

# China's Digitalization and its Implications for China-South Korea Economic Cooperation

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## I. Introduction

In recent decades, the diffusion of digital technology into every corner of our social and economic lives, the process known as digitalization, has been remaking the entire world. This digitalization, including the acceleration of digitization<sup>1</sup> and digital transformation in business operations and social interactions, enhances the potential of individuals, enterprises, industries, and government within the whole economy, exhibiting a scenario entirely different from the Solow Paradox.<sup>2</sup> As we enter a new era called the 4th Industrial Revolution, where digital technology blurs the boundary between the physical, digital and biological world according to Schwab (2017), we can expect a more prominent role by digitalization in boosting productivity and economic growth.

As the second largest economy in the world, China is experiencing a new wave of digitalization with new drivers, and this paper identifies the complementarities in digitalization between China and South Korea, going on to argue how the so-called “dragon and tiger” of Asia should cooperate in the digitalization journey to achieve quality-oriented and innovative economic growth.

## II. A New Round of Digitalization in China

### 1. China's Initial Stage of ICT Development

ICT development plays an essential role in the process of digitalization. Since the early 1980s, China actively strengthened the development of its ICT sector within the backdrop of the “opening-up” reform. The government launched reform initiatives aiming to restructure the Ministry of the Electronic Industry, delegate more power to the ICT enterprises, and released the Development Strategy of Electronic Information Industry,

<sup>1</sup> Digitization refers to the process of encoding analog information into zeros and ones so that can be stored, read, processed, and transmitted by computers, while digitalization includes the developments and use of ICT. In general, we use the term digitization in a more micro-level context, and digitalization at a more macro-level. Although some minor and ignorable differences may exist, digitalization, digital transformation and digital economy are interchangeable in this paper.

<sup>2</sup> For a systematic review of the Solow Paradox, please refer to Triplett and Jack E (1999).

which emphasized the transition from ICT device manufacturing to ICT use. Despite these efforts, however, the use of ICT showed slow development owing to the high costs involved and immature level of technology.

In order to expedite technological innovation in ICT and its applications, China has positioned the ICT sector as a pillar industry through the adoption of catching-up strategies, such as by supporting development of the Internet, accelerating the reform of telecommunication industry, enhancing the role of big companies and SMEs, and launching “attracting in” and “walking out” strategies in trade and investment. These efforts created an open and favorable atmosphere for the development of e-commerce, web2.0 community, and mobile phone industry, which laid the foundation for the upcoming new wave of digitalization. In the 1990s, China developed its ICT sector at an average speed of four times the world average, emerging as the largest market for telephone users and second-largest for Internet users in the world since 2002 (Heshmati and Yang, 2006). Thanks to the nation’s unremitting and concerted efforts to become the world’s factory, China became the world’s largest ICT exporter, overtaking Japan and the European Union in 2003 and the United States in 2004. China’s ICT industry is also the largest manufacturing sector within the Chinese economy (Ning, 2009). The number of mobile phone users per thousand people increased from 3 in 1995 to 414 in 2007, which can be attributed to the notable technological progress and price decrease in services and devices.

Although the astonishing pace of ICT progress shows the promise that China’s digital economy holds, there still exists a huge gap between China and developed countries since the 2000s.

## 1.2 Progress of Digitalization in China and its New Drivers

If we take 1994 as the starting point for China establishing a permanent Internet basis, 2004 marked the 10th anniversary of Internet development in China. This year saw the first round of IPOs of Internet companies in China, ranging from online community operators like Tencent to online talent recruitment services such as 51job, which represented the beginning of a new round of digitalization. From then on, China witnessed rapid growth in e-commerce and development of the mobile internet sector, with Alibaba’s B2B business going public in Chinese Hong Kong in 2007, China’s three telecommunications operators obtaining their licenses for 3G operations in 2009, and the government launching the Internet Plus Initiative to expedite digitalization in 2015. Especially in recent years, not only can people enjoy a cashless life using the smartphone and e-commerce platform, enterprises can also deploy clouding services and big data technology to enhance their operational efficiency.

Three reshaped momentums drive the new round of digitalization. The first one is the more prominent role of data owing to the remarkable progress of ICT use, which was impeded by the high cost involved and technological immaturity at the early stages of development. In recent decades, the prominence of the cost and immaturity problems has declined. The improved digital technology and infrastructure have led to a sharp rise in the popularity of the Internet, with Internet user penetration rate surging from 1.8% in 2000 to 55.8% in 2017, around 9 percentage points higher than the world average. Also, as cloud computing, network and Internet access have become a critical part of the digital infrastructure, larger volumes of data can be collected,

stored and analyzed. Considering how crucial data are to business in many cases, data resource has become a new factor in the production. For example, the smart city, the critical entrance with public welfare and flow economic effects today, is in essence a comprehensive data processing system with a variety of sub-platforms. The flow economy, a popular business model for Internet companies, and data-driven business heavily rely on the availability of personal and enterprise-level data. Similarly, if anyone wants to tap into the advantages from data interaction and self-adaption, they must embrace this digital transformation. Therefore, the importance of data promotes the digitalization dramatically.

The broader involvement of private business and venture capital is also a critical element for the new round of digitalization. It alleviates the challenges incurred by government dominance and ensures digital transformation is more market-oriented and efficient. Thanks to the substantial reforms made early on and environment of loose regulation, most manufacturing and Internet-based services are highly competitive. In these industries, the government adopts a neutral stance toward private sectors and even tolerates their exploitation of legal loopholes. In the meantime, private businesses show their capabilities to innovate at a faster pace, cater to customized tastes, and maximize the network effect in digitalization, which allows them to become the champions in launching new digitalized products and services. For example, the Alibaba Group gained more than 45% of the Chinese IaaS market in 2017, with the second to sixth place companies totaling 44.3% of market share, according to a report released by IDC in July 2018. Some analyses attribute Alibaba's success to the lower prices it offer compared to its western counterparts. However, more important is

Alibaba's strategy to build an ecosystem including more than 8000 companies and meet their demands in time with its leading technologies. In addition, recent efforts to raise public awareness of innovation and entrepreneurship have also brought about the rapid expansion of venture capital in promoting digitalization. Attracted by the flow economy effect and the promising prospect of technological opportunities, a great amount of venture capital concentrates on newly emerging areas related to digitalization. In 2017, the investment from angel capital increased to RMB 14.7 billion yuan from 1.22 billion yuan in 2013, with a considerable proportion flooding into the areas of Internet services, information technology, unmanned vehicles, and precision medicine.

The new round of digitalization cannot be achieved in the absence of the active role of the government. However, the target and behavior of the government have changed substantially. Instead of facilitating digitalization through an industry-level view, the Chinese government is strengthening the top-level design of digitalization by developing national strategies on big data and Internet application. For example, a decision was made to implement a national strategy for big data at the Third Plenary Session of the Central Committee of the CPC in 2015. The 13th Five-year Plan (2016-2020) further defined that big data is a kind of vital strategic resource to be developed and utilized. In 2016, China released a notice on the implementation of projects in the four areas of data application, data sharing, digital infrastructure, and relevant standard systems. Besides the specific grants and funds as part of the industrial policy, the government is also accelerating regulatory reforms and formulating regulatory rules for emerging industries in keeping with the principle of encouraging innovation and conducting regula-

tion in a tolerant and prudent way. The favorable regulation atmosphere has ignited the prosperity of digitalization in areas like transportation and accommodation, with many unexpected digital applications and new types of business springing out. In a report released by Didi, one of the biggest online platforms for taxi services in China, the company brokered more than 7.43 billion mobile travel services deals in 2017, equivalent to five deals per person per year on average.

### III. Identifying the Complementarities in Digitalization between China and South Korea

#### 2.1 Strategy of Analysis

Complementarity is a relationship or situation in which two or more different things improve or emphasize each other's qualities. In the context of two nations in digitalization, it always means the significant gap in digital transformation and to what extent the countries can cooperate to utilize the potential complementary assets fully. Teece (1986) first used the term “complementary assets” to explore how to profit from technological innovation in the field of strategy. He claims that assets, infrastructure or capabilities are indispensable to support the successful commercialization and marketing of technological innovations, other than those assets fundamentally associated with the innovation in question. In the era of the digital economy, the value-capture problem for innovators in the digital economy involves some different challenges from those in the industrial economy, with the dynamics of platforms and ecosystems being important (Teece, 2018). In this sense, the assets, infrastructure, capabilities, platforms, and ecosys-

tems conducive to ICT diffusion are complementary with those assets associated with ICT development in the process of digitalization.

Therefore, we can develop the digitalization matrix as a framework to capture the elements of digitalization and launch an analysis to identify the gap of digitalization between China and South Korea by measuring the matrix. In order to ensure the objectivity of all the indicators, we only select the standard and comparable indicators with the availability of data. The analysis can show the strength and weakness of digitalization between China and South Korea in the absolute gap and exhibit the relative gap among all the elements across the matrix. By exploring the rationales behind the absolute and relative gaps between the two countries further, we can investigate whether and to what extent the “dragon and tiger” can tap into the complementary assets.

#### 2.2 Digitalization Matrix

We develop a 2×3 matrix as a framework to capture the elements of digitalization (Fig. 1).<sup>3</sup> Our matrix has three columns that represent dimensions in digitalization, namely factor, industry, and governance, thus covering all the possible fields that can be digitalized. Generally, digitalization of factors creates the conditions for industrial digital transformation and further derives more demands on digitalized governance. The matrix also has two rows which categorize elements into the produc-

<sup>3</sup> It is easy to extend this matrix framework by splitting the existing dimensions into more concrete ones or adding a new row in the spectrum extending from production to application. Considering the unavailability of comparable data on digitalization of China and South Korea, the paper will not discuss the possible extension in the following analysis.

tion/physical or the consumption/application sides according to their distances to the customer. The matrix allows us to go beyond the firm-level analysis and traditional industry classification to identify the potential complementarities between China and South Korea comprehensively.<sup>4</sup> More importantly, this departure also let us incorporate elements associated with platforms and ecosystems, which lie at the core of the digital economy.

**Figure 1. Digitalization Matrix**

Consumption/ Application side	Data collection and application	Digitalization of consumption and trade	E-regulation
	Digital talents education and digital infrastructure	Digitalization of production process	Data security and transaction rules
Production/ Physical side			
	Factor	Industry	Governance

**F**actor digitalization mainly refers to changes in the types, forms, and connotations of factors and their broad application against the backdrop of the digital economy. Its production/physical side includes factors like digital skills and digital infrastructure, both of which are critical input factors in the digital economy. For example, digital literacy is regarded as an increasingly important part of human capital. Abiad *et al.* (2018) find that better-performing middle-income countries (MICs) tend to invest more in the ICT infrastructure, which produces a more significant and sustained impact on output in MICs than in low-income countries. The consumption/application side includes the factors related to ICT usage, which reflects the extent to which data are collected and utilized by the public.

**I**ndustrial digitalization mainly refers to the adoption of digital technology to strengthen

the business in the aspects of efficiency and profit. The production/physical side consists of elements such as digitization of production processes, digital transformation in the supply chain, and so on. For example, the IoT enables a real-time flow of information about the operational status and condition of equipment with a large amount of value created. The application of IoT is projected to generate 1.2 to 3.7 trillion US dollars of value globally by 2025 (Manyika *et al.*, 2015). The consumption/application side contains not only the consumption and trade of digital products and services but also the broad utilization of e-commerce. In 2017, e-retail sales accounted for 10.2 percent of all retail sales worldwide, which is expected to reach 17.5 percent in 2021 according to the Statista's analysis.

**D**igital transformation in governance mainly refers to improving regulation with digital technology and dealing with the new regulatory challenges incurred by the digitalization. Its production/physical side includes the data security, transaction rules, and standards. They are more relevant to the physical and institutional conditions and lay the foundation of digitalization. The consumption/application side of governance digitalization is involved with many e-regulations like an online public consultation and government service. These elements are the application of digital technologies to create a more favorable and convenient environment for business and the public.

## 2.3 Indicators and Measurement

**A**s stated above, the matrix should be measured based on the relevant indicators with reliable and comparable data. Therefore, we select some standard indicators which are widely used in international studies. All the indicators, together with their measurement and data

<sup>4</sup> The matrix can also be extended by adding more rows or/and splitting the existing columns.



source, are given in Table 1.

As for the dimension of the factor, the element in the production/physical side is measured by indicators which reflect ICT access and digital skills. For example, the factor of international Internet bandwidth refers to the average usage of all international links, including fiber optic cables, radio links, and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). It is an indication of the available ICT infrastructure and individuals' access to basic ICTs. On the consumption/application side, we employ two indicators, namely Internet user penetration rate and active mobile-broadband subscription per 100 inhabitants, both of which capture the intensity and usage of ICT.

Regarding industrial digitalization, elements on the production/physical side are measured by two indicators, namely ICT manufacturing and services expenditure on R&D as a percentage of GDP and robot density which is defined by the number of installed industrial robots per 10,000 employees in the manufacturing industry. They can exhibit the progress of ICT innovation and automation of production. Progress on the consumption/application side in digital transformation can be described by indicators such as the share of export in ICT goods, E-commerce sales as a percentage of total retail sales, and online shopping penetration rate. For example, a higher share of e-commerce in total retail sales always represents the broader application of digital technology in retail.

In terms of digital transformation in governance, elements on the production/physical side are measured by two indicators. First is the proportion of enterprises having a formal policy to manage digital privacy risks in all enterprises, which represents the strength of priva-

cy protection at the firm level. The other is the percentage of the total number of secured servers in the hosting country. A higher percentage suggests the businesses are more likely to be operating in an environment with a high level of digital security. It is worth noting that although the data of these two indicators are unavailable for China, we still choose them because South Korea ranked first in both of them among the OECD countries in 2017 while China lagged far behind.<sup>5</sup> According to a 2015 survey by a Chinese internet security organization, 44 percent of Chinese websites had security vulnerabilities that led to data leakages.<sup>6</sup> In an annual report released by the Chinese Cybersecurity Emergency Response Team (CN-CERT), the Chinese National Vulnerabilities Database archived 16,000 security vulnerabilities, 47.4 percent up from 2016.

<sup>5</sup> We assume that China is at the OECD's average level.

<sup>6</sup> Minter, A. Chinese Learning the Value of Privacy Available at <https://www.japantimes.co.jp/opinion/2017/03/25/commentary/world-commentary/chinese-learning-value-privacy/#.W8qlNy5uapo> (accessed November 21, 2018)

Table 1. Indicators of the Digitalization Matrix and Data Sources

Dimension	Item	Indicator	Data Source
Factor	Data collection and application	<ul style="list-style-type: none"> <li>Internet user penetration rate</li> <li>Active mobile-broadband subscription per 100 inhabitants</li> </ul>	World Bank; ITU
	Digital talents education and digital infrastructure	<ul style="list-style-type: none"> <li>International Internet bandwidth per Internet user</li> <li>Mobile-cellular telephone subscriptions per 100 inhabitants</li> <li>Gross enrolment ratio at tertiary-level</li> <li>Mean years of schooling</li> </ul>	ITU; UNESCO
Industry	Digitalization of consumption and trade	<ul style="list-style-type: none"> <li>The share of export in ICT goods</li> <li>E-commerce sales as percentage of total retail sales</li> <li>Online shopping penetration rate</li> </ul>	OECD; Statista
	Digitalization of production process	<ul style="list-style-type: none"> <li>ICT manufacturing and services expenditure on R&amp;D as a percentage of GDP</li> <li>Robot density</li> </ul>	OECD; IFR
Governance	E-regulation	<ul style="list-style-type: none"> <li>Government online service index</li> <li>E-participation index</li> </ul>	UN
	Data security and transaction rules	<ul style="list-style-type: none"> <li>Enterprises having a formal policy to manage digital privacy risks</li> <li>Secured server by hosting country</li> </ul>	OECD

Note: ITU is the abbreviation of the International Telecommunication Union; IFR is the abbreviation of the International Federation of Robotics.

## 2.4 Results and Analysis

We can arrive at the following two conclusions based on an analysis of the digitalization matrix through selected indicators. First, South Korea has prominent advantages over China in digitalization. We use the red and blue color to indicate this situation in Fig. 2, as elements in red represents areas in which China has more of an advantage while those in blue indicate the opposite. For example, although China's Internet user penetration rate witnessed a remarkable surge to 53.3% in 2016, it is still

forty percentage points lower than that of South Korea. China is almost half of South Korea in terms of the gross enrolment ratio at tertiary level and mean years of schooling. Other aspects are similar except for the consumption/application side in industrial digitalization. In China, ICT goods account for a more significant portion of exports than South Korea. Also, almost 23% of total Chinese retail sales are related to e-commerce in 2017, just seven percentage points higher than that of South Korea. This sharp contrast shows how China and South Korea differ in their re-

spective strengths. For China, the vast market size and business flexibility in catering to customers' tastes result in rapid ICT diffusion. However, South Korea is more sophisticated in terms of ICT innovation and e-governance, depending on its own leading technologies and improved institutions, rather than adopting ICT from abroad. This is similar to situations where many information technology services have been introduced in Korea since the great

success of ADSL and CDMA operations, but only a few of these services have succeeded. Park *et al.* (2017) pointed out that the absence of a business model was related to the partial success of services in achieving market diffusion as well as revenue. Therefore, we can argue South Korea adopts an exploration-oriented path, while China is more exploitation-oriented, both of which are complementary in essence.

**Figure 2. Colored Digitalization Matrix Using Data from China and South Korea**

Consumption/ Application side	Data collection and application	Digitalization of consumption and trade	E-regulation
	Digital talents education and digital infrastructure	Digitalization of production process	Data security and transaction rules
Production/ Physical side			
	Factor	Industry	Governance

Note: The element in red represents areas in which China has more of an advantage, while the blue areas indicate an opposite situation. The darker the color the more sizeable a relative gap of digitalization exists between China and South Korea.

Second, the most substantial relative gap between China and South Korea lies in the production/physical side of industrial digitalization and the least lies in the consumption/application side of digital transformation in governance. We use the shade of color to represent the size of the relative gap, as a darker color implies a greater relative gap. For example, one of the stark contrasts is the robot density in China (68), just around one-tenth of South Korea. With respect to the ICT manufacturing and services expenditure on R&D as a percentage of GDP, the level of South Korea is more than four times than that of China. The two indicators depict industrial digitalization on the production side, suggesting a prominent relative gap between these two countries.

Therefore, the results imply China and South Korea have the most significant complementarity in these areas. Also, other fields like digital talent education, digital infrastructure, data security, and transaction rules also exhibit significant potential to complement each other. To summarize, we can identify the complementarities between China and South Korea in digitalization as existing on the production/physical side.



## IV. Enhancing China-South Korea Economic Cooperation by Leveraging China's Digitalization

### 3.1 The Trend of China's Digitalization and the Implications for South Korea

In less than fifty years since the end of the Korean War, South Korea has transformed itself from a poverty-stricken country into a leading ICT country due to the changing global economic environment, government policies, and Korean cultural characteristics supporting ICT diffusion (Lee, 2003). Facing the new economic challenges in the recent decade, South Korea is again making preparations for the 4th Industrial Revolution, represented by hyper-connectivity and super intelligence, and the digital economy which combines internet technologies and the real economy. This is why the South Korean government has proposed initiatives aiming to boost innovative growth.

As a major neighbor of South Korea, China also regards digitalization as one of its top priorities to achieve quality-oriented economic development. Especially in recent years, the new round of digitalization has stepped into a new stage, aiming to speed up digitalization towards the production/physical side across the three dimensions, yielding potential opportunities for China and South Korea. In the dimension of factors, smart city initiatives will be a promising area in the future. The private-sector giants enable cities across China to rapidly enhance their tech and innovation capabilities to meet citizens' needs. As for industrial digitalization, the development of IoT and industrial Internet will be pronounced. In order

to accelerate this process, the Chinese government issued its Guidelines on the Development of Industrial Internet, promoted the adoption of clouding service at the firm level, established a standard system for smart manufacturing, and set up a batch of demonstration zones for service-oriented manufacturing. In the meantime, Chinese enterprises experienced an increase in the contribution made by smart manufacturing to profit in the past few years according to a survey conducted by Deloitte in 2017. The trend is expected to continue in the near future and will attract more employers to capture digital dividends. With regard to the digital transformation in governance, this trend will become even more pronounced through the enhancement of e-participation and strengthening of institutional blocks. Considering the prominent complementarities in digitalization that exist between the two economies, it would be reasonable to reinforce China-South Korea economic cooperation by leveraging China's digitalization.

### 3.2 Suggestions for China-South Korea Economic Cooperation on Digitalization

Currently, China and South Korea are coping with structural challenges in their economies and share the similar goal of development, namely quality-oriented growth and innovative growth. Based on the analysis above, this paper argues the dragon and the tiger should develop a closer economic cooperation relationship in boosting digitalization.

Firstly, *strengthening the existing economic cooperation mechanism to enhance policy coordination in digitalization*. Although both countries are involved in a great variety of multilateral cooperative networks such as the G20, ASEAN Plus Three, APEC, Japan-

China-ROK Trilateral Cooperation, a closer and more efficient bilateral economic cooperation on investment, trade, and innovation should be one of the priorities for China and South Korea. To fully tap into the potential complementarities in digitalization, the two governments should take concrete steps to let digitalization be part of their economic cooperation. For example, the Ministry of Strategy and Finance and China's National Development and Reform Commission could reach an agreement to cooperate on promoting the digital economy, and further develop their dialogue on the digital economy and digital silk road through the Korea-China Economic Ministers' Meeting and the joint committee on science and technology. As a critical principle for digitalization cooperation, it is necessary to emphasize policy coordination on supporting value capture to keep a society's innovation engine fueled in the digital era. Otherwise, incentives to innovate will be compromised and the government itself will need to fund enabling technologies (Teece, 2018).

**S**econdly, *sparking up multi-level collaboration on smart city initiatives*. In the digital era, the smart city becomes a critical entrance to boost public welfare and monetize Internet flow effects today. It is essentially a comprehensive data processing system with a variety of sub-platforms. Across the world, over a thousand smart city pilots have been launched. China is home to half of these cities, amounting to a staggering 500 pilots.<sup>7</sup> Korea plays a leading role in the development of such smart city and low-carbon green city initiatives based on its advanced digital technologies. For

example, the Seoul Open Data Plaza opened 4,700 datasets in 10 areas such as general administration, culture & tourism, public health, and environment. The Smart City Busan initiative involves the establishment of smart infrastructure and systems ranging from transportation, disaster management, energy consumption to utilizing IoT tech. As China has the largest number of smart city pilots in the world, it provides significant opportunities for Korean businesses to apply their leading technologies and gain abundant experiences through PPP contracts. Public research institutes and universities also can play an active role in enhancing the academic and practical communications on smart cities. Both governments can jointly launch smart cities pilots in northeastern China and share the returns based on long-term contracts, which could grow into an important part of China-Korea cooperation in the future.

**T**hirdly, *screening areas with high complementarity to boost industrial digitalization*. South Korea has chosen the eight industries of new energy, future cars, drones, smart factories, smart city, smart farm, fin-tech, and bio-health as drivers of innovative growth. According to the Ministry of Strategy and Finance, the Korean government plans to invest around 3.5 trillion won in 2019 to support the innovative development of these eight industries. China has also listed ten priority areas in the Made in China 2025 initiative, ranging from ICT development to ICT adoption and diffusion. Although some industries overlap largely, it is critical to identify and take advantage of these complementarities. Our analysis indicates the complementarities between China and South Korea in digitalization lie on the production/physical side. Therefore, it would be promising to promote cooperation in the production/physical side of the industries

<sup>7</sup> Lin, C. J. 2018. Five Chinese Smart Cities Leading the Way. Available at <https://govinsider.asia/security/five-chinese-smart-cities-leading-way/> (accessed July 10, 2018).

above. At the same time, it is necessary to leverage the market size advantage in China so that the businesses from China and South Korea can share economic benefits in the end.

Fourthly, *sharing the experience of promoting digital economy governance*. Korea is one of the earliest countries to launch an e-government initiative. It has established many best and well-known practices like the establishment of government integrated data centers and the On-Nara business process system, promotion of government information sharing, adoption of the E-procurement KONEPS system and online civil service Minwon 24. Although China has many similar mechanisms, there is still massive room for improvement regarding the quality and efficiency of its e-government platform. In the aspect of digital security as well, China can learn from South Korea's lessons. For example, firms in Korea are actively implementing security measures, and the Korean government promotes digital security risk awareness in SMEs by providing tax incentives for companies that invest in digital security products (OECD, 2017). Also, the two countries can launch a dialogue on how to prevent monopolies and protect privacy in the digital area by setting up consulting panels or committees. **KIEP**

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