

STARTUPS AND INNOVATIONS BASED ON 5G TECHNOLOGY IN WESTERN BALKAN COUNTRIES - OPPORTUNITIES AND LIMITATIONS

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Abstract—5G technology, as the fifth generation of high-speed mobile networks, represents a new phase in the development of mobile communications and the opportunities it offers are enormous. Startups that creatively use this technology will not only transform their businesses but will also contribute to the evolution of entire industries. The aim of this article is to show that there is still a lot of space for the development of startups in the countries of the region, especially with the introduction and development of 5G technologies.

Keywords—5G, startup, regulator, business model canvas

I. INTRODUCTION

Services based on 5G technology are key to a wide range of innovative applications and have the power to reshape various sectors of the economy and improve the daily lives of citizens, while startups take advantage of the market changes caused by technological progress.

TABLE I. STARTUP INDEX IN THE WESTERN BALKAN COUNTRIES

No.	Country	Rank	Total Score
1	Croatia	48	4.564
2	Serbia	53	3.195
3	Albania	71	0.970
4	N. Macedonia	77	0.850
5	Bosnia and Herzegovina	96	0.454

Table I show ranking of the Western Balkan countries compared to the global ranking of world countries by number of startups [1].

By focusing on innovative solutions in smart cities, healthcare, entertainment, manufacturing and agriculture, entrepreneurs can lead the 5G revolution. The key to success will be understanding the unique capabilities of 5G and applying them to solve real-life problems.

II. IDENTIFYING BUSINESS OPPORTUNITIES BASED ON 5G TECHNOLOGY

The introduction of new technologies never has the same effect on the transformation and growth of production capabilities of different sectors of the economy, and so it is with 5G technology, although it is designed to generate enormous value for the global economy. While in some sectors a complete transformation of the way production activities is carried out and the development of completely new products and technologies can be expected, in some other, predominantly traditional service industries, the availability of 5G will not have such a great impact.

Figure 1 illustrates the expected key beneficiaries of investments within the 5G market. Investment in 5G networks will benefit various stakeholders in the 5G market value chain, including service providers consisting of traditional MNOs and private service providers; industry partners such as public/government institutions, private enterprises and vertical markets; and equipment manufacturers, device manufacturers and technology providers.

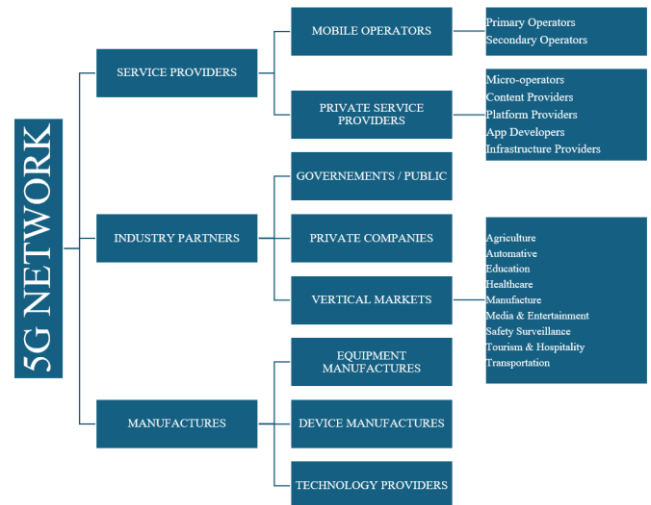


Fig. 1. 5G Key Investment Beneficiaries. [2]

Below are identified the vertical industries and application scenarios of 5G technologies that leave the most space for startups.

A. Advanced Manufacturing Solutions

Startups can focus on:

- Real-time monitoring: Developing applications that use sensors to monitor equipment performance and predict maintenance needs.
- Automated supply chain management: Implementing IoT devices to track inventory and optimize logistics. 5G can transform fleet management systems by offering real-time tracking, navigation, and communication. Owners can use software that monitors vehicle health, tracks deliveries, and optimizes routes – all in real time.
- Wireless networks in factories enable faster and more accurate communication between machines and devices and monitor production performance.

B. Agricultural Technology

- Precision agriculture - using drones and sensors to monitor crop health, environment and climate conditions in real time or livestock monitoring: using IoT devices to track the health and location of livestock.
- Automatic irrigation systems involve the implementation of smart irrigation solutions that respond to real-time weather data.

C. Augmented Reality and Virtual Reality Applications

Technological advances have significantly impacted lifestyles, demanding fast connectivity and enhanced user experience. At a time when virtual and physical collide, with the capabilities provided by 5G technology, companies can create immersive experiences for customers, whether it's interactive ads, virtual showrooms, virtual store tours or even AR games.

Telecommunications companies can leverage AR for customer support and troubleshooting, as well as transforming network maintenance and infrastructure management processes. Real-time assistance from remote experts will be enabled, reducing the need for on-site visits and increasing operational efficiency.

In virtual classrooms, AR and VR can be used to create interactive and engaging learning environments that entertain students and improve their understanding of complex subjects.

D. Energy Management Solutions

Companies in this sector recognize the possibilities of implementing solutions based on 5G technologies and networks within their business, both in the production process and in the transmission and distribution of electricity. This is especially important since electricity production from both conventional and renewable energy sources is represented in the Western Balkan countries.

Companies that focus on renewable energy can offer end users solutions to gain insight into their energy consumption,

enabling better efficiency and lower maintenance costs for energy systems.

The transmission of metering data from multiple metering points at high speeds with low latency is a challenge for power systems. Improving the reading of user consumption through remotely readable meters is also of interest to companies in this sector, to automate readings, operate almost instantly, reduce the possibility of errors and process delays, while at the same time engaging as few people as possible [3].

E. E-commerce Improvements

In recent years, online sales have been growing rapidly, and this trend has intensified further during the global COVID-19 pandemic. We can certainly expect this trend to continue in the future, with the addition of options that allow customers to purchase personalized products.

The availability of 5G technology will enable the development of various consumer applications. An example is interactive virtual mirrors through which you can try on certain clothes, without the need to go to a physical store. With appropriate software support, such an application can suggest other clothing items that match the selected item in style, color and size.

5G can also help automate supply chain processes. Retailers or shopping malls can use smart sensors and IoT devices to track and manage the movement of goods through the supply chain. This reduces human error, speeds up delivery times, and improves overall supply chain performance.

F. Logistics

The use of IoT technology based on 5G networks enables real-time tracking of shipments, assets and people throughout the logistics value chain, from warehouses, long-distance transport to delivery to end customers. A prerequisite for real-time tracking of shipments is the installation of sensors on the means of transport and the goods themselves. The availability of real-time information also enables better connectivity of transport companies with the network of customers and suppliers, thus minimizing the distance that vehicles travel without goods.

For example, IoT sensors can be attached to individual items to accurately identify and locate them, significantly improving shelf storage, managing inventory and picking operations (the process of removing goods from storage locations based on customer requests) and packaging, with a detailed understanding of where exactly a particular product is at any given time.

The use of 5G technology also brings certain benefits to the end user. The end user would have the ability to manage their shipments by scheduling a delivery date and time, combining deliveries if they are expecting two or more shipments, and so on. All these capabilities contribute to efficiency, cost reduction, and customer satisfaction.

G. Partnership with Mobile Operators

Mobile operators often seek partnerships with startups to stay competitive, drive innovation, and adapt to rapidly changing technology landscapes. Main benefits which mobile operators can have from cooperation with startups are:

- Innovation and agility,
- New revenue streams,
- Access to emerging technologies,
- Customer experience enhancement,
- Cost efficiency,
- Digital transformation [4].

Startups play a key role in helping telecom operators unlock the full potential of 5G by delivering innovative solutions, accelerating deployments, and enabling new revenue-generating use cases.

5G Use cases startups can enable for telecom operators are:

- Smart Manufacturing (Industry 4.0) - real-time monitoring, predictive maintenance, remote robotics; example: a startup offering a low-latency robot control platform via private 5G networks in factories,
- AR/VR for consumer and enterprise - immersive gaming, remote assistance, virtual training; example: a startup offering remote maintenance support via AR glasses powered by 5G edge connectivity,
- Autonomous vehicles and drones - vehicle-to-everything (V2X) communication, drone delivery, real-time video analytics; example: a drone startup collaborating with telcos to offer B2B logistics over 5G infrastructure,
- Smart cities - smart traffic, surveillance, waste management, and infrastructure monitoring; example: a startup deploying real-time traffic analytics using 5G edge computing,
- 5G network tools - planning, monitoring, securing, and managing 5G networks; example: a startup offering AI-powered network slicing management or zero-touch provisioning.

III. CURRENT STATE AND ROLE OF THE REGULATOR

Key areas that still require special commitment to create the necessary climate for digital transition in our region are broadband connectivity, 5G coverage and penetration, especially in rural areas, data interoperability and data security, integration of digital technologies by enterprises, and digitalization of Public Administration. Broadband penetration and interoperability of public and private sector services are essential for creating a cohesive and vibrant regional market that stimulates economic growth, creates more jobs, fosters innovation and prepares the Balkan region for its alignment with the EU's single digital market. In this regard, a Memorandum of Understanding on the 5G Roadmap for Digital Transformation in the Western Balkans was signed in October 2020 [5].

Although we see that the potential of 5G technologies is very large, there are challenges to their introduction that should be considered at the level of each individual country:

- Infrastructure costs: Building the necessary infrastructure for 5G can be expensive and time-

consuming, and the construction of common infrastructure is not yet regulated in the Western Balkan countries.

- Regulatory Obstacles: Managing regulations and obtaining permits can be complex, time-consuming and expensive.
- Security issues: With increased capabilities comes the need for enhanced cyber security measures.

The role of the regulator is to, in addition to adopting the necessary regulations and defining the conditions for issuing licenses, identify all potential applications of 5G technology and develop their scenarios from the aspect of the necessary licenses and the procedure for obtaining them, given that numerous vertical industries will also be the end users of this technology and apply it for their own needs, not just mobile operators.

It is also necessary to foresee the implementation of pilot projects to enable testing of 5G technologies on a non-commercial basis, and this must be carried out in coordination with mobile operators.

In parallel with all the above activities, the regulator should actively work on raising awareness about the benefits and communicating the risks of introducing 5G mobile communication networks. It is extremely important to adequately respond to the identified public concerns regarding the impact of electromagnetic emissions on the environment and the safety of 5G networks.

Below is an overview of the situation in individual Western Balkan countries in terms of regulatory conditions for the introduction of 5G technologies and how far they have come.

A. Bosnia and Herzegovina Delay's 5G Launch

Looking at the example of Bosnia and Herzegovina, the first task relates to the harmonization of the regulatory framework in the field of electronic communications with EU regulations, which implies amending the existing Communications Law or adopting a new one in order to align it with Directive (EU) 2018/1972 on the European Electronic Communications Code (EECC) [6] and adopting the Sectoral Electronic Communications Policy of Bosnia and Herzegovina for the period 2023-2027. As a follow-up, it is necessary to align Rule 86/2018 – Plan for the Use and Allocation of Radio Frequency Spectrum in Bosnia and Herzegovina[7] with international regulations relating to the implementation of 5G networks, and to adopt a Decision setting the deadline for granting a license for the use of RF spectrum for the provision of services via the 5G network, the conditions for issuing licenses and the price, method and procedure for payment.

The second step involves ensuring the uninterrupted use of radio frequencies from the range for the implementation of 5G mobile networks throughout the territory of BiH and requires the release of the 3400-3800 MHz range. Previously, this band was intended for fixed access networks, and accordingly, on the state territory of Bosnia and Herzegovina, frequency blocks from this band were allocated to the Ministry of Security and the Identification Document Agency (IDDEA). Compatibility studies of 5G and fixed access networks have shown that these networks cannot coexist in the same geographical area and in the same

frequency blocks, therefore it is necessary to free up spectrum for the implementation of 5G.

B. Start of Procedure to Deploy 5G Networks in Serbia

In 2019, based on the Regulator's request, the Faculty of Electrical Engineering in Belgrade developed a Study on the selection of the optimal auction model for frequency bands for existing and new 5G Technologies [8]. The Radio Frequency Allocation Plan and RF Frequency Allocation Plans for the 700 MHz, 2500-2690 MHz and 3.6 GHz bands were adopted in accordance with the European Frequency Allocation Table (2020-2021) [9]. All 5G pioneer bands are available for MFCN. Since 2019, testing in the 700 MHz and 3.6 GHz bands has been conducted in science and technology parks in 3 cities. These networks have remained open, thus providing an environment for digital companies, start-ups, students, etc. to test and use different 5G use cases. The 800 MHz and 2.1 GHz bands have also been tested for dynamic spectrum sharing. Following the expressed interest in using the 700 MHz, 900 MHz, 2.1 GHz, 2.6 GHz and 3.6 GHz bands, the Regulator decided in October 2021 that the conditions for issuing licenses for the use of spectrum in the 700 MHz, 2500-2690 GHz bands are met [10].

The start of the procedure involves the publication of a draft rulebook on the minimum conditions for issuing individual licenses for the use of radio frequency spectrum based on a public tender procedure in certain radio frequency bands and the holding of public consultations for a period of 30 days. After the public consultations, the final version of the draft rulebook will be prepared and published, after which the Regulatory Authority for Electronic Communications and Postal Services (RATEL) will conduct a public tender procedure for the allocation of radio frequency bands required for the introduction of next-generation mobile networks. The Ministry expects RATEL to complete the procedure by mid-2025.

C. Montenegro as one of the 5G Pioneers in the Region

The roadmap for the introduction of 5G mobile communication networks with a detailed action plan for 2022 was adopted in December 2021, as the first step in creating the 5G Strategy [11]. In August 2023, the Strategy for the Development of 5G Mobile Communication Networks in Montenegro 2023-2027 was adopted, with the Action Plan 2023-2024[12]. Activities to complete the regulatory and technical framework for the use of frequencies for the early implementation of 5G networks were completed with the adoption of the Radio Frequency Allocation Plan and the allocation plans for MFCN in the 700 MHz, 3.6 GHz and 26 GHz bands, as well as the revision of the allocation plan for 9 MHz, 10 MHz in the 700 MHz, 3.6 GHz and 26 GHz bands. MHz, 2 GHz and 2.6 GHz bands to enable the implementation of the new radio technology [13].

Mobile operators are testing 5G in the 3.6 GHz band based on provisional licenses issued in April 2022. Crnogorski Telekom and One Crna Gora launched commercial 5G DSS networks using the 2 GHz and 2.6 GHz bands in Q1 and Q2 2022. Mtel launched 5G services in the urban area of Podgorica. DSS-based 5G signal is available to more than 80% of the total population of Montenegro. 5G DSS services are available in every municipality [14].

D. 5G Further Expanded in North Macedonia

The 5G introduction and development plan was prepared by a working group established by the relevant ministry and adopted in 2019. In 2021, a new by-law related to the annual fee for frequencies was adopted, which foresees a 50-70% reduction in the annual fee for 5G frequencies. [15] A proposal to pay the fee for several installments throughout the year is also under consideration. The radio frequency allocation plan, in accordance with the relevant ITU/CEPT-ECC/ERC recommendations [16], was adopted in 2021.

All 5G pioneer bands are available in North Macedonia. The coordination process for the 700 MHz band with Serbia, Bulgaria and Greece has been completed. Frequency coordination with Albania has also been agreed in technical terms. The two regulators signed a Joint Declaration in February 2022, which will lead to the signing of a formal bilateral agreement for the coordination of the 470-694 MHz band. Both operators have tested 5G, while the first commercial 5G DSS network was launched in February 2022. The first public auction for the 700 MHz and 3.6 GHz bands was launched in 2021, and failed based on a decision of the Commission for the Protection of Competition regarding the legality of the entire process. The second auction for the 700 MHz and 3.6 GHz bands was successfully completed in July 2022. Five licenses were issued in these frequency bands, two licenses (for both mobile operators) in the 700 MHz band and three licenses (for both mobile operators and one for FWA services) in the 3.6 GHz band. The first condition for covering 1 large city with a 5G signal by the end of 2023 has been met. According to the latest measurements carried out by the Regulator in May 2023 in the territory of Skopje, the average data transfer speed is around 200 Mbps regardless of the technology, and the maximum selection is higher than 1000 Mbps [17]. So far, 5G has been implemented in 26 cities in Macedonia.

E. 5G corridor between Albania and Kosovo

The 5G roadmap in Albania was prepared with the support of World Bank experts in 2021. Also, considering the views of Albanian operators on measures to be taken to encourage investment in 5G, the Regulator prepared a study on new technologies for mobile broadband in Albania, which was approved by the Board of Directors in March 2022.[18] The new Radio Frequency Allocation Plan was adopted in December 2020. The 800 MHz tender in 2019 concluded with two 10 MHz band awards to two operators. The 5G pioneer bands of 3.6 GHz and 26 GHz are free of charge. The 700 MHz band is still used for TV broadcasting, although it was already scheduled to be released for mobile services by June 2022.[19] The 700 MHz release process is at an advanced stage, due to technical assistance provided through the IPA project, cooperation between the Regulator and the Audiovisual Media Authority (AMA), as well as neighboring economies. In 2019, one operator successfully tested the 3.6-3.7 GHz band. The Regulator is currently preparing documentation to start consultations for licensing 5G networks in the available pioneer bands during 2024.

Three licenses for 5G testing have been issued in Kosovo: two for university campuses in Prizren and Prishtina, while one license was issued to a mobile operator for testing in different locations. During 2022, the Regulator reduced the annual frequency fees by 40%. In early 2023, the

first 5G licenses were issued, in the 800MHz and 3.6 GHz bands [20]. Operators were given a grace period of 2 years, as well as the possibility of paying the license in installments. Based on the prepared new methodology, the frequency fee was reduced by 50%. The coverage obligation imposed on operators is 90% of the territory of Kosovo by 2029. The regulator also allocated capacity for the first private 5G network (90 MHz in the 3710-3800 MHz band).

IV. ECONOMIC EFFECTS OF THE DEVELOPMENT OF 5G TECHNOLOGY

In the past period, research and assessments of the impact of 5G technology availability have been mainly conducted, while not enough attention has been paid to the analysis of the various effects that the development and introduction of 5G technologies can have on the business of entrepreneurs, observed by sector or region. Cultural, institutional and regulatory differences can make a region more suitable ground for the development and application of 5G technologies. Also, different business models, structure and market orientation of entrepreneurs play a very important role in their readiness to adopt and approach the application of new technologies, such as 5G. The aim is to assess what effect the application of 5G technologies has on the creation of new businesses, customer relations, payment models, business costs and logistics.

One of the most significant impacts of the ongoing 5G revolution is the opportunity it creates for startups to innovate and enter various industries. 5G, as a transformative technology that enables new applications, services, and business models that were not possible before, significantly influences startup investment decisions by opening new market opportunities, fostering technological innovation, enabling scalability, improving user experience, facilitating data analysis, and fostering infrastructure development.

The deployment of 5G technology is expected to dramatically improve the performance of customer relationship management (CRM) systems by enabling faster and more reliable access to customer data. This is crucial for organizations aiming to provide real-time responses and personalized customer experiences. The low latency and high data rate capabilities enable the seamless integration of advanced technologies such as artificial intelligence (AI) and machine learning (ML) into CRM systems [21]. These technologies can analyze vast amounts of data in real time, providing insights that can help organizations predict customer behavior, personalize offers, and automate routine tasks. For example, AI-powered chatbots can instantly resolve customer queries, providing a 24/7 customer service solution that is both efficient and scalable.

The increased connectivity offered by 5G allows organizations to collect more detailed and diverse customer data from a wider range of sources, including IoT devices. This data can be used to gain a deeper understanding of customer preferences and behavior, allowing organizations to more effectively determine their business strategies and adapt them to customers.

In terms of payments, 5G significantly accelerates the development of mobile payments, i.e. it enables an increase in the number of devices used for mobile payments, including smartphones and tablets. In addition, due to the increase in speed and reduced latency, the speed of payment

transactions increases, which significantly affects user satisfaction. Due to the low latency, it is possible to apply advanced fraud detection systems, which increases the security of mobile payment transactions and user trust in this payment method.

One of the most significant impacts of 5G technology is its potential to improve operational efficiency in various industrial sectors. The ultra-low latency and high data rates provided by 5G networks enable real-time data processing and communication, which are critical for the implementation of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI) and machine learning. The effect in the form of reduced operating costs is realistically expected in industries such as ICT, agriculture and logistics, while in the manufacturing industry and tourism a slight increase in operating costs can be expected due to the cost of adapting to new technological trends in these areas. In the logistics and transport sector, 5G technology can lead to significant progress by enabling the development of smart logistics systems and autonomous vehicles.

V. BUSINESS MODEL CANVAS

This model provides a comprehensive overview of how a company operating within a modern technological framework can structure its business strategy [22]. By aligning with modern technologies, such as 5G technology and IoT, companies can adapt their components such as partnerships and revenue streams to thrive in this dynamic landscape.

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
<ul style="list-style-type: none"> Mobile Network Operators Content Providers Network Infrastructure and Equipment Manufacturers Regulator Facility Owners and Users 	<ul style="list-style-type: none"> 5G Network Construction Spectrum Management 5G Technology Development Network Maintenance Marketing and Sales Competitive Management 	<ul style="list-style-type: none"> Customized services Increased connectivity Increased user satisfaction New business opportunities for startups 	<ul style="list-style-type: none"> Consultative approach User feedback 	<ul style="list-style-type: none"> Telecom operators Vertical industries Developers and innovators Private networks Government and public sector End users
Key Resources			Channels	
<ul style="list-style-type: none"> 5G infrastructure Trained workforce 			<ul style="list-style-type: none"> Direct Sales Partnerships Online portals 	
Cost Structure		Revenue Streams		
<ul style="list-style-type: none"> Infrastructure costs Launch of 5G Platform costs Marketing and sales costs 		<ul style="list-style-type: none"> Subscription to the network slices Billing based on throughput, reduced latency, data volume, etc. Premium services 		

Fig. 2. Business Canvas Model.

As important as mobile operators are and have been identified as key partners for 5G technology, equally important are equipment manufacturers and network infrastructure itself, content providers, and regulators, who are responsible for laying the foundations for the use of the technology and identifying potential applications. Technology development and construction of 5G networks are critical activities without which further development of potential applications and benefits are not possible. Customized services and the ability to connect many devices will result in increased revenue sources, which will result in monetization of investments in the 5G network. Granting licenses for the use of 5G spectrum and efficient spectrum management to prevent interference and interoperability between private and public networks is a very challenging activity that precedes the construction of networks and is therefore of great importance [23].

A consultative approach and agility in the way of working are key to maintaining good customer relationships. Providing continuous support and guarantees of high-quality services is essential. Identifying and understanding the target groups for 5G technology is crucial to exploit market opportunities and trigger growth. Key market segments include telecom operators, vertical industries, developers and innovators, government institutions and the public sector, and end users. By tailoring marketing strategies and solutions to the specific needs of these segments, companies can effectively position themselves in the competitive 5G market and contribute to improving global connectivity. The Canvas model suggests various channels, such as direct sales teams that deal with enterprises and developers, partnerships in specific industries such as automotive, gaming, IoT device manufacturers, etc., and also self-service online portals for smaller customers [24]. Infrastructure costs such as network development and maintenance, finances allocated for the introduction and construction of the 5G network, and sales and marketing costs to promote new technologies are included in the cost structure.

VI. CONCLUSION

The deployment of 5G technologies in Western Balkan countries presents a transformative opportunity for startups. By offering ultra-low latency, high-speed connectivity and ability to support massive device networks, 5G serves as a critical enabler for disruptive applications across sectors such as smart agriculture, e-health, logistics, advanced manufacturing, and immersive media.

Startups in the region can leverage 5G to create novel solutions tailored to local needs while remaining globally competitive. The emerging startup ecosystems in Western Balkan countries are gradually aligning with the digital transformation trends seen across the EU, supported by international funding, government strategies, and public-private partnerships.

Despite its many benefits, the deployment of 5G technology also brings several challenges. The deployment of 5G infrastructure requires significant investments in new base stations, network upgrades, and the development of compatible devices. In addition, with increased connectivity and high-speed data exchange enabled by 5G networks, concerns about cybersecurity and data privacy are also increasing. Additionally, without stronger collaboration between telecom operators, governments, academia, and startups, the innovation potential of 5G could remain underutilized.

To take the full benefits of 5G, Western Balkan countries must adopt coordinated policies that foster innovation, streamline spectrum management, encourage investment, and nurture tech talent. Only through such comprehensive efforts can the region position itself as a dynamic hub for 5G-enabled startups and next-generation digital innovation.

Generally, the following prerequisites need to be met to further develop the startup ecosystem in the Western Balkan:

- Legally define the term startup to distinguish it from newly established companies.
- Introduction of a state-level startup support program in the form of grants and tax breaks.

- Support for the organization of startup events that connect entrepreneurs, investors and other key ecosystem stakeholders.

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