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РЕЗЮМЕ

За последние несколько десятилетий произошел огромный прогресс в области мобильной беспроводной связи. Этот прогресс длился несколько поколений и продолжается по сей день. Разработка мобильной беспроводной связи началась с 1G, и будущие поколения 2G, 3G, 4G и 5G, 6G, 7G в настоящее время изучаются. В этой статье дается обзор эволюции мобильного поколения путем сравнения проблем и функций, которые развили каждое поколение, и объяснения того, как улучшения были внесены из предыдущего поколения в следующее. В этой статье мы попытались рассмотреть различные поколения мобильных беспроводных технологий с точки зрения их функциональности, производительности, преимуществ и недостатков. Поколение мобильной беспроводной связи (G) обычно относится к изменению характера, скорости, технологии и частоты системы. Каждое поколение имеет определенные стандарты, возможности, методы и новые функции, которые отличают его от предыдущего.

В статье рассматриваются эволюция и развитие различных поколений мобильных беспроводных технологий, а также их важность и преимущества одного перед другим.

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POSSIBILITIES FOR THE APPLICATION OF INFORMATION TECHNOLOGIES IN AGRICULTURE

ANNOTATION

The use of information technology has revolutionized agriculture, providing new solutions to age-old challenges and paving the way for sustainable and efficient farming practices. This article explores the impact of information technology on the agricultural industry, highlighting the ways in which technology has transformed everything from planting and harvesting to supply chain management and marketing. The article examines how farmers can use technologies such as GPS, sensors, drones, and data analytics to optimize crop production, conserve resources, and reduce waste. It also explores how digital platforms can improve communication between farmers, processors, and consumers, enabling more transparency and traceability in the food supply chain. Finally, the article discusses the challenges associated with implementing information technology in agriculture, including the cost of adopting new systems and the need for training and support for farmers. Overall, the article underscores the importance of technology in driving innovation and growth in agriculture, and the need for continued investment in this area to ensure a sustainable future for the industry.

Key words: *Information technologies, the IoT system, agriculture, UAV`s, RFID tags, smart farming, animal husbandry, harvest, modernization.*

Introduction. Building Kazakhstan has a long history of animal husbandry, and it plays a crucial role in the country's economy. Kazakhstan is strategically located at the crossroads of Europe and Asia, making it an important transit point for agricultural goods. The country's position as a transport hub provides a competitive advantage for exporting agricultural products to neighboring countries. With a large territory and population, the Russian Federation imports meat from Kazakhstan to meet its demand, while China has a high consumption rate of beef, creating an opportunity for Kazakhstan to expand its agro-industrial business.

The agricultural sector in Kazakhstan is not only a major contributor to the country's economy but also plays a significant role in providing employment opportunities, particularly in rural areas. As of 2021, approximately 3 million people were employed in the agricultural sector, making up around a quarter of the country's workforce [1].

In addition to its contribution to the GDP, agriculture also plays an important role in the country's exports. According to the National Bank of Kazakhstan, the agricultural sector accounted for 17.7% of the country's total exports in 2020, with the main exports being wheat, flour, and oilseeds [2].

To meet the growing demand and remain competitive, Kazakhstan recognizes the need to adopt new information technologies in agriculture. Therefore, the government of Kazakhstan is increasingly focusing on implementing digital technologies in the agricultural sector to increase labor productivity, enhance the industry's investment attractiveness, improve the quality of products, and reduce production costs.

Kazakhstan's agriculture sector is increasingly focused on animal husbandry, given its importance to the national economy. The country has a large and diverse livestock sector, with significant production of meat, milk, and wool. In this article, we will examine several large agricultural companies in Kazakhstan and the information technologies they are using to improve their operations. We will also observe the various information technologies used in animal husbandry in Kazakhstan and their impact on the sector's productivity and sustainability. Moreover, we will compare the use of information technologies in animal husbandry in Kazakhstan with other countries, such as the United States and India, to provide insights into how Kazakhstan can further improve its adoption of these technologies and remain competitive in the global market.

Materials and research methods. The research on the agriculture sector in Kazakhstan includes an analysis of various state programs aimed at supporting and regulating the agro-industrial complex, promoting digitalization, and fostering green growth.

During the processing of materials and conducting the study, various analytical methods were employed to ensure a comprehensive and accurate analysis. These included an in-depth analysis of

scientific literature, the use of comparison methods, trend monitoring, and other techniques aimed at providing a comprehensive understanding of the subject matter. This approach enabled the identification of key patterns and trends, as well as the formulation of informed conclusions and recommendations.

The utilization of these methods has enabled a thorough examination of the state programs supporting and regulating the agro-industrial complex, digitalization, and green growth in Kazakhstan. The findings of this study provide valuable insights into the current state of the agriculture sector in Kazakhstan, as well as its future prospects.

Through this process, it was found that many countries are adopting digital technologies in agriculture to improve efficiency and increase productivity. These technologies include precision agriculture, drones, sensors, and the Internet of Things (IoT). Precision agriculture involves using data and analytics to optimize crop yields, reduce waste, and increase profits. Drones and sensors can be used for monitoring crops, soil conditions, and weather patterns. IoT devices can be used to collect data and automate processes, improving efficiency and reducing costs [3].

The adoption of digital technologies in agriculture has had a significant impact on productivity and profitability in many countries. For example, in the United States, precision agriculture has been found to increase yields by up to 25%, while reducing costs by up to 15%. In Brazil, the adoption of precision agriculture technologies has led to a 40% increase in productivity [4].

Overall, it is clear that the adoption of digital technologies in agriculture is a growing trend that has the potential to transform the industry. As more and more countries invest in these technologies, it is likely that we will see further improvements in productivity, efficiency, and sustainability in the years to come.

Results and its discussion. One Smart farming involves managing a vast array of technologies, including sensors, drones, apps, and other software and hardware. However, this complexity is overcome by the use of IoT technology, which integrates all available data sources into a single functional system that can be accessed in real-time from the field. This approach to farming has numerous benefits, such as improving crop yields, reducing waste, and optimizing energy, fuel, water, and fertilizer consumption. Moreover, farmers can selectively automate certain processes while retaining others that are better done manually, depending on the nature of the business and the data provided by sensors.

IoT-based smart agriculture offers various solutions, including smart greenhouses with unique climate control systems, remote management of pastures and livestock, monitoring of the territory using drones, long-term forecasts and financial analytics, precision irrigation, targeted control of plant diseases and pests, control of crops and harvest, and weather tracking and forecasting. Although implementing IoT smart farming solutions can be expensive initially, it is more cost-effective in the long run than traditional farming methods [5].

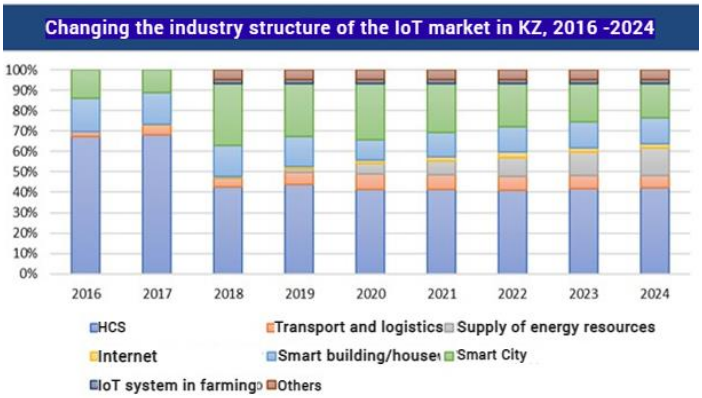
There are several IoT system platforms that are commonly used in agriculture. The choice of platform will depend on the specific needs and requirements of the farm or operation. Here are some of the top platforms:

•IBM Watson IoT: IBM Watson IoT is an industrial IoT platform that offers powerful analytics and cognitive capabilities to help farmers manage and optimize their operations. It provides real-time insights into crop health, soil moisture, weather conditions, and other factors that affect crop yields [6].

•Microsoft Azure IoT: Microsoft Azure IoT is a cloud-based IoT platform that offers a wide range of services for data storage, processing, and analysis. It can be used to monitor crops and livestock, track weather conditions, and manage irrigation systems [7].

•AWS IoT: AWS IoT is a cloud-based IoT platform that offers a range of tools for collecting, processing, and analyzing data from sensors and other IoT devices. It can be used to monitor soil moisture levels, track crop growth, and optimize irrigation systems [8].

Based on the information provided, it appears that the development of the Internet of Things (IoT) ecosystem in agriculture is still at an early stage in Kazakhstan. While some large agro-industrial complexes with state and private support have started to adopt IoT elements, there is still a need for wider adoption across the agriculture sector, particularly for small farms and private gardeners [9].



Picture 1 – Changing the industry structure of the IoT market in KZ, 2016-2024
Source: J'son & Partners Consulting

By estimates of J'son & Partners Consulting, the total share of three most widely provided segments of the market will decrease in relative calculation at the expense of the advancing growth of other segments, such as supply of energy resources to the enterprises and the organizations and also due to implementation of the systems of the automated accounting of supply of energy resources and implementation of Smart Grid technologies, "smart" agriculture and industrial Internet of Things [10].

Globally, the largest world operators (AT & T, Telefonica, Verizon, Orange, Deutschetelekom, Vodafone) are actively involved in the IoT segment, offering specialized wireless equipment, sensors, analytical platforms, and other solutions for managing IoT devices. In the IoT ecosystem, the functions of operators as telecommunication services are significantly expanding, becoming a key link that guarantees the availability and safety of IoT applications. By cooperating and integrating with full-scale IoT platforms, operators can access new markets and customers [11].

Beeline is one of the major telecommunication service providers in Kazakhstan, which has been actively involved in building an IoT ecosystem for agriculture. The company has been testing a new project in the Pavlodar region of Kazakhstan, which uses IoT sensors and data transmission to monitor the movement and health of livestock during grazing [12].

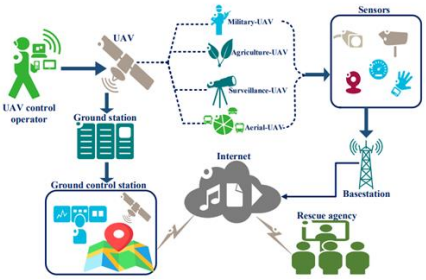
In addition to launching projects for the introduction of the Internet, it is essential for the state and private entrepreneurs to engage in equipping rural areas with electricity and other basic infrastructure. This can provide farmers with reliable access to power and communication networks, which are essential for the successful implementation of IoT solutions.

Furthermore, the government and private sector should work together to develop policies and initiatives that promote the adoption of IoT solutions in agriculture, particularly in rural areas. This can involve providing funding and incentives for farmers to invest in IoT technologies, as well as building the necessary infrastructure and support systems to facilitate their use.

Overall, the successful adoption of IoT solutions in agriculture in Kazakhstan will require a concerted effort from all stakeholders, including the government, private sector, and rural communities themselves. By working together, it may be possible to overcome the challenges of limited infrastructure and unlock the full potential of IoT in agriculture.

One of the main and important elements of the Internet that deliver information to the database is unmanned aerial vehicles (UAVs). Breeding and managing livestock can be challenging, especially when it comes to monitoring their location and condition during grazing periods. To ensure the safety of the herd and prevent theft and other threats, it is important to have an accurate and effective monitoring system in place. One such system involves using unmanned aerial vehicles (UAVs) equipped with photo, video, or infrared cameras to fly over and survey large grazing areas in a short amount of time. This method is not only more affordable than using manned aviation, but it also significantly reduces monitoring costs. The UAVs can fly for up to 5 hours and cover distances of up to 100 km, with the option to switch out batteries for continued surveillance. The collected data is processed and decoded using specialized software developed by companies such as Albatros LLC. Overall, using UAVs for herd management provides a cost-effective and efficient solution for monitoring livestock during grazing periods.

Using unmanned aerial vehicles (UAVs) equipped with cameras is an accurate and cost-effective way to monitor herds during grazing. The UAVs can fly pre-set routes and take photos or videos, which are processed and analyzed by special software.



Picture 2 - UAV monitoring system

The software automatically recognizes animals and their coordinates, allowing farmers to detect and respond to threats such as wolves or thieves. The program can also create an electronic map of animal locations and enable continuous video monitoring in automatic mode. This method simplifies herd management and reduces the risk of operator error [13].

Here are the top 4 best and most popular UAVs (unmanned aerial vehicles) used in agriculture:

• DJI Phantom 4 RTK: This UAV is equipped with RTK (Real-Time Kinematic) positioning technology, which provides highly accurate data for mapping and surveying. It also has a high-resolution camera for capturing detailed imagery.

• SenseFly eBee X: This fixed-wing UAV has a long flight time and can cover large areas quickly. It also has a range of sensors, including a multispectral camera for analyzing crop health.

• PrecisionHawk Lancaster: This UAV is designed for precision agriculture and can be equipped with a range of sensors, including RGB and multispectral cameras, to capture high-quality data. It also has long flight times and can cover large areas.

Parrot Bluegrass: This versatile UAV can be used for a range of agricultural applications, including mapping, surveying, and crop analysis. It has a high-resolution camera and a range of sensors, including a multispectral sensor for analyzing crop health [14].

The use of unmanned drones in agriculture is becoming increasingly popular worldwide, including in Kazakhstan. Drones can be used to collect data on crop growth, soil conditions, and weather patterns, as well as for crop monitoring, mapping, and spraying.

Additionally, the Kazakhstan government has also shown interest in using drones in agriculture to increase efficiency and productivity. In 2020, the Ministry of Agriculture announced plans to develop a program for the use of drones in agriculture, which will include the creation of a regulatory framework for their use and the training of operators [15].

Unmanned aerial vehicles and separately UAV services in Kazakhstan are offered by TerraPoint. The multi-purpose drones offered by the company are designed for monitoring, aerial photography and cartography in the field of agriculture and allow aerial photography from a height of 100 to 3000 meters. When purchasing a UAV as a property, TerraPoint provides a free training service for the user of the aircraft. When an agricultural enterprise orders UAV services, TerraPoint provides services in accordance with the agreed terms of reference for the season: analysis of the NDVI vegetation index, monitoring of infestation, sifting, heterogeneity, disease development [16].

The small number of unmanned drones in the agriculture of Kazakhstan is due to several factors. First, the use of drones in agriculture is a relatively new technology that has not yet been widely adopted. Secondly, the presence of restrictions on the use of unmanned aerial vehicles in some areas may limit their use in agriculture. Finally, agricultural producers may face limited access to finance, which can make it difficult to acquire and use drones in their operations.

However, there is a growing interest in the use of drones in agriculture in Kazakhstan, and public and private organizations are beginning to develop programs and infrastructure for the use of these technologies in the agricultural sector. Thus, over time, the number of unmanned drones in the agriculture of Kazakhstan is expected to increase.

RFID technology is widely used in animal husbandry to track individual animals. RFID tags with unique identification numbers are attached to the animals, and the data is linked to a database

containing information about their health, breed, and production data. This technology is commonly used in dairy farming to monitor milk production and quality, and to adjust the milking process to suit each cow's needs. Additionally, RFID tags can be used to monitor animal health by tracking movement and detecting any unusual behavior or symptoms. Early intervention and treatment can be provided, reducing disease spread and improving animal welfare [17].

Some of the top RFID systems used in animal husbandry include:

• Allflex: Allflex is a leading provider of animal identification and monitoring solutions. Its RFID tags are used in over 50 countries, including Kazakhstan. They offer a range of tags and readers suitable for different applications and environments.

• Delaval: Delaval is a global leader in dairy farming solutions, including automated milking systems and herd management software. Their RFID tags and readers are designed specifically for use in dairy farming.

• Tru-Test: Tru-Test is a provider of weighing and EID (electronic identification) solutions for livestock management. Their RFID tags and readers are used in a range of applications, from weighing individual animals to tracking their movement and health status.

Livestock such as cattle and small ruminants are commonly tagged with RFID ear tags (HDX, FDX), which are easy to install and provide lifelong identification. However, these tags can be lost or easily removed by unauthorized individuals. An alternative method of tagging involves the use of a bolus, which is an RFID tag enclosed in a heavy ceramic case and designed to be inserted into the animal's stomach.

In Kazakhstan, the "Kazbeef Group" uses ear RFID tags, while another major livestock company, "Terra," uses bolus RFID tags. Terra currently utilizes the Austrian program smaXtec BASIC to monitor and track the tags. This software can be installed on personal computers and cell phones, allowing users to access information on the physical activity, temperature, and internal biological processes of the animals. The data received from the tags provides necessary instructions to veterinarians, and in case of any sudden changes, a notification of danger is sent mmediately to all personnel [18]. Thanks to the use of this app, Terra's feedlot has experienced a 20% increase in the number of cattle born.

Also, RFID (Radio Frequency Identification) and drones can be used together to count cows in precision livestock farming. RFID tags are attached to the cows, and drones equipped with RFID readers fly over the herd, counting the number of tags that are detected. This method eliminates the need for manual counting, which can be time-consuming and inaccurate.

The use of RFID and drones for counting cows can provide farmers with real-time data on the number of animals in their herd, which can be used to make informed decisions about herd management, such as feed and water allocation, breeding and health care. provide more information [19].

Increase investment in research and development to improve agricultural productivity, sustainability, and profitability. This could include developing new technologies, breeding better crops and livestock, and improving soil health.

Problems

There are several challenges and problems facing the agriculture sector in Kazakhstan. Here are some of the most significant:

1. Land degradation: Soil degradation due to overuse, erosion, and desertification is a significant issue in Kazakhstan, leading to reduced productivity and land loss.

2. Lack of investment: The agriculture sector in Kazakhstan suffers from a lack of investment, particularly in technology and infrastructure, which hampers the sector's ability to modernize and improve its productivity.

3. Water scarcity: Kazakhstan is a semi-arid country, and water scarcity is a significant challenge, particularly in the southern regions. This limits agricultural production and affects the availability of water for livestock.

4. Small farm size: A majority of farms in Kazakhstan are small and subsistence-based, making it difficult for farmers to invest in modern farming methods, technology, and inputs.

5. Limited access to markets: Many farmers in Kazakhstan have limited access to markets due to inadequate infrastructure, poor transport links, and inadequate marketing networks.

6. Climate change: Climate change has led to more frequent and severe weather events such as droughts, floods, and heatwaves, which pose a threat to crop yields and livestock production.

7. Limited agricultural education: There is a shortage of skilled labor in the agriculture sector in Kazakhstan, which hampers the sector's ability to modernize and improve productivity.

Solutions

There are some of important ways how to solve problems.

1. Provide training and education for farmers to improve their skills and knowledge of modern farming practices. This could include workshops, field days, and extension programs.

2. The way to support young people is by offering professional practice programs for students. During these programs, students can gain hands-on experience working on farms and other agricultural businesses. This can help them develop the skills and knowledge necessary to succeed in the industry. Additionally, holding meetings and events between students and farmers can help to inform young people about the opportunities and importance of working in agriculture. This can be done through partnerships between agro-technological universities and medium or small farms. By connecting students with farmers, they can gain a better understanding of the industry and the impact they can make in improving it.

3. Invest in infrastructure, such as roads, irrigation systems, and storage facilities, to support the growth and development of the agriculture sector.

4. Investing in infrastructure is crucial for the growth and development of the agriculture sector in Kazakhstan. For instance, building and improving roads can make it easier and faster to transport agricultural goods from farms to markets, reducing transportation costs and improving farmers' income.

5. Improving irrigation systems can also significantly increase agricultural productivity. By providing water to crops in a controlled manner, farmers can produce higher yields and diversify their crops. In many parts of Kazakhstan, the use of modern irrigation systems can help farmers grow crops in arid and semi-arid regions where water is scarce.

6. Storage facilities are also crucial for the agriculture sector. By providing adequate storage facilities, farmers can store their crops for longer periods of time, avoiding spoilage and reducing waste. This can also help farmers sell their crops at a better price by allowing them to wait for higher prices before selling. Overall, investing in infrastructure can lead to significant improvements in the agriculture sector, including increased productivity, profitability, and sustainability.

7. Increase support for small and medium-sized farms, including access to credit, technical assistance, and marketing support.

8. Supporting small and medium-sized farms is a key strategy for promoting sustainable and equitable growth in the agriculture sector. Many countries have implemented programs to increase access to credit, technical assistance, and marketing support for small and medium-sized farmers. For example, in India, the government has established the National Bank for Agriculture and Rural Development (NABARD), which provides credit and other financial services to small and marginal farmers. NABARD also offers technical assistance and training programs to help farmers improve their productivity and profitability [20].

9. In Brazil, the government has implemented a program called "Programa Nacional de Fortalecimento da Agricultura Familiar" (National Program for Strengthening Family Agriculture), which provides credit, technical assistance, and marketing support to small family farmers. The program has been successful in improving the income and living standards of millions of rural families.

10. Overall, supporting small and medium-sized farms can help to promote inclusive growth and poverty reduction in rural areas. By providing access to credit, technical assistance, and marketing support, these farmers can improve their productivity and profitability, leading to better livelihoods and increased food security.

11. Encourage the adoption of digital technologies, such as precision farming, remote sensing, and data analytics, to improve decision-making, reduce costs, and increase yields.

12. Data analytics can also be used to improve decision-making on the farm. By analyzing data on factors such as weather patterns, market trends, and crop performance, farmers can make more informed decisions about when to plant, when to harvest, and how much to produce. This can lead to more efficient use of resources and increased profitability.

13. Countries such as the United States and Canada have already made significant investments in digital agriculture technologies and are reaping the benefits. For example, the use of precision agriculture technologies in the US has led to a 20% reduction in water usage and a 15% increase in crop yields. Similarly, in Canada, the adoption of precision agriculture technologies has led to a 25% reduction in fertilizer use and a 20% increase in crop yields [22].

14. By encouraging the adoption of digital technologies in agriculture, Kazakhstan can increase its productivity, reduce costs, and improve sustainability, making it a more attractive sector for investors and young people looking for opportunities.

15. Foster collaboration between farmers, researchers, and policymakers to identify and address challenges facing the agriculture sector, and to develop solutions that benefit all stakeholders.

16. Collaboration between farmers, researchers, and policymakers is essential for creating a sustainable and profitable agriculture sector. By working together, these stakeholders can identify the challenges facing the industry and develop innovative solutions to address them.

17. The Dutch government, research institutions, and farmers have worked closely together to develop advanced farming technologies and techniques, such as precision farming and sustainable agriculture. This has helped the country become a leading exporter of agricultural products, despite its small size and relatively low level of arable land.

18. Another example is the United States' Cooperative Extension System, which is a partnership between the US Department of Agriculture, state land-grant universities, and local governments. This program provides research-based information and education to farmers, helping them to make informed decisions and improve their operations. Through this collaboration, farmers are able to access the latest scientific research and apply it to their own farms, while researchers gain valuable feedback and data from the field [23].

In both of these examples, collaboration has played a crucial role in driving innovation and improving the sustainability and profitability of agriculture. By fostering these types of partnerships, other countries can also benefit from the expertise of researchers, policymakers, and farmers, leading to more efficient and sustainable farming practices.

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ТҮЙІН

Бұл ғылыми мақала әлемдік және отандық нарықтағы ауыл шаруашылығының ерекшеліктерін салыстыра отырып, ақпараттық технологиялардың оған әсерін зерттейді. Ауылшаруашылық секторындағы өнімділік пен тұрақтылықты арттыру үшін дәл егіншілік, қашықтықтан зондтау және деректерді талдау сияқты әртүрлі технологиялық жетістіктер қалай пайдаланылатыны туралы ақпарат береді. Бұдан басқа, мақала ақпараттық технологияларды Қазақстанның ауыл шаруашылығы саласына интеграциялауға байланысты проблемалар мен мүмкіндіктерге, сондай-ақ фермерлер мен жалпы экономика үшін әлеуетті пайдаға жарық түсіреді.

Жалпы, бұл мақаланың мақсаты – ақпараттық технологиялардың Қазақстандағы ауыл шаруашылығы ландшафтын қалай өзгертетінін және оның саланың болашағын қалыптастыруда қандай рөл атқара алатынын көрсету. Ауыл шаруашылығындағы ақпараттық технологиялар артықшылықтары мен проблемаларын жариялай отырып, бұл мақала саясаткерлерге, фермерлерге және Қазақстанда ауыл шаруашылығы секторын дамытуға мүдделі мүдделі тараптарға құнды ақпарат бере алады.

АЛҒЫС

Бұл жарияланым Erasmus+ ACeSYRI «Компьютерлік ғылымдар саласындағы докторанттар мен жас зерттеушілерге арналған озық орталық» жобасын іске асыру нәтижесі, тіркеу нөмірі 610166-EPP-1-2019-1-SK-EPPKA2-CBHE-JP.

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