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Who Leads China's 5G Technology Ecosystem? A Network Analysis of China's Cooperation on Association Standards

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I. Introduction

China's digital transformation is emerging as a driving force for the future growth of the Chinese economy in the post-Covid era and is also an important topic for the U.S.-China competition in the 4th industrial revolution. In addition, according to the World Digital Competitiveness Ranking released by IMD every year, China's Digital Competition Ranking rose from 35th in 2016 to 16th in 2020. During the same period, Korea's ranking rose from 17th to 8th. Korea is considered to have an advantage in digital competition with China, but the gap between the two countries has narrowed sharply as China's competitiveness has recently risen rapidly. Accordingly, the main purpose of this analysis is to understand the competitiveness of the Chinese 5G industry. In particular, it analyzes standardization strategies among major companies that are creating a 5G industrial ecosystem.

II. China's Promotion of Association Standards in 5G Field

With the revision of the Standardization Law of the People's Republic of China in 2018, the standardization of next-generation mobile communication, a strategic emerging industry, is being promoted as a national strategy. In addition, "association standards" have been added as a new standard, these being standards that can be drafted and enacted by all legally registered social associations under the Ministry of Civil Affairs of the People's Republic of China. In the electronics and telecommunications sectors, including the 5G industry, the Chinese Standardization Association, and the Chinese Communications Standardization Association (CCSA) are also promoting association standards by collecting opinions from companies and various social fields (e.g., institutes).

The CCSA was established in 2002 and as of 2019, a total of 784 members are affiliated with the association. Since its establishment, it has played an important role in China's information and communication policies and standards, including 400 national standards, 4,000 industrial standards, and 289 association standards in the ICT sector. The CCSA conducts screening at the technical committee and the Technical Committee Joint Meeting within the association and announces a project plan to promote an association standard only after the final review of the agenda is passed. In 2020, a total of 82 projects related to association standards were conducted. The project plan specifies the organizations in charge of standard promotion (lead agency), participating organizations, technical areas, and contains the main contents of the standard.

Moreover, it is noteworthy that the number of standards submitted by the CCSA to international standards organizations every year is expected to increase from 7,216 in 2017 to 10,146 in 2019. Therefore, we intend to analyze the CCSA's standard promotion network of associations member companies. The results of this domestic analysis are expected to help analyze China's strategy, which is gradually expanding its influence on international telecommunications standards.

III. Network Analysis of 5G Industry Associate Standards in China

1. Assumptions

This network analysis was conducted based on two assumptions about cooperation between companies around association standards. The first assumption is that cooperation between companies is a two-way relationship in promoting the association standards. In other words, the standard implementation process of this analysis is viewed as cooperation in order to achieve the common goal of exchanging information and establishing standards, where Company A establishes plans for the standard in question as a “lead agency” and another Company B participates in the project as a “participating agency.” Therefore, cooperation between A and B is not a one-sided relationship (or a directional relationship) but is instead viewed as a bilateral relationship or an undirected tie. Thus, we conducted an undirected network analysis. Based on this assumption, the adjacency matrix of this network analysis consists of a symmetric matrix.

The second assumption is that the more cooperative projects between institutions are carried out, the higher reliability will be between both sides. This means that if A is working on three standard projects with B, it trusts cooperation with B more than C, with which it is engaged in one standard project. Therefore, the intensity of connection between subjects is measured by the number of cooperation between companies. Based on these assumptions, the target of this network analysis is designed as an undirected and weighted network.

2. Methodology

The greater the centrality of the company constituting the network, the more it can be interpreted as playing an important role in the network, and the indicators for analyzing this centrality are very diverse. Among them, this study aims to identify companies that play important roles in this network, focusing on the concepts of closeness centrality, betweenness centrality, and eigenvector centrality. In this network analysis, the closeness centrality of an institution (or company) measures whether the institution is at the center of this network and represents the proximity to connected institutions within the network. Therefore, the institution with the largest indicator value is the subject that can distribute and spread its resources (information) to the entire network the fastest.

In addition, in this network analysis, betweenness centrality measures the degree to which a company is located between other companies in the network, with larger betweenness centrality indicating greater influence in controlling the flow of information in the network.

Since this network is undirected and weighted, closeness centrality and betweenness centrality were analyzed through a method considering weights. In this analysis, the reliability formed through cooperation between companies was set as a weight for analyzing the network centrality of companies.

Finally, eigenvector centrality increases the indicator value as cooperation with companies that occupy an important position on the network increases. Therefore, eigenvector centrality was analyzed to find the most influential central actor in the network. The targets of the analysis are 82 association standard projects announced by the CCSA in 2020. Network analysis was conducted on 46 cooperative projects, excluding projects promoted by one lead agency (34 in total) and two projects which did not specify the lead agency and participating agency.

A total of 87 companies participated in 46 cooperative projects, which are samples of this analysis, including China's three major mobile carriers, Huawei, ZTE, and the China Academy of Information and Communication Technology (CAICT).

3. Results

This network was found to consist of 87 companies and 422 edges. Based on eigenvector centrality, it was confirmed that the CAICT, China Telecom, China Unicom, Huawei, and Oppo are in a very important position in the network. In particular, it can be seen that the CAICT is the core of the network, with a significantly larger value than that of institutions participating in the network in all analyzed centrality indicators.

Figure 1 below shows the 2020 CCSA's association standard cooperation network. Based on the calculated eigenvector centrality of each institution, the size of the institution (node) in the graph was set, and the larger the number of

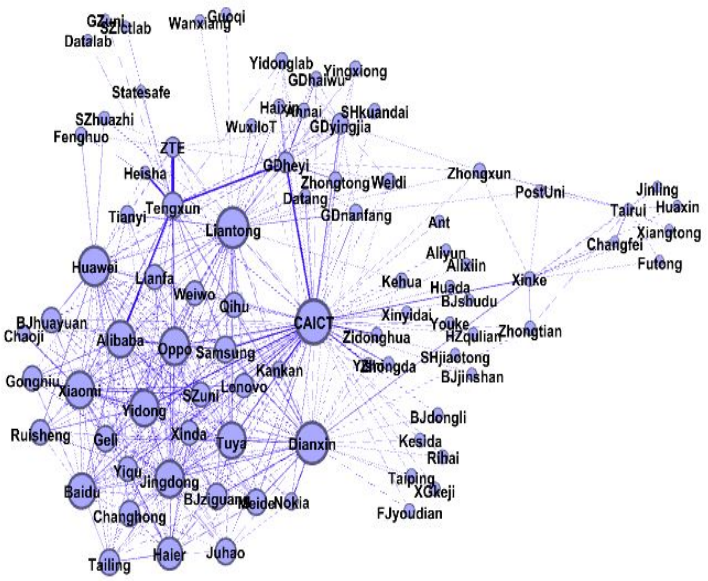
cooperation between institutions, the thicker edge was marked. It can be seen that the CAICT, which has the greatest Eigenvector centrality, is leading the corporate cooperation on association standards and is in the most important position in the related corporate network.

Table 1. The Centrality of Major Agencies in China's Association Standard Network

Agency	Eigenvector	Closeness	Betweenness
CAICT	1.00	1.90	7.81
China Telecom	0.94	0.97	0.25
China Unicom	0.88	0.78	0.94
Huawei	0.85	0.61	0.35
Oppo	0.79	1.29	-0.01
Jingdong	0.78	0.96	-0.21
Xiaomi	0.77	0.77	0.12
Alibaba	0.76	1.47	0.51
China Mobile	0.76	1.44	0.67
Tuya	0.75	1.39	0.75

Note: 1) Ordered by eigenvector centrality
2) Closeness centrality, betweenness centrality are weighted and standardization values.
3) Pearson correlation coefficient between proximity centrality and proximity centrality (basic method without weight) was 0.61, and Pearson correlation coefficient between mediation centrality without weight and mediation centrality considering weight was 0.89, and both correlation coefficients were statistically significant at the 5% confidence level.
Source: Author's calculations using CCSA association standard cooperative projects

Figure 1. CCSA Association Standard Cooperation Network



Note: The larger the eigenvector centrality, the larger the node size.
Source: Author's calculations using CCSA association standard cooperative projects

As a government think tank under China's Ministry of Industrial Information and Communication, the CAICT plays an important role in the digital transformation, such as developing China's digital economy estimation method and establishing domestic ICT policies. In addition, this institute plays an important role in expanding the domestic 5G industry, such as chairing the China 5G Application Industry Array, an organization jointly formed by companies, associations, and research institutes, to expand 5G technology applications in China.

Considering that the CAICT is an important think tank influencing the enactment of China's ICT policy, it coordinates the collaboration of companies in 5G applications (big data, blockchain, etc.), and plays the role of management or supervisor. In addition, although the CCSA is an association composed of companies and research institutes, it can be evaluated that the Chinese government's influence on the promotion and content of 5G association standards can be quite large in that it is closely related to the CAICT.

IV. Conclusion

First, the results of our analysis of China's standardization promotion system indicate that the market influence of Chinese local companies in the Chinese digital industry ecosystem will continue to grow, which is likely to serve as a barrier to entry into the Chinese market for companies that fail to participate in association standards. This is because among the association standards of the 5G industry, contents related to safety certification or service evaluation systems are expected to develop into a certification that can gain trust from consumers in the Chinese market and increase consumer acceptance of new services or products. Foreign companies are likely to be alienated from participating in this standard, so it is necessary to continuously monitor developments in this area. Second, domestic standard cooperation is also likely to lead to strengthening the capabilities of Chinese companies in international telecommunications standards. The accumulation of experience and technology gained through the cooperation on domestic association standards has strengthened China's influence in international standards organizations of 5G technology, which can be expected to lead 6G technology standards in the future. In particular, since China is ahead of the U.S. in terms of establishing 5G base stations, Chinese companies are likely to push for 6G standards that can be easily linked to 5G base stations. Finally, the results of this analysis highlight that the CAICT plays a role in promoting standard cooperation among member companies in the CCSA. This strategy is expected to have the effect of promoting companies' investment in technology development by creating a collaboration environment between local companies. And it presents guidelines for areas where regulations are not yet clear. Therefore, in order to secure competitiveness in the 5G field, which is rapidly changing in many areas, the Korean government needs to encourage research cooperation between research institutes, academia, and companies. KIEP