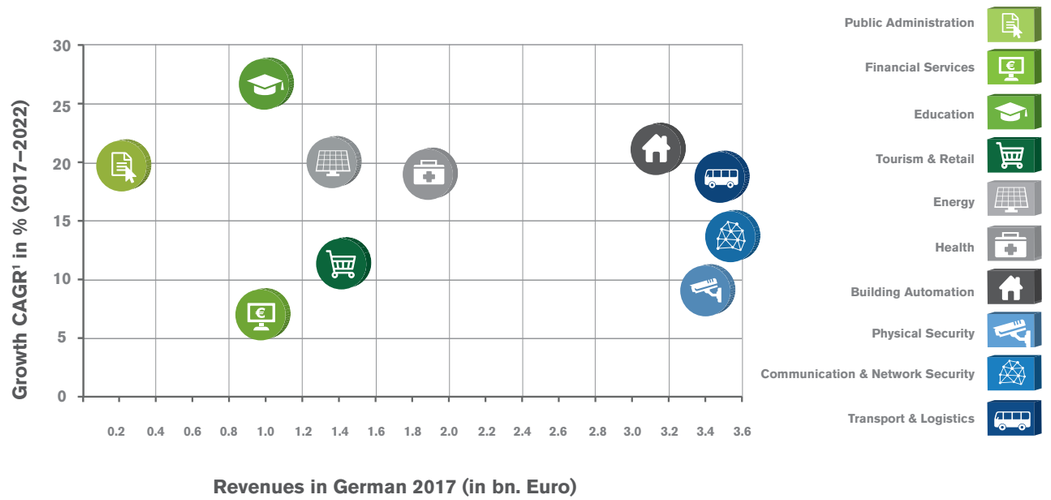
The important growth driver for the segment "Building Automation" is, alongside the use of modern technology in industrial and commercial real estate, above all the strongly growing smart home area. Thus, eco and Arthur D. Little forecast a smart home penetration of around 20 percent of all households by 2022, driven by strongly increasing housing construction.

A further important trend is the massive investment in both the public and private education and health infrastructures. Major drivers of this are the annual increase in sales figures for mobile health devices (for example, portable blood sugar measurement devices) of more than 30 percent by 2022, and the digitalization of educational institutions and the associated spending on hardware, software, and services like cloud platforms and digital educational materials.

An EU directive which stipulates that by 2020 a total of 80 percent of all households are to be equipped with smart meters will lead to substantial growth in the smart city segment "Energy".

The detailed comparison of all ten segments according to revenues in 2017 and annual growth for 2017 – 2022 is presented in Figure 3. This illustrates the varying market potential for companies.

FIG. 3 **Revenue and Growth of the Smart City Segments in Germany in Comparison**



Sources: Arthur D. Little, eco
1) CAGR = Compound Annual Growth Rate

Figure 3 shows a range of growth rates between and within market segments – both in the distribution and in the forecast growth in revenues:

More than 65 percent of the total smart city market revenues were generated by the four market segments “Transport & Logistics”, “Communication Services & Network Security”, “Physical Security” and “Building Automation” in 2017. The dominance of these four segments will not change before 2022.

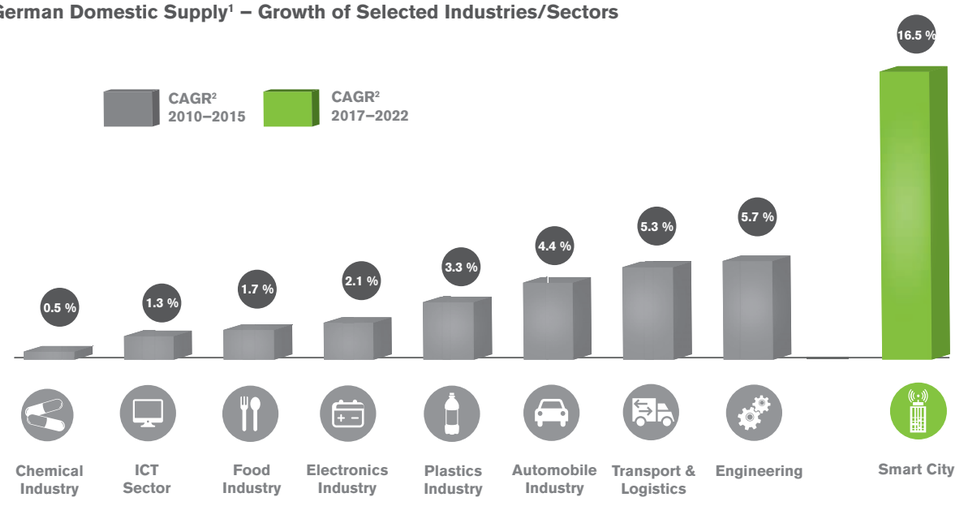
With annual growth of around 27 percent, the market segment “Education” is increasing most strongly. This is certainly good news, given that German educational institutions lag considerably behind other nations in the area of digitalization. The international leader, in the eyes of eco and Arthur D. Little, is Sweden, where holistic digitalization concepts have been pursued for a long time now.

The segments “Financial Services” and “Tourism & Retail”, in contrast, will record only comparably moderate growth rates of around seven and eleven percent, respectively, until 2022, and with revenues each of under 1.5 billion Euro in 2017, rank among the smaller smart city markets. The reason for the relatively low growth of “Tourism & Retail” is, for example, the moderate growth in digital advertising spaces, whose revenues (2017) made up nearly 60 percent of the segment. Nonetheless, a closer look shows that sub-segments and growth areas like location-based services, and cashless online payment processes (e.g. PayPal) will gain in importance and experience annual growth rates of up to 30 percent.

2.2. The German Smart City Market as Growth Area

The enormous potential for companies can above all be seen when the growth of traditional German industry sectors in previous years is compared with the forecasts for the smart city solutions (see Figure 4).

FIG. 4 German Domestic Supply[1] – Growth of Selected Industries/Sectors



Sources: Arthur D. Little, BITKOM, BMWi, Bundesverband der deutschen Ernährungsindustrie, Destatis, eco, DSLV, EITO, Statista, VDMA, Verband der Chemischen Industrie, Zentralverband Elektrotechnik und Elektroindustrie
1) Domestic supply = domestic production (P) + German imports (M) – German exports (X)
2) CAGR = Compound Annual Growth Rate

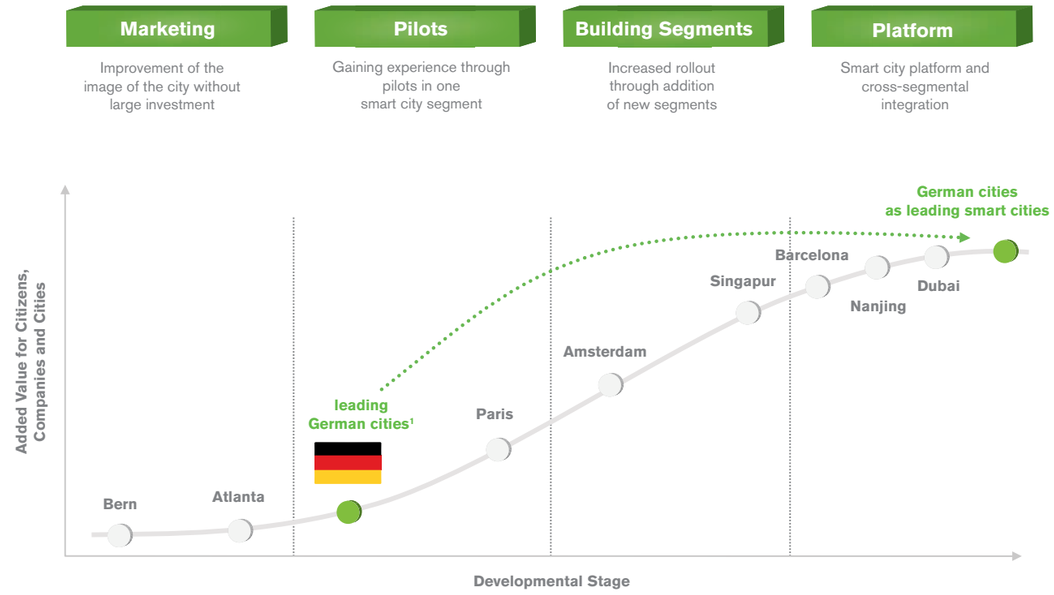
While average revenue growth of 16.5 percent annually is forecast for the smart city market in coming years, classic large German sectors only grew by around 0.5 to six percent respectively in the years 2010 to 2015. Thus, it can be worthwhile for companies in the ICT sector, which recorded an average annual growth of 1.3 percent, to develop new business fields in the smart city environment with relevant competencies, and in this way to generate revenues and increase profits. A detailed list of the relevant competencies can be found in Chapter 3.

2.3. German Cities: Need for Action

In general, the high growth potential of over 16 percent demonstrated above is driven by the transformation of German cities towards a holistic smart city concept. But what exactly does this mean?

The status quo of German cities is illustrated in Figure 5. An international comparison makes it clear that there are marked differences in the maturity of different smart city approaches. Depending on the service offer and the strategy being pursued, cities can thus be categorized into four developmental stages.

FIG. 5 Smart City Developmental Stages: German Cities in International Comparison



Sources: Arthur D. Little, eco
1) Frankfurt, Berlin, Munich

Despite a range of pilot projects, the German smart city market is still in the embryonic phase. The promising holistic approach of an open and cross-segmental platform, as can be seen in Figure 5, is hardly evident in the leading German smart cities like Stuttgart, Frankfurt, Berlin, or Munich – some action urgently needs to be taken here. In contrast, international leaders like Nanjing and Barcelona demonstrate how, through a holistic concept, the quality of life of inhabitants can be improved and an efficient urban infrastructure can be established.

In order to move up the ranks in international comparison in the coming years to become leading smart cities, German cities and companies should work closely together to realize a holistic approach. This means the integration of a whole range of different smart city offers – from mobility to energy management and on to security solutions – in one coherent strategy. To achieve this, an open and cross-segmental smart city platform should act as the link between all services. How this works and how it is built is explained in Chapter 3.3.

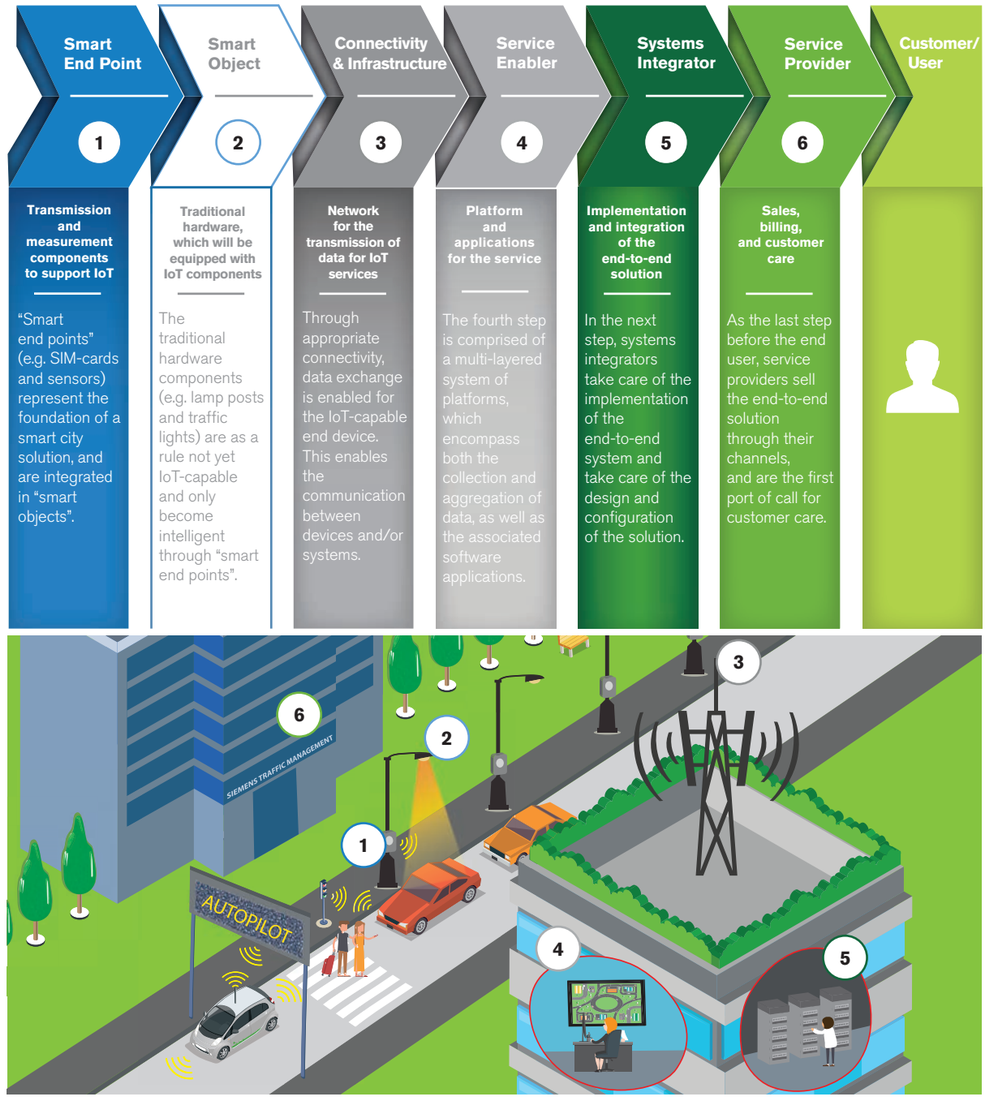
3. Smart City as Opportunity for German Companies

3.1. The Value Chain and Relevant Competencies

Identifying the collaborative potential between companies to encourage the horizontal integration of applications requires a detailed analysis of the smart city value chain. This is presented, with its six elements, in Figure 6. The smart object is presented in white, as the hardware for traditional services, which is merely upgraded, is not an object of the calculation and thus not a part of the smart city market. However, in order to be able to present a complete picture of the smart city ecosystem, the smart object is part of the value chain. The lower part of the diagram uses an example to illustrate the value contribution of the individual elements in value creation, as well as the synergies arising through the interconnection of various smart city solutions with the help of a holistic platform architecture.

FIG. 6

The Smart City Value Chain – Using the Example of Data Exchange Between "Smart Street Lighting" and "Traffic Management"



Sources: Arthur D. Little, eco

The example in Figure 6 describes the value contribution of the individual value creation elements of smart city solutions and demonstrates the advantages of data transfer between the two solutions "smart street lighting" and "traffic management". "Smart street lighting" means lighting systems that, thanks to their IoT components, can adapt the strength of their lighting to the traffic and thus consume up to 35 percent less energy than traditional street lights.

"Traffic management" describes digital systems that, for example, optimize traffic flow in a city through intelligent traffic light switching. Through this, both CO_2 emissions and traffic jams can be effectively reduced. Thanks to the data exchange over a horizontal smart city platform, both solutions can benefit from one another, creating real added value for citizens, companies, and cities.

1. As a first step for the smart city solutions presented here, there is need for smart end points that, in the case of the example application, are represented by (motion) sensors and transmission units, for example, a gateway.

2. Subsequently, the smart end points are attached to a traditional light pole and/or traffic light. The two objects thus become IoT-capable and now have the possibility to send and receive data, with the result that information on pedestrian and road traffic can be collected.

3. To enable this data exchange, stable and reliable transmission networks ensure that the data from the "smart street light" or the "intelligent traffic light" can be transferred.

4. In an integrated solution, the data collected is fed into a smart city platform. On the one hand, this enables the control of the lighting and traffic light systems, and on the other hand it allows the combined processing and analysis of the data collected by both systems. Thus, the data generated about the street lighting can be informative concerning the level of traffic in a given suburb. Through the cross-segmental exchange of data, the traffic management system can, for example optimize the traffic light switching, and control the traffic more efficiently.

5. The many hardware and software elements of the two smart city solutions are now integrated into the platform and configured by a systems integrator.

6. Finally, the service provider sells the end-to-end solution on the market and as a rule acts as the contact person for the users.

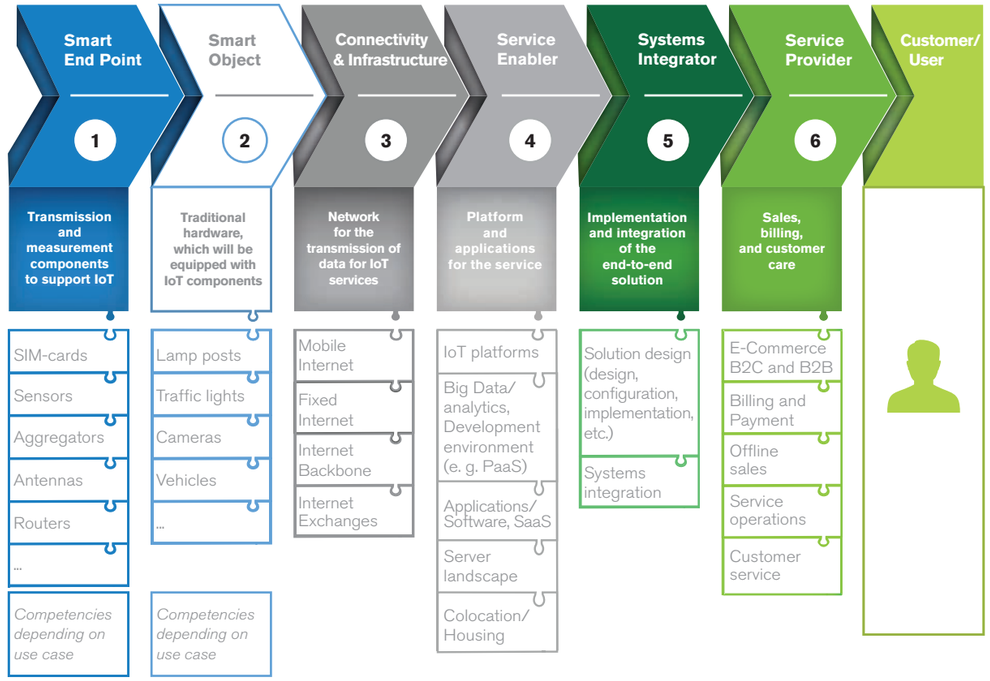
As simply and clearly delineated as the smart city business model appears in this example application, the market is nevertheless highly fragmented and complex. On the one hand, cities have great demands for individualization and extensive urban solutions. On the other hand, from the perspective of the company and as a result of the highly diverse market segments (from energy to financial services and on to education; see Chapter 1.3) and the associated fields of application, it is hardly possible for one company alone to cover all competencies along the value chain. Depending on the strategic direction, size, and existing core competencies, providers of smart city solutions offer products or services for one specific step in the value chain or even a broad portfolio of competencies for several elements in the value chain.

Above all for complex solutions, it is essential for success to join forces with other companies, in order to bring "best-in-class" solutions for smart cities onto the market with bundled competencies. Close cooperation at the horizontal level (between specialists in different technologies and sectors), for example, between providers of sensor solutions, traffic infrastructure and software, are decisive. In this way, the companies build a complete smart city ecosystem, with the objective of offering smart products and services as end-to-end solutions (for example, joint product development or joint sales) through strategic partnerships. In particular, large international corporations from the USA and Asia encompass with their solutions more and more areas of the smart city business.

Not infrequently, the emphasis here is placed on strategic, long-term partnerships with cities (for example, Cisco and Hamburg) and investments in digitalization projects (for example, the planned 500 million US Dollar investment by Cisco as part of the "Deutschland Digital" program).

In conducting the study, eco and Arthur D. Little have identified nearly 50 competencies along the value chain (see excerpt in Figure 7) that are necessary to cover the majority of the use cases in the area of the smart city. As a result of the multitude of different competencies and the breadth of the smart city portfolio with its more than ten segments, companies are hardly able to offer end-to-end solutions on their own. This diversity is especially clear in the first two elements of the value chain, the "smart end points" and the "smart objects". While German companies like Siemens and Bosch rank among the large manufacturers of "smart end points" in the energy segment, in the Building Automation segment the hardware is produced predominantly by overseas corporations (for example, Cisco). As a result of the enormous market volume, companies from a wide range of sectors, from the construction industry to the IT sector, are trying to become a part of the smart city market. However, in order to master the complexity mentioned above, partnerships need to be the basis. Telecommunication providers, for example, take the approach of collaborating both with international technology corporations as well as with small providers of niche solutions, in order to jointly completely cover large parts of the value chain.

FIG. 7 **The Smart City Value Chain and its Competencies**



Sources: Arthur D. Little, eco

3.2. Operation of a Smart City Platform

As with all IoT business models, the smart city platform should be highlighted as an integral component of the value chain. Such a platform bundles urban data, services, and applications from all segments, both technically and organizationally. It serves not only as a link between the individual applications, but also, through its open structure, enables the collection and preparation of data and the exchange of data between the different systems and market segments. This leads to greater benefit for the users, lower costs, and a much larger number of smart city services. An isolated platform, in contrast, does not allow this cross-service data usage. Through the lack of holistic data usage, enormous synergy effects are lost for citizens, companies, and the city.

An open and holistic smart city platform ("Service Enabler") consists as a rule of three levels:

The IoT platform serves as a connection between the smart end points (sensors etc.) and the complete platform infrastructure. Its task is both the management of all connected devices and the aggregation of all data from across all segments.

The core can be found in the second level (Big Data/analytics, development environment), with two important functions: Firstly, the collected data is assessed and analyzed, for example through predictive analytics or machine-learning algorithms. Secondly, it serves as the development environment and provides application developers access to the analyzed data of all segments, through data interfaces and PaaS functions, so that they can develop integrated solutions.

The software and SaaS level contains end-consumer applications and enables users to make use of the smart city solutions via a web interface.

3.3. Successful Case Studies

In leading smart cities like Barcelona and Dubai, an open and holistic platform counts as one of the success factors of the strategy. How this platform strategy works and what advantages it offers are illustrated in the following case studies. Here, it is shown how successful smart city models should be built from the perspective of the city, and how companies can best offer these.

With successful smart city projects, cities can succeed in making metropolitan regions sustainably more livable for inhabitants and resident companies, as well as more future proof. These many solutions are integrated in an open and horizontal smart city platform.

An efficient infrastructure contributes substantially to reducing costs and saving resources. A good example for this is Dubai, as can be seen in Figure 8. The city invested large sums in the segment Transport & Logistics, in particular in the traffic infrastructure (for example, intelligent management of parking spaces), in intelligent traffic management (traffic light systems and traffic monitoring), and in public transport (for example, driverless buses).
Through this, traffic jams and thus also CO2 emissions are reduced.

As a result of the market volume and the annual growth of 16.5 percent until 2022, smart city solutions offer companies high potential for growth. They can benefit from this by building an ecosystem together with a range of partners and jointly offer holistic smart city solutions (see Chapter 3.1).

Through successful implementation, they can develop new areas of business, generate additional revenues, and increase profits. Figure 9 gives an example of such a targeted collaboration between Cisco and Citelum.

FIG. 8 **Example: Smart Dubai – An Internationally Leading Smart City**

The Project

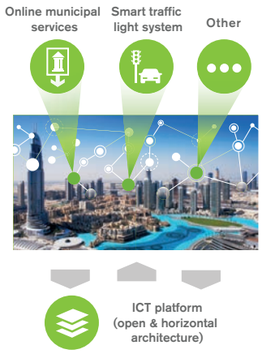
Dubai is pursuing the objective of being the smartest city in the world by 2021. Central to this is the necessary ICT infrastructure, which enables the development of cross-segmental solutions through an open platform.

Challenges

- Traffic congestion costs the economy in Dubai 790 m US Dollars annually
- Every inhabitant of Dubai spends an average of 72 hours per year in traffic jams
- Municipal services are inefficient, with up to twelve weeks' waiting times.
- Dubai searched for a holistic smart city concept, which offers cross-segmental solutions for citizens and many applications.

Solutions

A platform for more than 150 smart city initiatives & services



Advantages

- 8 % less and 7 % faster traffic
- 17 % less time spent in traffic jams
- Reduction of CO2 emissions by 16 %
- Duration of municipal services reduced to three weeks
- Given that all data is on one platform, more extensive exchange is possible between the applications
- Use of more than 100 services through a one-time registration using digital ID

Sources: Arthur D. Little, eco, www.smartdubai.com

FIG. 9 **Example: From the Isolated Solution to a Smart City Ecosystem**

The Companies

Citelum is a niche provider in the area of "smart street lighting". Cisco is a leading technology corporation and provider of infrastructure solutions in the area of smart city, such as the "Smart + Connected Digital Platform".

Challenges

for Citelum

- Alone, can only offer isolated solutions
- Is dependent on the existing ICT infrastructure of the respective city

for Cisco

- Offers only infrastructure and basic applications
- Has no own applications for special niche solutions that can be adapted to the requirements of the city

Solutions

Creation of a smart city ecosystem through a strategic partnership between a leading smart city platform provider and the niche provider of an isolated solution

Niche provider of "smart street lighting" technology

Leading provider of smart city ICT infrastructure

Advantages

for Citelum

- Gains access to an existing smart city ecosystem
- Is offered as part of a complete package

for Cisco

- Can integrate niche solutions into their own platform
- Can offer an end-to-end solution as a package
- Expands existing portfolio of smart city services

Sources: Arthur D. Little, eco, Website Cisco, Website Citelum

3.4. Success Factors and Market Opportunities for German Companies and Cities

Based on the analysis of numerous international case studies on smart cities, including Dubai, Singapore, Barcelona, Nanjing, and Vienna, eco and Arthur D. Little have identified five critical success factors for companies and cities respectively. These serve as an orientation in order to, from the perspective of the city, achieve the successful transformation to a smart city, and from the perspective of a company, position themselves successfully on the German smart city market.

FIG. 10

Sources: Arthur D. Little, eco

4. Summary and Outlook

The smart city market is one of the fastest growing sectors in Germany for the coming years. According to eco and Arthur D. Little, the smart city market in Germany in 2017 will experience revenues of approx. 20.4 billion Euro. By 2022, this is expected to have more than doubled, reaching around 43.8 billion Euro. A comparison with other industry sectors makes clear that the smart city market, with an expected growth of more than 16 percent per year, will be an attractive market – both for companies in the Internet industry and for companies in adjacent industries.

In the course of this enormous growth, eco and Arthur D. Little see influential trends in the coming years – both on the provider-side and on the side of German cities:

Business models of providers will change: While currently many companies are still following a strategy of achieving revenues based above all on hardware, these concepts will more and more give way to service and licensing models.

The smart city market will experience a wave of collaborations between diverse providers. To be able to offer holistic services, there is a need for a range of capabilities. International corporations are already demonstrating how, through close cooperation with other providers, their own competencies can be expanded. German companies will also follow this example and make partnerships across segments.

For cities, the topic smart city will become more and more a competitive factor for the success of a location. They will strongly drive the use of new technologies, in order to remain attractive. German cities will follow the example of international leaders like Dubai (see Figure 8), in which smart city solutions have long since lost the status of pilot projects.

Integral components of a smart city strategy will be the ICT infrastructure and, above all, the smart city platform. Through these, data exchange can take place between the segments and their applications, and the full potential of all service offers can be exploited.

As a whole, these trends will ensure that smart services become established in German cities. Access to the city's aggregated data via a central and open platform structure will become the breeding ground for innovation and progress in German cities. Companies, universities, and entrepreneurs will have the possibility of developing new solutions to decisively improve the quality of life and the efficiency of urban regions.

Interview

What smart city solutions do you help municipalities with, so that they can develop into cities of the future?

With our high-speed communications networks and 'Internet of Things' solutions, we ensure comprehensive digitalization in cities, and connect people, machines, and infrastructures. One highlight from our portfolio is, among others, the connected rubbish bin, which independently reports how full it is, and thus enables better and more efficient waste disposal. Together with partners, we also offer digitally connected street lights with integrated filling points for e-cars, Wi-Fi hotspots, emergency call functions and sensors for parking space management and the measurement of air quality.

How will the smart city market in Germany develop in the next five years? How great is the potential, and what are the important success factors?

The Germany smart city market offers enormous potential. This is because digitalization and intelligent interconnection are necessary in order to overcome the challenges of central topics like traffic control, power supply, pollution, and security. What is most important here are the close collaborations between municipalities and companies with smart city expertise and the courage of all decision-makers to try out new things. It is important to include the citizens right from the beginning and make the benefits of digitalization comprehensible for them.

How important are collaborations with other companies for you to be a successful part of the smart city market/ecosystem in the long term?

Cross-sector cooperation is decisive for the success of smart city services. A company cannot master the complexity of the diverse areas of application alone. We work with a large network of partners and offer them access to our IoT-Future Lab, where they can test their IoT applications and further develop them. Currently, for example, we are working with DB Systel, the digital service provider for Deutsche Bahn, the German railroad company, on intelligent connected rubbish bins for railway stations.

Alexander Saul

Director
Enterprise
Vodafone Deutschland

5. Methods, Definitions and Market Description

The figures on the size of the markets, the individual market segments, and the further segmentation that form the basis for this study are based on data from eco and Arthur D. Little, as well as on a range of secondary sources from associations (VATM, BIU etc.), publications by the German Bureau of Statistics (Statistischem Bundesamt), and other services (for example Statista and Destatis).

Market Description

Exclusively components that would not exist in a traditional "not-smart" city form part of the calculation, and therefore part of the market. If a traditional service is merely upgraded, the existing hardware and software do not form part of the calculation and are not part of the smart city market. The following examples illustrate the demarcation:

"Intelligent lighting": The costs for the lamp post are not part of the smart city market, because the lamp post is, as a rule, merely upgraded. Thus, only the new components, such as sensors, gateways, software, connectivity, and the platform are part of the smart city market.

Electric filling stations: The costs along the value chain (investment and operation) are in their entirety part of the smart city market. Electric filling stations are, as a rule, completely newly constructed and manufactured products and not simply an upgrade of an existing traditional filling station.

Definitions

Smart City
A smart city is a city that constantly looks to improve both the life of its citizens and visitors, and the conditions for economically successful trade, and in so doing becomes more efficient, technologically more advanced, greener, and more socially inclusive. eco and Arthur D. Little place the main emphasis on the advancement of ICT-supported urban innovations.

Smart City Platform
A smart city platform bundles urban data, services, and applications technically and organizationally, acts as a link between the applications of different segments, aggregates the data of all solutions, and enables data exchange between the participants – it offers developers access, in order to plan applications.

Smart City Ecosystem
We understand a smart city ecosystem to be the strategic cooperation of companies in identifying the specifications and requirements of a city and to be able to offer products and services as end-to-end solutions.

Value Chain Elements	Competency	Description
Smart End Points	**Aggregator**	Collect data from the sensors and summarize them, so that a condensed form of the data can be forwarded to the IoT platform and can be analyzed
Connectivity & Infrastructure	**Internet Exchange**	Public exchange point for data and networks of different backbone providers
	Internet Backbone	Basic infrastructure of the Internet: rental of fiber-optic infrastructure and associated services, and data transmission services
	Fixed Internet Access Network	Encompasses all broadband Internet access in a given location via fixed-line Internet
	Mobile Internet Access Point	Encompasses all broadband Internet access in a given location via the mobile Internet network
Service Enabler	**Colocation & Housing**	Housing: Accommodation and network connection of company-own servers in an external data center Colocation: Provision of at least one complete rack for company hardware and the necessary infrastructure for the operation of the servers
	PaaS (Platform as a Service)	A cloud-computing service which makes the hardware and software tools available on company-own infrastructure for application development, freeing the user from the necessity of owning hardware and software for the development and use of applications
	SaaS (Software as a Service)	A cloud-computing service which makes software available that is owned and administered by one or more providers. The provider provides the software on the basis of a range of joint code and data definitions, which can be used in a one-to-many model by all customers on a pay-per-use or subscription basis
	IoT Platform	Serves as the connection between the smart end points and the platform infrastructure, manages all devices and collects their data
Service Providers	**E-Commerce B2C**	Websites or applications that sell goods or services to end consumers over the Internet
	E-Commerce B2B	Websites or applications that enable Business-to-Business-procurement, sales and exchange of goods and services over the Internet, including E-Commerce processes that are concluded via electronic data interchange (EDI)

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Publication Details

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