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Supporting Belt and Road Construction Through Engineering Science and Technology

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Abstract: The Belt and Road initiative is China's plan to build a community of shared future for humankind, and represents China's vision for the world in a new era. Engineering science and technology has played an important supporting role in Belt and Road construction, especially in major infrastructure construction, energy and resource development, and international industrial cooperation, ensuring the smooth progress of major construction projects. This study examines the opportunities and challenges faced by engineering science and technology in supporting Belt and Road construction; outlines the strategic goals and overall tasks in various stages before 2035; and elaborates the development strategy of "supporting Belt and Road construction through engineering science and technology" and its corresponding safeguarding measures. Moreover, the study identified new requirements for engineering science and technology in advancing Belt and Road construction, including development of a system of key technologies, frontier and high technology breakthroughs, and international cooperation; and concludes that it is necessary to optimize the allocation of research and development resources at the national level, to give better scope to the supporting and leading role of engineering science and technology.

Keywords: Belt and Road initiative; engineering science and technology; 2035; development strategy

1 Introduction

In the work report to the 19th National Congress of the Communist Party of China, a call was made to "pursue the Belt and Road initiative as a priority, give equal emphasis to 'bringing in' and 'going global,' follow the principle of achieving shared growth through discussion and collaboration, and increase openness and cooperation in building innovation capacity. With these efforts, we hope to make new ground in opening China further through links running eastward and westward, across land and sea." In 2018, General Secretary Xi Jinping pointed out that in advancing the Belt and Road initiative, we should transition from high-level planning to intensive and meticulous implementation, so as to realize high-quality development, bring benefits to local people, and build a global community in a shared future.

The idea of the Belt and Road is rooted in the historical soil of the Silk Road, which has been a shining ribbon in the development of human civilization for two thousand years. Co-building the Belt and Road gives new connotations to the harmonious development of humankind in the twenty-first century and holds the vision of the people in all the countries along the Belt and Road. Co-building the Belt and Road and its core ideas has won high recognition from the United Nations, the G20, APEC, and other regional organizations. Important progress has been made in Belt and Road construction. As of the end of March 2019, China had signed 173 cooperation documents with 125 countries and 29 international organizations, with participating countries extending from Asia and Europe to in Africa, Latin America, and

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the South Pacific [1].

Engineering science and technology is an important source of the development of social productive forces, and a major force in changing the world, playing the role of fundamental support, and providing strategic leadership in the construction of the Belt and Road. By leveraging China's comparative advantages in engineering science and technology, it is possible to form technological advantages in major infrastructure construction, information and communications, manufacturing, energy, resources development and other areas and help to break through technical bottlenecks, improve engineering quality, and build brand images in the implementation of major projects along the Belt and Road. In the six years after the co-construction of the Belt and Road began, engineering science and technology has been an important safeguard for the smooth development of major related projects. Looking to the future, undertaking strategic research on supporting Belt and Road construction through engineering science and technology toward 2035 is now an urgent and significant topic for Chinese engineering science and technology circles.

2 Remarkable results have been achieved in supporting Belt and Road construction through engineering science and technology

2.1 Engineering technology in transportation, information, and other fields has strongly boosted infrastructure construction along the Belt and Road

Strengthening infrastructure construction and promoting cross-national and -regional connectivity is a top priority for co-building the Belt and Road. In 2019, China Railway Express operated trains to 108 cities in 16 countries in Western Asia and Europe. Chinese high-speed rail set technology has been fully used in the Jakarta–Bandung High-Speed Railway in Indonesia, the Moscow–Kazan High-Speed Railway in Russia, and other foreign high-speed rail projects. Chinese bridge construction technology has become a key safeguard for the construction of the Maldives–China Friendship Cross-Sea Bridge. China-developed tunnel boring machines have been used in the construction of the No. 1 Tunnel of the Jakarta–Bandung High-Speed Railway and the Gaoligong Mountain Tunnel of the China–Laos Railway. China's information and communications technology (ICT) system supports the construction of land and sea cables and backbone networks in 12 countries along the Belt and Road, with 34 cross-border land cables and 6 sea cables built. The Chinese Beidou system provides navigation services for more than 30 countries and regions along the Belt and Road, and has found wide application in transportation and port management in Pakistan; land planning and river transportation supervision in Myanmar; and refined fine agriculture, pest disaster supervision, and other uses in Laos.

2.2 Energy and resources development technology provides effective support for resources and energy projects and corresponding engineering services in countries along the Belt and Road

Energy and resources cooperation is a key area of work in the Belt and Road initiative. China attaches great importance to the construction of oil, natural gas, electrical energy, and other infrastructure and works with relevant countries to maintain the safe operation of cross-border oil and gas pipelines. As of the end of 2018, more than 100 projects in 23 countries along the Belt and Road had been implemented with the use of complex conventional land oil and gas field exploration and development technology, high-grade steel pipeline technology for complex terrains, and other technologies from China. Integrated coal mining, coal-power integration, and other Chinese technologies have supported the smooth implementation of more than 30 projects in 9 countries. The Hualong-1, China's third-generation nuclear power technology, has provided core support for the Karachi nuclear power plant in Pakistan. The export of Chinese UHVDC transmission technology to the Belo Monte Hydropower Plant in Brazil marks the first time that China's UHV transmission technology, equipment, and experience have gone onto the world stage [2].

2.3 Cooperation in manufacturing, chemical, and alloy industries provides substantive safeguards for building the Belt and Road into a belt and road of prosperity

Engaging in international cooperation in production capacity and equipment manufacturing is also a top priority for co-building the Belt and Road. The Chinese manufacturing industry has the capacity to provide countries and regions along the Belt and Road with related products and services. China has carried out considerable cooperation in such application fields as ports, railways, highways, electricity, aviation, and telecommunications in the manufacturing sector, improving infrastructure conditions of cooperative countries in remarkable ways. As of early 2019, China has signed capacity cooperation documents with more than 40 countries, including Kazakhstan, Egypt, Ethiopia, and Brazil. SINOPEC Engineering has contracted more than 100 projects in more than ten countries, with a cumulative contractual

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value of more than US$15 billion. Industrial cooperation has created a favorable condition for countries participating in the Belt and Road to develop their economies and improve the livelihood of their people.

2.4 Advantageous technologies in the ecological environmental protection, agriculture, and healthcare fields have helped boost ecological, green, and healthcare development in countries along the Belt and Road

China is committed to building a "Green Silk Road," and has actively carried out engineering technical support and project cooperation in environmental protection, pollution prevention and control, ecological restoration, and other fields, proactively fulfilling its international responsibilities. As of the end of 2018, agricultural research institutions in China had signed nearly 50 intergovernmental cooperation agreements and more than 70 interdepartmental cooperation agreements or memoranda with countries along the Belt and Road, and built several international joint laboratories and agricultural technology demonstration bases [2]. Traditional Chinese medicine has been promoted in 183 countries and regions; 113 countries and regions have approved the use of acupuncture; and Russia, Cuba, Vietnam, Singapore, and the United Arab Emirates and other countries have now licensed Traditional Chinese Medicine in the form of drugs.

3 Engineering science and technology supports the Belt and Road to face a new situation

3.1 New development opportunities

Since the co-building of the Belt and Road began six years ago, countries along the Belt and Road have made substantial gains and achieved coordinated development, showing growing enthusiasm for and identification with the initiative. This favorable environment creates new development opportunities for engineering science and technology to support the Belt and Road.

First, it provides opportunities for China to integrate itself into the global supply chain, the industrial chain, and the value chain. China has formed and is continuously deepening a posture of comprehensive opening up, and Chinese manufacturing is gradually transforming and upgrading toward high-end manufacturing, intelligent manufacturing, and green manufacturing. Co-building the Belt and Road will help to establish a high-level landscape of international cooperation and division of work.

Second, countries along the Belt and Road have an urgent need for infrastructure construction and technology upgrades in transportation, information, production capacity, and other fields. China holds an advanced position globally in rail transportation equipment, power equipment, and engineering machinery, and can meet the technology and application needs of infrastructure construction in countries along the Belt and Road.

Third, Chinese engineering technologies, represented by high-speed railway, complex conventional land oil and gas exploration and development, and UHV power transmission and transformation technologies, have been recognized worldwide for their system application and value creation modes, thus laying a market foundation for the transformation and implementation of relevant transnational projects.

3.2 Issues and challenges

In recent years, world trade and economic development are facing huge risks and challenges under the rise of global forces of terrorism, extremism, and populism, and increasing geopolitical instability. The Belt and Road initiative involves many countries and is inevitably affected by the world situation.

First, European and US companies have first-mover advantages in the markets of countries along the Belt and Road. For example, oil exploration and power distribution equipment in many Central Asian countries is provided by European and US enterprises. For historical reasons, some countries along the Belt and Road are also inclined to adopt European and US standards and products. Chinese enterprises have not fully entered the middle- and high-ends of the value chain in the international industrial division of work. They have yet to form full-core technology systems in key fields. These, together with weak basic innovation capability and inadequate core intellectual property rights, constrain their competitiveness in markets along the Belt and Road.

Second, some countries along the Belt and Road have a backward infrastructure and lack international talent, which prevents the full play of the supporting role of science and technology. Infrastructure construction in relevant countries is still weak and lags behind others, and there are obvious deficiencies or bottlenecks in the transportation interconnection of the six economic corridors along the Belt and Road. For example, the China Railway Express has few external channels and serious congestion problems at key hubs. In some regions, facilities standards are not unified, planning and

coordination are insufficient, and there is no common infrastructure blueprint. Besides, there is also a lack of internationalized engineering talents in relevant countries, and the breadth and depth of people-to-people exchanges in the field of engineering science and technology need to be strengthened.

Third, Europe and the United States still dominate existing international rules, intellectual property, and engineering science and technology standards. These, together with the suspicion and resistance of some countries along the Belt and Road, have increased the entry barriers to China's technologies, standards, investments, and cooperation projects. Under the various political systems, religious cultures, economic foundations, and infrastructure conditions, and with a high level of economic dependence on and cultural identification with European and American countries, countries along the Belt and Road have a low degree of acceptance of China-led systems and models. As a result, there has been no fundamental improvement in the industrial entry barriers or high difficulties of cooperation and integration that Chinese engineering science and technology faces in supporting the development of countries along the Belt and Road. One of the clear signs of this is that the relevant technical standards are not uniform enough, thus restricting technology connectivity and project expansion.

Fourth, the special geopolitics and harsh natural environment along the Belt and Road pose severe challenges, resulting in natural risks for Chinese enterprises to expand. Some Chinese enterprises lack international market operation experience and a sufficient understanding of the unique political risks of countries along the Belt and Road, and have yet to completely come out of their domestic development mindset. As a result, relevant cooperation projects may face unexpected risks and lack scientific contingency plans to resolve major and seemingly intractable impacts. Multiple countries along the Belt and Road have harsh natural environments with geological plate collisions and suture zones, marine glacier coverage zones, and coral reefs. These have brought new major technological challenges to the green construction and safety operation of infrastructure.

4 Safeguarding measures for supporting Belt and Road construction through science and technology

4.1 Establishing an engineering science and technology talent training system

We should strengthen dialogue and consultation with international organizations; work with WFEO, IEA, FEIAP, and other agencies; push forward the mutual recognition of engineering education qualifications; and establish a mechanism of mutual recognition of qualifications among countries along the Belt and Road, and promote the flow of engineering science and technology talent and the allocation of intellectual resources.

To promote international academic exchange in the fields of engineering science and technology and education, academic cooperation with UNESCO, ICEE, IKCEST, and various international engineering education production and learning alliances should also be strengthened.

4.2 Coordinating the establishment of a taxation and financial support system

A market-oriented and diversified funding mechanism should be explored and established, first by leveraging the full play of the role of the Silk Road Fund, the Asian Infrastructure Investment Bank, and sovereign funds of various countries, and second by removing institutional barriers. We should guide commercial equity investment funds and social investors to participate in the implementation of key projects along the Belt and Road, and should reasonably increase financial support for key research, application, and demonstration of engineering science and technology. We should offer preferential policies such as low-interest loans for key projects, and consolidate income taxes levied on overseas incomes from undertaking multiple national engineering projects or undertaking multiple projects in one country. Incomes from technology transfer may be exempted from income tax, and enterprises should be supported to continue to use technology incomes for technology innovation and R&D.

4.3 Establishing a system of prevention and control against overseas security risks

Given the complexity of the regional environment along the Belt and Road, we should routinely and comprehensively collect and sort out relevant dynamic information on uncertainties and establish scientific risk identification, evaluation, and early warning systems for possible political, economic, social, and legal risks in countries along the Belt and Road. We should set up risk assessment and research institutions for key overseas projects, optimize the risk-sharing mechanism through risk funds or insurance, and improve Chinese enterprises' ability to prevent and control various risks and provide security safeguards. We should comprehensively sort out and specify the status of China's technological property rights,

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form a dynamic update mode, and prevent and resolve the risk of the outbound shift of industrial chains.

5 Concluding remarks

The Belt and Road initiative is an important practice platform initiated by China to establish a shared future for humankind, with the participation of multiple currieries, under the rubrics of peace, development, cooperation, and a win-win approach in the current era. Promoting the innovation of engineering science and technology, and sharing the results of engineering science and technology, is an important way to solve the common challenges of humankind, boosting the coordinated development of the world and fostering its common prosperity.

Through strategic research on supporting Belt and Road construction through engineering science and technology, this study has expounded on the strategic goals of engineering science and technology development and the overall tasks that China is planning in various stages until 2035; the current study also made strategic recommendations and put forward corresponding safeguard measures. Through continuous focus and research in engineering science and technology circles, it is hoped that engineering science and technology can play a more crucial, advanced, and fundamental supporting role in the future construction of the Belt and Road.

References

[1] Office of the Leading Group for Promoting the Belt and Road Initiative. The Belt and Road initiative progress, contributions and prospects [R/OL]. (2019-04-22) [2019-07-15]. http://www. xinhuanet.com/world/2019-04/22/c_1124399473.htm.Chinese.

[2] Chinese Academy of Engineering. Project report of the support of engineering science and technology for the Belt and Road construction [R]. Beijing: Chinese Academy of Engineering, 2019. Chinese.