Network Intelligence Studies
Volume VI, Issue 12 (2/2018)

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INNOVATION, A KEY ELEMENT OF BUSINESS MODELS IN THE FOURTH INDUSTRIAL REVOLUTION

Case Study

Keywords
Innovation,
Business Model,
Fourth Industrial Revolution,
Deutsche Bahn

JEL Classification
M00, O30

Abstract

The aim of the paper is to present the relationship between the concepts of innovation and business models in the Fourth Industrial Revolution. In this respect, the authors present the case of a German company, Deutsche Bahn (DB). Innovation constitutes a core factor that will secure our society's prosperity in the future, as it creates real and sustainable value. A key element in the successful path to Industry 4.0 is the expansion of new technologies or processes towards the development of innovative business models. The continuous worldwide changes, the shift from physical to digital or from closed-sources to open-sources and the new ways of doing business (networks) lead to the development of companies by creating and implementing business models in which innovation is constantly required. In order to reach the aim of the paper the authors used a quantitative research method and a case study. The findings of the research showed that innovation represents a key element in developing new business models that lead to better performances in any company that aims to be part of the Fourth Industrial Revolution.

INTRODUCTION

Since its emergence, the world economy has witnessed four remarkable industrial revolutions. Over the past three centuries, these industrial revolutions have continued to shape the world economy through the design and implementation of new and advanced methods and organizations for producing goods and providing services (Stearns, 2013). By marking the onset of the industrial society, the First Industrial Revolution began in Britain in the late eighteenth century when the steam engine and the power loom were invented (De Vries, 1994). The British Industrial Revolution put accent on the development of several industrial sectors, such as cotton, coal or iron, and brought a huge economic and social transformation of the first capitalist economy of the world. In addition, it changed the organization of work and Work 1.0 came about with the introduction of the modern factory system (Mantoux, 1928) and the emergence of trade unions. Industrialization became a key economic process, which occurred in local, national, international and global contexts, and involved political, social, economic and cultural forces (O'Brien, 2006). From an economic point of view, the British Industrial Revolution represented the result of prosperity and growth in various British regions, such as the Lancashire cotton industry or the Wealden iron industry (Hoppit, 1987) and turned the country into the workshop of the world (Henderson, 1961).

In the mid nineteenth century, the Industrial Revolution entered a new phase of its evolution as inventions multiplied rapidly. What is called the Second Industrial Revolution brought the Age of Steel, the discovery of electricity and the expansion of the machines of mass production. The new technological inventions led to the creation and development of a new economy characterized by faster growth in productivity (Atkeson and Kehoe, 2001). As the world's most powerful nation, Victorian Britain succeeded in becoming an urban, industrial and commercial empire (Evans, 2018). The increasing social problems in the factory system and the pressure of the organized labor became ever higher and finally led to the introduction of the first social insurance in Germany. This marked the beginning of Work 2.0. After the end of the Second World War, the Third Industrial Revolution launched the Information Age (Greenwood, 1997), an era of knowledge-based progress and of rapid development of information technology (IT). The spread of the so-called Third Wave (Toffler, 1980) led to an IT transition in every industrial sector and, therefore, to an impressive impact of the electronic innovations in society (Dosi and Galambos, 2013). The increasing use of computers at the workplace, the consolidation of the welfare state and of the workers' rights made possible the emergence of Work 3.0.

In the Fourth Industrial Revolution or Industry 4.0 physical and digital technologies have merged and allowed for the formation of the digital enterprises (Deloitte, 2018). In this currently ongoing industrial revolution, the change is in the ever deeper linking of products and processes via the Internet. Similar to social networks, intelligent machines and production parts exchange information with each other and with people in order to organize themselves independently and to coordinate processes and deadlines. Digitization and digital transformation are enabling new forms of communication, collaboration and value creation, and are decisively influencing the business models around the world. The impact of Industry 4.0 on the workforce is referred to as Work 4.0, which outlines a vision towards good quality jobs in an era of continuous digital change (Bundesministerium für Arbeit und Soziales, 2016).

Starting from the increasing interest in the Fourth Industrial Revolution, a question arises: is there any relationship between innovation and business models in Industry 4.0? The paper tries to answer this question by analyzing the numerous sources of secondary data through a comprehensive literature review and by illustrating the case of a German company, Deutsche Bahn.

The remaining subdivisions of the paper are organized as follows: Section 2 deals with the literature review. The research methodology is presented in Section 3. Section 4 provides a discussion of the findings. Paper ends with conclusions.

LITERATURE REVIEW

The main concepts of the paper are innovation, business model, and the Fourth Industrial Revolution. The concept of innovation has been defined in different ways. Some researchers consider that the fresh thinking induced by innovation leads to value creation while others see innovation as the implementation of a new product/process, a new marketing/organizational method (Gault, 2018) or as a mindset, a new way to think about business strategies (Kuczmarski, 1996). A business model shows the way an organization creates, delivers, and captures value (Osterwalder et al., 2014). In its turn, the Fourth Industrial Revolution refers to the fusion of several technologies (e.g., nanotechnology, quantum computing) and their interaction across the following three domains: physical, digital and

biological (Schwab, 2017). As Industry 4.0 creates an integrated relationship between business and technology, innovation is increasingly representing a key element of today's business models (Mandapaty, 2016). Moreover, successful business model innovation leads to value creation (Wirtz, 2017). Therefore, there is a link among innovation, business model and the Fourth Industrial Revolution.

RESEARCH METHODOLOGY

In order to achieve the research objective, the authors used a quantitative research method combined with a case study. The information was gathered from numerous sources of secondary data, such as books and articles from the domains of management, marketing, economic history and innovation, or corporate reports of Deutsche Bahn, through a desk research. The literature review was carried out mostly in the German libraries where the electronic databases (e.g., Elsevier, Cambridge University Press, Emerald Insight) were found and consulted.

The German railway from to 1.0 to 4.0

Deutsche Bahn (briefly DB AG, colloquially also only DB) is a German transport company with seat in Berlin. It originated in 1994 from the merger of the German Federal Railways and the German Reichsbahn and was transformed into a public corporation, 100% owned by the German government. It is the largest railway and railway infrastructure company in Central Europe and has been operating internationally for several years.

The group is subdivided into a large number of companies, including DB Regio (local passenger transport), DB long-distance transport (long-distance passenger transport) and DB Cargo (rail freight transport). DB Netz operates the railway infrastructure and thus the largest railway network in Europe. In rail transport, the company generates about half of its total revenue. The other half of the operating business comprises the further transport and logistics business as well as various service providers. The company generates big part of its sales through public transport contracts. Like every modern company it has changed from year to year, as can be seen in Table 1.

Investing in a better tomorrow for many years, new market data collated every year show the improvement and the growth from one year to another at DB, more details presented in Table 2.

From the beginning of 2003 to the beginning of 2017 the group sales of the company grew from 23,029 billion EUR to 42,7 – a growth of almost 182% in 14 years. The investment and continuous development can be seen also in the growth of employees from 242,759 in 2003 to 310,937 by end of 2017.

On November 30, 2003, Deutsche Bahn had a total of 282,3 million tons of freight transport going up to 400,2 million tons in 2017. Based on the current investment and digitalization plan, the number is expected to grow even more by 2025 (Figure No. 1). Since 2011, the company has distributed a dividend of 500 million euros to the federal government as the sole owner. In 2012, a dividend of € 525 million was paid out, € 200 million in 2013, € 700 million in 2014 and € 850 million in 2015 and 2016, respectively. From 2017, the DB lowered the dividend distribution to 600 million euros. For several years, the dividend has been fully paid back as investment to the company.

DB group is divided in multiple departments such DB Long Distance, DB Regional, DB Arriva, DB Cargo, DB Schenker, DB Netze Track, DB Netze Stations or DB Netze Energy – each one of them has an independent management and business model structure. The overview of revenues per each department on internal and external activities can be seen in Table No. 3.

Innovative business model at DB in the Fourth Industrial Revolution

New technologies facilitate new ways of collaborating. Storing data in encrypted form in the cloud with DB Office 365, for example, makes it easy for colleagues to work on a document at the same time, whether in the office, travelling on the ICE or working on-site at the customer. By using tablets provided by Deutsche Bahn, train drivers are now more independent and, for example, receive timetable instructions in digital form. Meanwhile, new working hours and workplace models are also being discussed at Deutsche Bahn and initial employer/works council agreements and collective agreements have been concluded. New working model at DB can be seen in Figure No. 2.

The use of social media in the corporate context – also referred to as social intranets – brings employees closer together and connects colleagues Group-wide. DB Systel's powerhouse for innovation, provides fresh momentum for developing new ideas based on creative methods such as design thinking. (Biehounek et al., 2015).

New technologies also facilitate new forms of teaching and learning. For instance, virtual reality (VR) – immersion in a digital reality – is not simply a visualization tool for engineers at Deutsche Bahn. With EVE (engaging virtual education), for example, it also plays an active role in driver training. New forms of collaborative learning, such as "pair programming" in software development or the "BarCamp" conference format based on the "Open Space" method are used successfully at DB Systel. Digital formats for professional development, such as webcasts or "blended

learning" are now an indispensable part of everyday professional and career development.

Digitization is radically changing the mobility market. "Customer needs are changing ever faster and becoming increasingly individual. Mobile platforms support the flexible use of various modes of transport – no matter where, no matter when" (Deutsche Bahn AG, 2018). Autonomous driving is gradually becoming a reality. "The boundaries between public transport and motorized individual transport are set to disappear in the near future" (Deutsche Bahn AG, 2018). A fundamental question will remain, however: How should people and goods get simply, safely and reliably from A to B while protecting the environment? "Finding new answers to this question is the key to entrepreneurial success in the age of digital mobility, and one of the main missions for DB" (Deutsche Bahn AG, 2018).

Deutsche Bahn wants to use a digitization offensive to improve its processes and offers. Around 150 projects are currently working on new applications and business models throughout the Group in order to keep pace with the changing mobility and logistics market. In the past, Deutsche Bahn has already provided a number of digital passenger services with its website bahn.de, the DB Navigator, the multimodal information app Qixxit as well as the apps for the DB car sharing service Flinkster and the DB bike sharing service Call a Bike started. There are also corresponding IT applications and systems in logistics, infrastructure and internal processes.

At its heart lies the use of innovative digital technologies and the promotion of those technologies that underpin this transformation. Whether industry collaborates, startups, university institutes or the hacker community, DB is specifically opening up to new forms of cooperation to deliver improvements for customers and employees rapidly. "Internet of Things (IoT) applications, drones, 3-D printing, or virtual and mixed reality are already helping improve quality and customer orientation" (Deutsche Bahn AG, 2018).

Based on the term "Industry 4.0", which describes the computerization of production technology, the marketing concept "Mobility 4.0" was created. This includes, on the one hand, greater use and integration of IT in traffic and logistics processes, as well as greater networking among the different modes of transport. Deutsche Bahn uses the term "Mobility 4.0" to market its digitization services in passenger transport.

Mobility 4.0 - DB aims to create a digital customer experience, whether on the train, in the car, autonomous bus or with a hire cycle. That starts with planning the journey and extends right through to billing and customer feedback. "The aim is to map all routes from A to B digitally to offer every customer the right solution – commuters as well as business travelers and holidaymakers" (Deutsche Bahn AG, 2018). Key to this is further networking the various modes of transport, as well as the physical and digital offerings. For that reason, DB also funds ride-sharing services, taxi and limousine services, or mobility comparison portals by investing in startups.

Since 2016 - passengers of the second class have been allowed to use the hotspots in the ICE trains free of charge.

Social Content Hub - At the beginning of 2015, DB Bahn launched its new owned media portal, inside.bahn.de, which is the central starting point for active customer interaction and is supplemented by the existing social media service channels. The Social Content Hub fulfills user expectations for inspiration, backgrounds, (self) help and interesting and entertaining content around the passenger traffic of Deutsche Bahn.

Door-to-door on BAHN.de and in the DB Navigator - The travel information will in future be visualized with a map that also includes rental bikes and car-sharing offers from DB. Perspectively, the passengers in the station will "be taken by the hand", directed to the right track, reserved seats and accompanied to their destination.

Infrastructure 4.0 - Using sensors and big data analyses, DB can monitor the condition of railway equipment or vehicles remotely in real time and then maintain them precisely when necessary. The successive introduction of the state-of-the-art train control system ETCS (European Train Control System) and digital points also form part of digitalizing the infrastructure.

Multicopter DB Security - DB Security wants to track metal thieves and graffiti sprayers with the help of drones. However, German authorities have so far refused to issue necessary night-flight permits. In addition, there are no legal regulations for the immersion flight (flight without direct visual contact).

RIM - Rail-in-Motion (RiM) allows employees with a locally flexible workplace, such as train drivers, to retrieve all necessary information on a single device in a situation-specific manner.

Production 4.0 - Industrialization of the timetable (neXt) - DB Netz has been working on the project "neXt (EU freight corridors)" since the beginning of 2010. This project will systematically introduce precast routes. Instead of tailoring road trains in addition to the annual timetable, as hitherto especially freight trains in occasional traffic, these are to be prepared in advance and offered to the customer as if from a catalog. For this purpose, DB Netz determines conceivable driving possibilities between nodes within certain time windows in advance. The order of the routes should be made via "click & ride". The project "neXt" on the EU corridors 1, 3 and 8 including some of the alternative routes should be realized. In the final state, "Next" is to be used to create the complete timetable - from

the long-term planning, which is drafted five years in advance, to the train path allocation in the network timetable four months before its entry into force. In addition, the capacity for construction work is considered.

Netzwerkbahn - The parallel production systems block train and single wagon are to be intelligently combined. In today's single wagon traffic production, wagons and wagon groups are routed to their destination through a largely hierarchical network. In this case, the car or group of cars are collected with operating trips from the customer or collection points (eg empty cars) and connected trains. In block trains, however, cars with mainly large and stable quantities are usually run without detours and changes in the shunting and node stations from their start to the finish. In current planning, single wagons and block trains are considered separately, which makes us less flexible in responding to changes in our customers. By producing in a "network", DB Schenker Rail reduces the utilization of resources to a uniform level. This creates the possibility to ensure steady transport even with volatile volumes, which can have a positive effect on the storage capacities of the customers. In addition, the flexibility and individuality of transports grows. At the same time, the bundling of systems will create capacity in the plants and on the routes.

Other projects part of *IT 4.0* are the focus on Internet of Things and Big Data or monitoring the external influences on the goods, checking the delivery time (real time data analyzes), GPS real-time monitoring on the Internet (24/7) savings. Industry customers can already track freight shipments in real time, including temperature fluctuations or vibrations in the container. Innovative storage solutions form part of the customer benefit when digitizing logistics processes, which DB is specifically promoting. "Online portals are also gradually improving access to transport services and boosting efficiency at the customer interface" (Deutsche Bahn AG, 2018). In freight transport, more than 600 "intelligent locomotives" are already in service on the German rail network, autonomously collecting data on their condition. By the end of 2020, up to 2,000 intelligent locomotives will be running across Europe, making rail operations for freight transport even more stable.

A business model is an architecture of value creation, that is, how the benefits are generated for the customers. This architecture includes a description of the different stages of value creation and the various economic agents and their roles in value creation. Every business has a business model because it is simply the description of their activity, nothing more, nothing less. Having a business model is not a strategy. A conscious change of the business model can be a strategy. They can be the starting point for innovations, companies can consciously change parts of their business model and try to work out an advantage over their competitors – this is the direction DB Group is growing, innovating and changing its strategy and business plan to satisfy all its customers.

DB tackles digitization in three areas - with new offerings at the customer interface, in operational and administrative processes, and with the development of new data-based business models. For this purpose, DB alone is investing about one billion euros in digitization projects throughout the company, and by 2019 will be providing an additional 100 million euros in venture capital in order to specifically promote start-up and start-up activities. In the meantime, digitization at DB has many facets, and new ones are constantly being added. Electronic newspapers and sightseeing tips in the ICE portal entertain travelers on long train journeys, including personalized travel information. Starting with spring, series and feature films will be added. Also, customers will be able to use car-sharing cars as well as electric scooters. Industrial customers can already track freight transports in real time, even temperature fluctuations or vibrations in the container. First fully automatic rail vehicles are being tested. Already driverless shuttle buses are rolling on the street in regular service, autonomous, networked trucks (platooning) will follow.

DB’s core service is to bring millions of passengers in regional and international transport each day to their desired destination in a punctual, safe, comfortable and environmentally friendly way. In strong connection with the digitization strategy and divided through multiple departments (as can be seen in Table 3) DB follows a core business plan, which is adjusted depending on each department. (The business plan is visible in Figure No. 3).

CONCLUSIONS

Every company, whether it is aware of it or not, has a business model. "The business model arises when a company is founded and develops continuously until it becomes economically viable" (Lead Innovation Blog, 2018). The exciting thing about business models is that a company not only has to concentrate on one model, but can operate several at the same time. The same applies also with DB, as it has under its umbrella several groups.

The innovative business model at DB provides many levers for innovation to deliver greater customer value, attract new customer groups or generate additional revenue. Innovations in all functions within the company, whether through purchasing, production, marketing or sales, can revolutionize a business model. Such innovations are also great levers to differentiate themselves from the competition. With the successful implementation of programs like Mobility 4.0, Infrastructure 4.0, Production 4.0 and IT 4.0 – DB has succeeded in

increasing their value, customer satisfaction or revenue on all levels. Continuing to invest in the future either in human capital, new technologies or their core processes – Deutsche Bahn AG is one of the main pioneers when it comes to innovation in their existing business models in the Fourth Industrial Revolution.

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ANNEXES

Table No. 1
Main achievements since the privatization of DB.

Milestone	Achievment
1994	The DB was founded with the entry in the commercial register of the city of Berlin. Berlin was headquartered on 4 January, Heinz Dürr was the first CEO.
1996	The regional railways were regionalized. The federal states directly ordered transport services with federal funds, because the tasks for local traffic were transferred to the federal states.
1997	The headquarters of Deutsche Bahn moved to Berlin, again in the fall of 2000 in the railway tower on Potsdamer Platz.
1998	The new railway line for high-speed traffic from Hanover to Berlin was opened. Travel times between Berlin and many destinations in western and southern Germany were shortened by about three quarters of an hour.
1993 - 1999	Another point of the 1993 railway reform came into effect on 1 June 1999, with retroactive effect from 1 January 1999, when its own joint stock companies for passenger transport (two companies), freight, network and stations were set up under the umbrella of a holding company. With the exception of the public limited company for railway stations, the foundations were so-called statutory "compulsory foundations".
2001 - 2010	DB operated the TV station Bahn TV
2002	With the timetable change on 15 December 2002, numerous changes came into force. A new pricing system was put into effect, 45.000 employees received new service contracts. At the same time, seven intercity express lines were operated via the new high-speed line Cologne-Rhine / Main.
2004	The Berlin-Hamburg extension line was put into operation at speeds of up to 230 km / h. Travel time on the 286 rail kilometers shortened to one and a half hours. In the following months, the number of passengers on this route rose sharply. The "Charter of rail passenger transport" of the Community of European Railways (GEB) has been implemented.
2006	Many new routes, such as the Nord-Süd-Fernbahn tunnel (Tiergartentunnel), with a total of six new stations (Berlin Hauptbahnhof, Gesundbrunnen, Jungfernheide, Potsdamer Platz, Südkreuz, Lichterfelde Ost) were opened on 28 May 2006. Upgraded line Berlin-Halle / Leipzig for 200 km / h and the high-speed line Nuremberg-Ingolstadt-Munich led to significantly reduced travel times.
2006	A new timetable came into force. Since then, the Intercity Express lines Munich-Nuremberg-Leipzig-Berlin-Hamburg and Munich-Nuremberg-Frankfurt-Cologne have been operating every hour. Between Nuremberg and Munich, as well as between Frankfurt and Cologne, an Intercity Express half-hour was made, in Leipzig, an hourly Intercity Express connection to and from Dresden was created. The full commissioning of the high-speed line Nuremberg-Ingolstadt-Munich reduced many travel times to and from Munich by about half an hour. On the Franconia-Saxony-Magistrale regional trains replaced the previously used Intercitys.
2007 - 2012	DB held a ten percent stake in the European rail company Thalys
2010	DB announced a public tender offer worth € 2.9 billion for the listed British transport company Arriva. The sale was completed on August 27, 2010.
2015	The company presented the "Future Rail" program. The quality of rail transport will be improved in three stages. For this, by 2020, 700 million euros will be spent.
2017	The Digitization Strategy of Deutsche Bahn.
Present - 2023	Automatic operation are planned in parts of the network.

Note. Source: Author's own creation after DB website.

Table No. 2
Development of DB over the years.

End of 31 December	2003	2010	2017
Group sales (€ billion)	23,029	34,41	42,7
Group result (€ billion)	−0,245	1,058	0,765
Consolidated total assets (€ billion)	47,647	52,003	56,436
Employees	242.759	276.310	310.935
Stations and stops	5.665	5.700	5.795
Company's own rail network (km)	35.593	33.723	36.003
Passenger transport services			
Travellers (billions)	1,682	1,95	2,251
Passenger-kilometres (billion)	69,534	78,582	88,636
Transport performance freight transport			
Freight transport (million tons)	282,3	415,4	400,2
Tonne-kilometres (billion)	79,864	105,794	98,445
Transport services DB rail network (DB Netz AG)			
Train kilometres DB trains (million)	917,8	1.034	1.188
Train kilometres of external companies (million)	71	195	249

Note. Source: Author's own creation after DB website.

Table No. 3
Revenue of DB Group.

Revenues adjusted (million €)	Total revenues		Change		External revenues		Change	
	2017	2016	absolute	%	2017	2016	absolute	%
DB Long-Distance	4,347	4,159	+ 188	+ 4.5	4,193	4,012	+ 181	+ 4.5
DB Regional	8,734	8,653	+ 81	+ 0.9	8,629	8,529	+ 100	+ 1.2
DB Arriva	5,345	5,093	+ 252	+ 4.9	5,338	5,085	+ 253	+ 5.0
DB Cargo	4,528	4,560	– 32	– 0.7	4,209	4,230	– 21	– 0.5
DB Schenker	16,430	15,128	+ 1,302	+ 8.6	16,345	15,059	+ 1,286	+ 8.5
DB Netze Track	5,364	5,228	+ 136	+ 2.6	1,522	1,408	+ 114	+ 8.1
DB Netze Stations	1,265	1,233	+ 32	+ 2.6	540	519	+ 21	+ 4.0
DB Netze Energy	2,794	2,779	+ 15	+ 0.5	1,301	1,194	+ 107	+ 9.0
Other	4,854	4,588	+ 266	+ 5.8	627	540	+ 87	+ 16.1
Consolidation	– 10,957	– 10,845	– 112	+ 1.0	–	–	–	–
DB Group	42,704	40,576	+ 2,128	+ 5.2	42,704	40,576	+ 2,128	+ 5.2

Note. Source: Author's own creation after DB website.

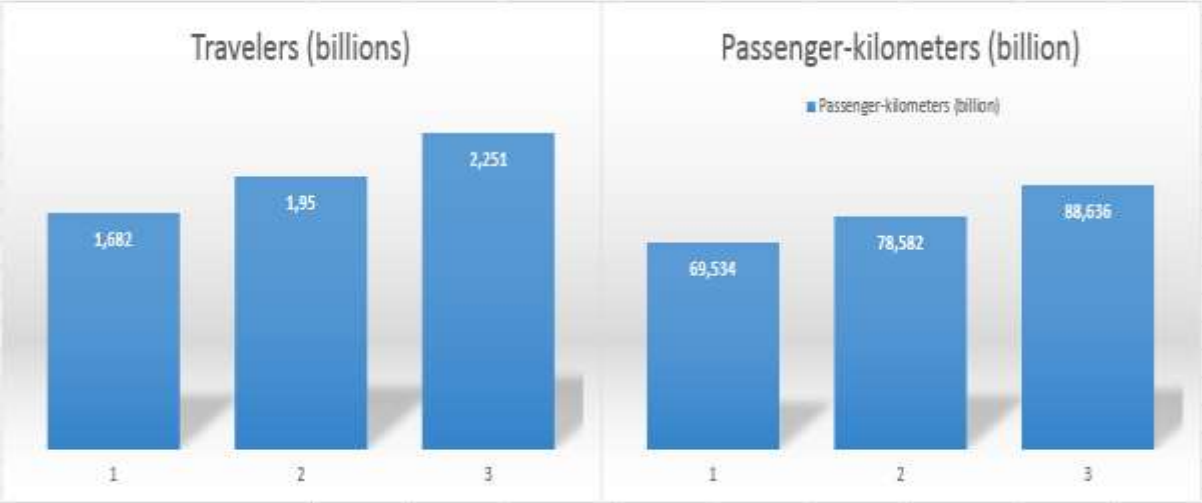

Figure No. 1 Growth of the number of travellers and kilometres from 2003(1), 2010(2) and 2017(3).
Note. Author's own creation.

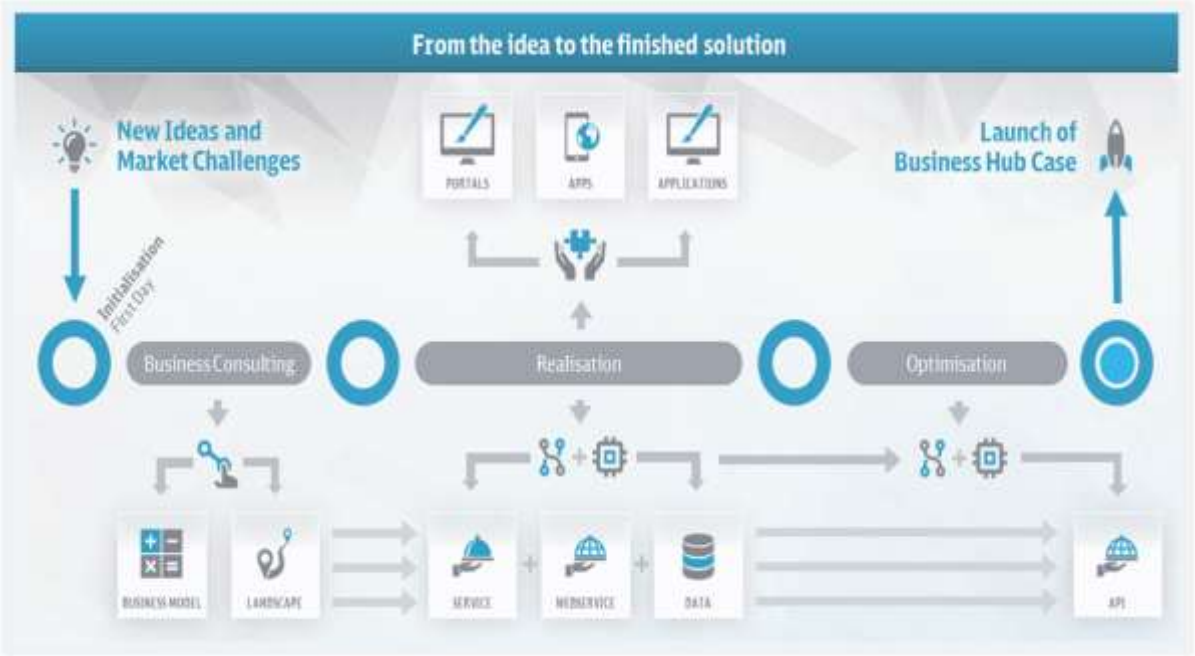

Figure No. 2 New working model at DB. From an idea to the finished solution
Note. Source: DB Systel GmbH.

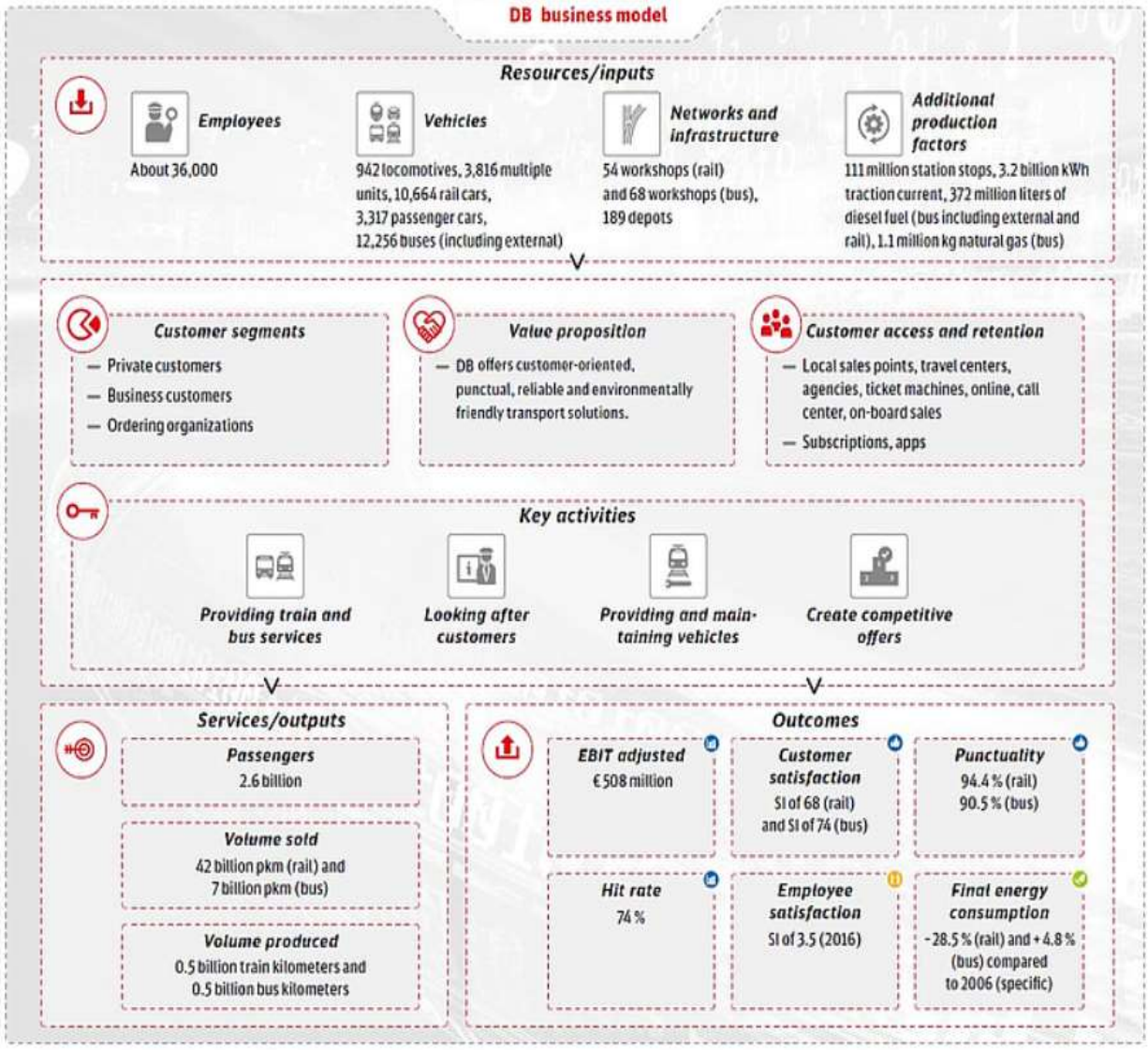

Figure No. 3 DB business model
Note. Source: DB website.