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Sustainable Competitive Position of Mobile Communication Companies: Comprehensive Perspectives of Insiders and Outsiders

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Abstract: The identification of a sustainable competitive position in enterprises is a common concern of information science and sustainable development research. Achievement of sustainable competitive position and superior performance is the first priority of business organizations. However, the existing research focuses on technology competition and light market competition. The research proposes a comprehensive framework for identifying an enterprise's sustainable competitive position based on a two-dimensional perspective of insiders (enterprise self-positioning) and outsiders (public cognition), including enterprise technology competition identification based on technology proximity, and enterprise market competition identification based on URL co-occurrence analysis. Based on the patents collected using the Derwent Innovation Index (DII) and the URL data collected from the Internet, the sustainable competitive position of mobile communication companies is identified from two dimensions of insiders and outsiders. QAP (quadratic assignment procedure) correlation analysis shows that these two dimensions are complementary. The two-dimensional perspective is integrated to comprehensively analyze the sustainable competitive position of Huawei, and thus obtain valuable information. In order to achieve the sustainability of competitive position in the industry, mobile communication enterprises must improve their management level (marketing characteristics of management and low cost structure), and must also have the ability to break through the governance system (rigid characteristics of governance) in a timely manner, and gain the ability to create value for customers in the long run (enhancement of public cognition and public image, and customer loyalty). Meanwhile, the mobile communication industry is a typical network externality market. If the companies want to obtain a sustainable competitive position in the competitive landscape, they need to manage user's expectations, expand the foundation of users, achieve extensive cooperation and alliances with manufacturers of complementary products, and improve the quality and reputation of their brands.

Keywords: sustainable competitive position; patent; URL co-occurrence; technology proximity; public cognition

1. Introduction

Industry competitiveness is an important theme in the economics of industrial organization. Competition often drives firms to advance to higher generations of technology or products [1–3]. Such technology advancement has characterized technological changes in many industries, from the software to the hardware industry. For instance, the technology of the mobile communication industry is evolving and the competition is becoming more and more intense. At present, many countries in

the world have announced commercial 5G network construction plans and estimated construction completion time. The commercialization and deployment of 5G tend to provide a broad set of opportunities for both the enterprises and the consumers. On the one hand, technology advancement enables firms to outperform competition through developing superior technological capabilitiesand enhancing their technological position [4,5]; on the other hand, competitive pressure can become so intense that a technology race emerges [6]. A firm may be so overwhelmed by competition that innovation value is eroded [7–10]. As such, how can managers identify the competitive position and sustainable competitive advantage?

To tackle this question, managers should scan the enterprise's dynamic sustainable competitive position so as to factor in the competitive pressure, not only from technological resources, but also from product markets [11]. The existing research on sustainability of competitive position has mostly examined the degree of "technology competition" separate from the degree of "market competition." Studies focusing on technology competition have captured its extent in different ways. Among them, patent information analysis has become a very important method in technology competition identification because the high degree of technical similarity between enterprises means the intensity of competition between the two [12]. Studies focusing on market competition mainly analyze the sustainability of competitive position from public opinion. Among them, questionnaire surveys and brand conversion analysis are the main research methods [13,14]. With the development of the Internet, scholars began to use the information contained in the network to identify the sustainable competitive position of the industry, that is, to identify competitors mainly from two aspects of network content or network link structure, mainly using the network co-link methodand the URL co-occurrence method [15–17]. However, few of these in-depth studies have examined firms' sustainable competitive position from the joint perspectives of technology and market competition; thus, our understanding of the interplay between technology and market competition and how this interplay affects firms' sustainable competitive position is still incomplete.

To fill this gap, our study employs comprehensive perspectives to examine the firm's sustainable competitive position, factoring in the simultaneous effects of technology competition and market competition. Using patent data as an indicator, we estimate the degree of technology competition of enterprises by measuring the technical similarities between enterprises, so as to examine the degree of fierce competition in the high value-added links such as R&D at the front end of the industry chain from the perspective of insiders. At the same time, we use the URL co-occurrence data as an indicator to obtain the public opinion on the overlap of the market position by comparing the co-occurrence value of the URL between enterprises, so as to obtain the judgment of the public on the sustainable competitive position of the enterprise from the perspective of the outsider. By superimposing these two perspectives, we have comprehensively examined the sustainable competitive position of the company and obtained valuable and new information.

This study contributes to the sustainable competitive position literature in three ways. First, our study adopts a comprehensive framework and exemplifies its usefulness in assessing a firm's sustainable competitive position that originates in technology competition and market competition. The joint framework allows us to identify sustainable competitive position from the perspectives of insiders and outsiders. Furthermore, our study shows that the analysis of the integration framework of insiders and outsiders can get a lot of valuable information, effectively avoiding the blind spots and misunderstandings by identifying competitors. For example, the joint framework can analyze which institutions are close to the technical positioning and the brand image of the company? Which institutions and the company only have one-dimensional competition? Which institutions are less competitive with the company and is there a possibility for synergy? In addition, our research provides a reference example for the integration of theory and methods of patent measurement and network measurement.

The next section of this four-section paper reviews the literature and develops research questions. The third section describes our empirical methodology and the results. The final section summarizes contributions, followed by suggestions for future work.

2. Literature Review

The analysis of industrial competitive position is not only an important theme of industrial organization economics, but also the basis for enterprises to understand the industry competition structure and carry out gap analysis and benchmarking management. Therefore, this research topic has continuously been paid attention to by personnel in the fields of information science, business management, science, etc., and has experienced the development process from basic theoretical research, to qualitative method application, and finally, to quantitative method exploration.

Indeed, a firm's competitive strategy is often shaped by its sustainable competitive position. Prior research has used the perspective of competitive position to identify sources of competitive pressure and conduct competitor analysis [18,19]. From this perspective, a firm's sustainable competitive position consists of factors related to both technology resources and product market, and a firm's competitive pressure comes from both technology competition and product market competition. The existing view of sustainable competitive position often employs a single framework in which firms are paired and assumed to compete directly against each other because of their high technological resource similarityor high market similarity [20–22].

The existing research on the technical competition is mainly based on the perspective of the enterprise, examining the technology resource similarity between enterprises from the perspective of the insiders. In the increasingly dynamic environment, patent information analysis has become a very important method in the identification of sustainable competitive position because the high degree of technical similarity between enterprises signifies the intensity of competition between the two. Researchers in the fields of information science and business management have designed multidimensional evaluation systems for analyzing competitive relations based on patent data. Common indicators include: the number of patents (used for measuring the scale of technological innovation), the patent application area (used for identifying the target market of enterprises), the International Patent Classification (IPC) or U.S. Patent Classification (UPC) (used for discovering the focus of technology R&D of enterprises), the number of invention patents or tripartite patents (used for evaluating enterprise's technical quality), the forward reference of the patent (used for evaluating the technical influence of enterprises), the back reference of the patent (used for determining technical originality), and so on [23–25]. Jaffeused the sales revenue of each product category to measure the proximity of technology positioning among enterprises [26]. Kwon et al. and No HJ et al. proposed concepts such as similarity, proximity, and distance of industry or enterprise, which can be improved to compare technology development structures [27,28]. Caviggioli proposed a technical distance measurement indicator-a reverse concept of technical similarity, which combines International Patent Classification (IPC)1, International Patent Classification(IPC)3, and World Intellectual Property Organization (WIPO) technology categories [29]. Meanwhile, the development of complex network theory provides important technical support for in-depth analysis of patent citation networks [30]. In recent years, the visualization of technology tracking based on patent citations have provided important assistance for in-depth insight into industry leaders and followers. At present, researchers try to use text mining technology to analyze and understand patent text items, so as to provide deeper business information for insight into the sustainable competitive position of enterprises [31–34].

The existing research on market competition is mainly based on public opinion and examines the degree of competition of the market position or brand image of the enterprise from the perspective of outsiders. Introducing public cognition into the research of an enterprise's sustainable competitive position, the competition relationship between enterprises can be interpreted from the perspective of third parties, and the research methods mainly include questionnaire surveys and brand conversion analysis. However, although the traditional questionnaire survey method can obtain first-hand information about public cognition, it has shortcomings in many aspects such as labor cost, time cost, sample representation, and horizontal contrast. The development of the Internet has provided new ideas and ways for the analysis of the sustainable competitive position of enterprises. These methods include network co-link analysis and URL co-occurrence analysis. Vaughanis a pioneer in the

application of co-link analysis methods to enterprise competitive information research and has done a lot of theoretical exploration and empirical work [15,16]. Co-link analysis found that most websites are not linked to competitors' websites, but they may all be linked by third parties [35]. The higher the similarity between enterprises, the greater the number of co-links and the higher the similarity of their business. However, in recent years, the available link data sources have gradually decreased. The classic search engines, such as Altavista, Alltheweb, and Yahoo, no longer exist or have canceled the support for link search. Google only returns sample data for link search, so it cannot be used for linked data collection, which greatly hindered the further development of co-link analysis. In order to solve the problem of lack of link analysis data sources, scholars are actively exploring new solutions. URL references are similar in structure and intent to hyperlinks, and data access is superior to web links, thereby developing a URL co-occurrence analysis, i.e., the URLs of the two networks are simultaneously included in the third website. Research by Thelwall et al. shows that URL co-occurrence can replace network co-link analysis [36]. Therefore, under the Internet self-organizing mechanism, the URL reference reflects the public's views and attitudes, and can reveal the sustainable competitive position and potential relationship between enterprises from a third-party perspective.

Unlike the framework used in studies in the existing literature on sustainable competitive position, our framework will account for the joint perspectives of insiders (enterprise self-positioning) and outsiders (public cognition). Our conceptualization of a firm's sustainable competitive position has the following attributes: (a) a focal firm's sustainable competitive position consists of two dimensions: enterprise self-positioning and public cognition; (b) the competitive position considers all competitors in the same industry as the focal firm; and (c) the competitive position changes when competitors make changes in their self-positioning and public cognition. In what follows, we elaborate how we conceptualize the enterprise self-positioning and public cognition dimensions. From the perspective of insiders (enterprise self-positioning), we collect patent data from the Derwent Innovation Index (DII) database, calculating the technology proximity between enterprises, and measure the technical competition position among enterprises. From the perspective of outsiders (public cognition), the URL reference is used as the data source to analyze the agglomeration effect of the co-occurrence of enterprise URLs to identify the public's common cognition of the inter-enterprise competition. Finally, we selected a company as the target organization to construct a two-dimensional coordinate axis with technical similarity and URL co-occurrence value, and simultaneously display the different strength competition position faced by the target enterprise from the joint perspectives of self-positioning and public cognition. Based on the comprehensive framework of enterprise self-positioning and public cognition, the research questions raised in this paper are as follows: How to identify the sustainable competitive position of the enterprises from the perspectives of enterprise self-positioning and public cognition? What is the difference between the results of the sustainable competitive position analysis from two perspectives? If we combine these two perspectives and re-examine the sustainable competitive position of enterprises, what valuable information will we get?

3. Methods

3.1. Conceptual Analysis Framework

The identification of the sustainable competitive position of enterprises and the sustainable development of enterprises may encounter many practical problems. For example, what is the reality of the sustainable competitive position of enterprises? How do companies define their competitors and sustainable competitive position? How does the public view the competitive relationship between enterprises? What is the difference between the two? How do we view this difference? How can companies maintain a sustainable competitive advantage? In response to these problems, this paper constructs a comprehensive framework for the identification of sustainable competitive position in enterprises (Figure 1), and examines the competitive relationship and intensity between enterprises from the perspectives of insiders (enterprise self-positioning) and outsiders (public cognition).

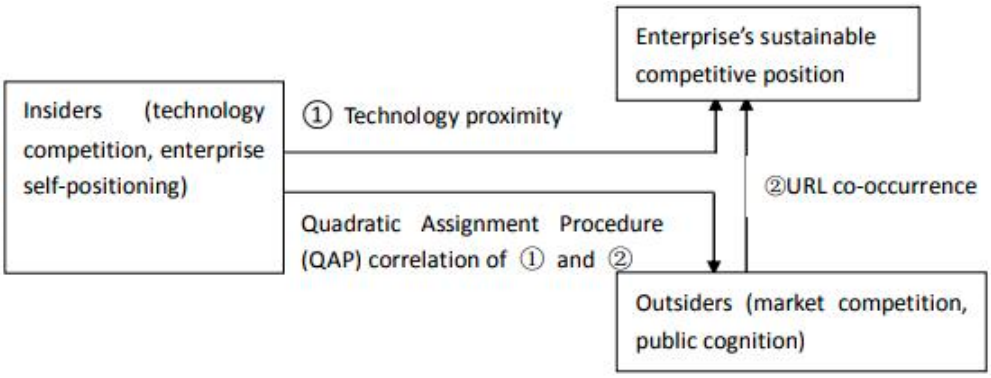

Figure 1. The comprehensive framework for the identification of enterprise's sustainable competitive position.

As shown in Figure 1, on the one hand, based on the insiders (enterprise self-positioning), this study shows the sustainable competitive position between enterprises. On the other hand, by adding the dimension of outsiders (public cognition), competitive relations and intensity among enterprises were analyzed from the perspective of the third party, which may provide overall opinions for understanding the competition position of the industry.

From the perspective of insiders (enterprise self-positioning), the sustainable competitive position of enterprises can be determined by observing the characteristics of their technological development. The characteristics of technology research and development reflect the key points and target markets of enterprises. Therefore, by analyzing the proximity of technology R&D among enterprises, we can see the fierce competition of enterprises. Therefore, how does one measure the characteristics of enterprise R&D? Considering authority, representativeness, usability, comparability, etc., patents are undoubtedly the best proxy indicators. This study uses DII patent data to calculate the technology proximity between firms to analyze the technological competition between firms. This paper adjusts one aspect when analyzing the technology proximity of enterprises, which is the choice of technical classification system.

From the perspective of outsiders (public cognition), the sustainable competitive position of enterprises can be identified via URL co-occurrence analysis. URL references reflect the views and attitudes of individuals and institutions on corporate competition, while URL co-occurrence reveals the realities and potential relationships between firms from a third-party perspective. Therefore, this study uses URL reference as a data source to analyze the aggregation effect of corporate URL co-occurrence to identify the public cognition of the inter-enterprise competitive relationship.

3.2. Data Collection

According to the data published by the Ministry of Industry and Information Technology of the People's Republic of China (MIIT), the number of China's mobile communication users has a sustained growth, reaching 714 million, which accounts for 1/3 of the users in the world. This study retrieves the relevant patent data from the Derwent Innovation Index (DII) database by taking LTE (long term evolution) as the key word, and defined the institution that has over 100 pieces of patent application as the mobile communication industry's technology leader, as shown in Table 1. It is important to note that the data in DII are patent families acquired through manual operation, so the number of patents in Table 1 will be lower than that of single patent in other databases.

As can be seen from Table 1, a total of 30 companies have more than 100 patents for communication technology patents (families), including traditional European and American communication giants, such as Ericsson and Qualcomm, as well as Chinese and Korean companies such as Huawei, ZTE, LG, and Samsung. The competition between the 30 leading companies in technology research and development will be analyzed below based on the comprehensive framework.

Table 1. The leading enterprises in mobile communication industry (the quantity of patent families' applications >100 pieces).

Serial No.	Number of Patents	Name of Enterprises	Serial No.	Number of Patents	Name of Enterprises	Serial No.	Number of Patents	Name of Enterprises
1	2898	LG	11	666	Fujitsu	21	341	InterDigital
2	2489	Ericsson	12	655	Kyocera	22	322	Electronics and Telecommunications Research Institute
3	2542	Qualcomm	13	617	BlackBerry	23	297	HTC
4	1805	Nokia	14	589	NEC	24	271	Renesas Electronics
5	1574	Huawei	15	569	Sharp	25	268	Verizon Communications
6	1560	Samsung	16	481	Broadcom	26	263	Datang
7	1335	NTT	17	389	Panasonic	27	196	Pantech
8	1227	ZTE	18	359	Apple	28	167	MediaTek
9	907	Intel	19	357	Motorola	29	113	Hitachi
10	902	Alcatel	20	350	AT&T	30	110	Mitsubishi

3.3. Analysis of Two Perspectives

3.3.1. The Perspective of Insiders (Technology Competition, Enterprise Self-Positioning)

Step 1 identifies the sustainable competitive position of enterprises based on the analysis of technology proximity from the perspective of insiders (technology competition, enterprise self-positioning). In order to measure the proximity degree of technology R&D structures among enterprises and find out their technical competition situation, this paper adopts patent data calculating technology proximity. Technology proximity is a reflection of the degree of similarity between technical structures and knowledge structures among firms. Generally speaking, the stronger the technology proximity between enterprises in the same industry, the stronger the degree of technological competition among enterprises. Enterprises in different clusters have large technological differences and strong complementarities, and the possibility of cooperation is greater. There are two main methods for measuring the proximity of technology: one is the technology flow matrix based on technology generation–technology use of the industrial sector proposed by Scherer [37]; the other is the technical distance method proposed by Jaffe [26], which is also the most widely used measurement method. This paper selects the angle calculation method based on enterprise technology category vector proposed by Jaffe to measure the technology proximity between enterprises. The calculation method is shown in Equation (1):

$$\mathrm{Tec}_{ij} = \frac{f_i f_j'}{\sqrt{\left(f_i f_i'\right)\left(f_j f_j'\right)}} \quad (1)$$

Among them, Tec_{ij} is the technical distance between enterprises i and j. f_i and f_j are the proportion of patents of enterprises i and j in different technical categories (International Patent Classification subcategory, the first 4 digits) P1, P2, . . . , PN expressed in vector form, and are transposes of vectors f_i and f_j. Because the technical classification has a great influence on the calculation results, this paper selects the IPC subcategory (the first 4 digits) as the patent technology category space. The specific measurement method is as follows.

First, count the N technical categories involved in patents owned by mobile communication companies; next, count the number of patents in each technology category of each enterprise, and divide the number of patents by the total number of patents to build an enterprise–technical classification matrix; then, each vector f_i, f_j is substituted into the calculation formula to obtain the technology proximity between enterprises.

The technology proximity of 30 mobile communication enterprises are calculated according to Equation (1). The results are shown in Table 2.

In order to further reveal the direct competition relationship between enterprises and the industry competitive position, the matrix in Table 2 was imported into software UCINET 6.0 [38], and the

multidimensional scale (MDS) analysis function was called; the data relationship selection proximity is shown in Figure 2.

Table 2. Technology proximity of mobile communication enterprises (enterprise number ≤30, partial).

No.	1	2	3	4	5	6	7	8	9	10
1	1.00	0.88	0.93	0.83	0.84	0.98	0.89	0.87	0.974	0.85
2	0.88	1.00	0.99	0.99	1.00	0.94	0.93	1.00	0.957	1.00
3	0.93	0.99	1.00	0.97	0.97	0.97	0.95	0.98	0.984	0.98
4	0.83	0.99	0.97	1.00	0.99	0.91	0.92	0.98	0.927	0.99
5	0.84	1.00	0.97	0.99	1.00	0.92	0.92	1.00	0.932	0.99
6	0.98	0.94	0.97	0.91	0.92	1.00	0.91	0.94	0.994	0.92
7	0.89	0.93	0.95	0.92	0.92	0.91	1.00	0.93	0.928	0.92
8	0.87	1.00	0.98	0.98	1.00	0.94	0.93	1.00	0.947	0.99
9	0.974	0.957	0.984	0.927	0.932	0.994	0.928	0.947	1.00	0.943
10	0.85	1.00	0.98	0.99	0.99	0.92	0.92	0.99	0.943	1.00
11	0.89	0.98	0.98	0.97	0.97	0.94	0.98	0.98	0.954	0.98
12	0.847	0.909	0.919	0.9	0.896	0.869	0.987	0.907	0.887	0.9
13	0.87	0.99	0.98	0.99	0.99	0.94	0.94	0.99	0.953	0.99
14	0.89	0.97	0.975	0.959	0.96	0.929	0.989	0.967	0.945	0.963
15	0.941	0.915	0.956	0.881	0.886	0.937	0.974	0.902	0.95	0.901
16	0.926	0.872	0.905	0.846	0.839	0.941	0.802	0.859	0.943	0.853
17	0.952	0.957	0.985	0.927	0.934	0.967	0.969	0.946	0.979	0.945
18	0.927	0.97	0.974	0.958	0.957	0.974	0.896	0.964	0.978	0.959
19	0.916	0.994	0.996	0.978	0.983	0.965	0.941	0.987	0.978	0.989
20	0.753	0.89	0.883	0.931	0.883	0.815	0.861	0.875	0.849	0.909
21	0.90	0.98	0.97	0.96	0.97	0.96	0.89	0.97	0.962	0.97
22	0.961	0.923	0.944	0.887	0.9	0.985	0.852	0.923	0.974	0.898
23	0.82	0.981	0.965	0.98	0.976	0.886	0.941	0.978	0.914	0.982
24	0.777	0.958	0.933	0.963	0.962	0.849	0.937	0.962	0.869	0.957
25	0.727	0.888	0.879	0.936	0.882	0.8	0.808	0.87	0.834	0.909
26	0.82	0.99	0.96	0.98	0.99	0.89	0.92	0.99	0.909	0.98
27	0.989	0.802	0.87	0.744	0.757	0.948	0.844	0.791	0.931	0.767
28	0.897	0.989	0.985	0.975	0.98	0.949	0.951	0.99	0.959	0.979
29	0.918	0.966	0.983	0.947	0.943	0.945	0.967	0.955	0.97	0.962
30	0.9	0.922	0.943	0.901	0.906	0.912	0.998	0.915	0.926	0.91

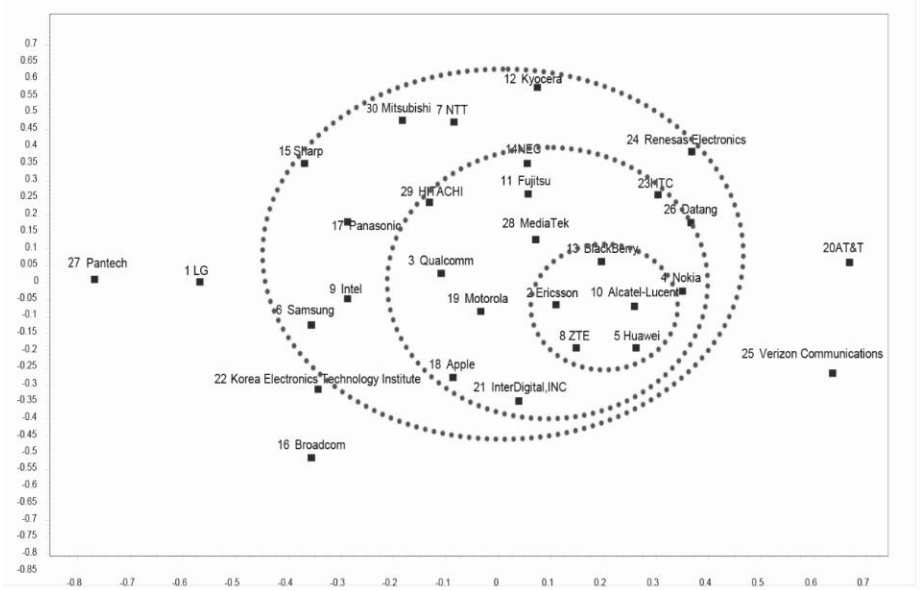

Figure 2. MDS analysis results of the technology proximity of mobile communication enterprises.

3.3.2. The Perspective of Outsiders (Market Competition, Public Cognition)

Step 2 identifies the sustainable competitive position of enterprises based on the analysis of URL co-occurrence from the perspective of outsiders (market competition, public cognition). The URL reference reflects the public's views and attitudes, and can reveal the competitive position and potential relationship between enterprises from a third-party perspective. The URL co-occurrence frequency refers to the frequency at which the URLs of enterprise website A and enterprise website B appear simultaneously on other website pages. Taking Nokia and Huawei as examples, the search formula for retrieving the URLs of two websites is "www.nokia.com www.huawei.com-site: www.nokia.com-site:www.huawei.com." Since May 2011, Bing has been the only international search engine that provides automated offline data sources for network metrology. Professor Thelwall developed Webometric Analyst 2.0 based on the Bing Application Programming Interface (API), which provides a good data collection tool for this article [39]. This article uses Webometric Analyst 2.0 to collect URL co-occurrence data between 30 mobile communication enterprises. The software obtains URL link data by querying a Microsoft Bing search, and can use the trial code to query 1000 URL co-occurrence data points for free, which can meet the sample requirements of this article. The URL co-occurrence data between the leading companies in the mobile communication industry obtained through the software is shown in Table 3.

Table 3. URL co-occurrence matrix (enterprise number ≤30, partial).

No.	1	2	3	30	4	5	6	7	8	9	10
1	0	256	184	99	639	330	498	60	349	288	83
2	256	0	563	78	554	469	611	126	419	503	468
3	184	563	0	42	383	423	579	59	210	493	258
4	639	554	383	151	0	549	191	128	477	492	422
5	330	469	423	27	549	0	512	141	142	372	384
6	498	611	579	263	191	512	0	145	522	371	371
7	60	126	59	15	128	141	145	0	74	193	80
8	349	419	210	3	477	142	522	74	0	439	226
9	288	503	493	194	492	372	371	193	439	0	493
10	83	468	258	7	422	384	371	80	226	493	0
11	557	522	449	543	509	609	440	252	659	362	557
12	50	114	98	187	83	336	27	47	200	37	50
13	528	242	277	322	379	640	50	135	427	155	528
14	254	518	483	599	451	631	287	216	708	250	254
15	91	80	45	88	53	361	22	54	137	25	91
16	118	325	519	367	264	485	50	151	547	167	118
17	596	455	344	650	409	723	182	166	660	169	596
18	548	562	406	447	549	142	454	389	635	399	548
19	660	581	511	568	504	596	125	514	607	380	660
20	359	475	516	517	397	413	229	208	730	412	359
21	7	88	79	63	71	66	11	32	84	51	7
22	17	170	161	182	126	400	20	80	272	78	17
23	715	189	341	680	229	704	44	337	563	68	715
24	43	122	168	148	102	372	61	52	424	41	43
25	257	382	369	100	244	525	106	96	483	263	257
26	4	31	8	8	31	8	14	44	6	4	4
27	55	32	19	88	28	119	9	22	22	6	55
28	1	25	34	35	17	33	6	12	51	3	1
29	340	337	240	446	246	610	105	125	663	131	340
30	99	78	42	151	27	263	15	3	194	7	99

As can be seen from Table 3, the URLs of the 30 companies have large differences in co-occurrence data, indicating that the competition and strength of these companies vary among public cognition. In order to further discover the public's cognition of the sustainable competitive position of mobile communication leading companies, the matrix in Table 3 was imported into software UCINET 6.0, and

the multi-dimensional scale (MDS) analysis function was called, and the data relationship selection similarity is shown in Figure 3.

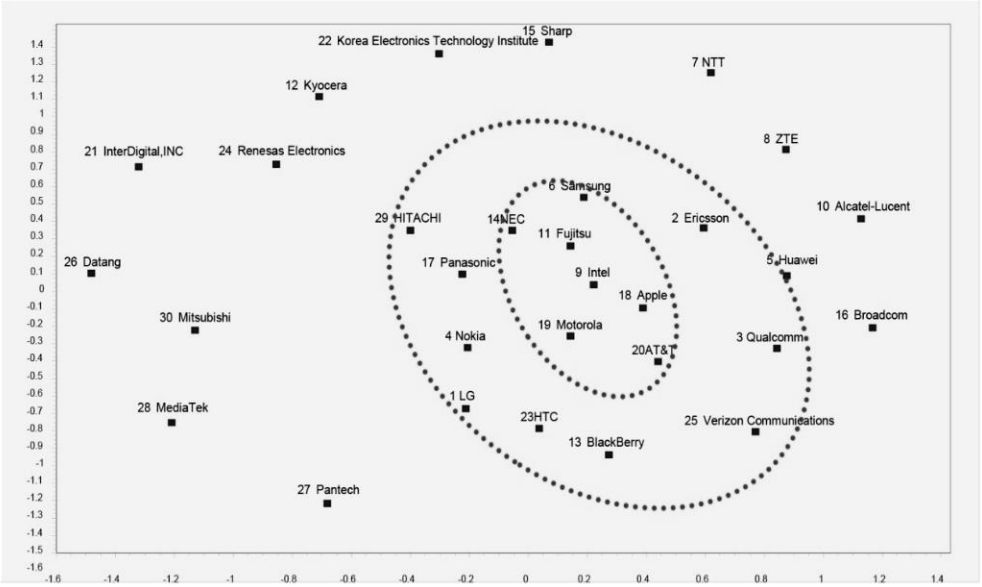

Figure 3. MDS analysis results of URL co-occurrence relation of mobile communication enterprises.

3.3.3. Panoramic Analysis of Sustainable Competitive Position with Comprehensive Framework Using Huawei as an Example

Based on the previous analysis, this paper takes Huawei as an example and integrates the two-dimensional perspective of insiders (self-positioning) and outsiders (public cognition), so as to show Huawei's competitive position in the mobile communication industry from the comprehensive dimensions of technology and market. In order to facilitate the display of the chart, this paper standardizes the URL co-occurrence data of other enterprises to Huawei, and the calculation formula is as shown in Equation (2):

$$URL'_{Hj} = \frac{URL_{Hj}}{max(URL_{Hj})} \quad (2)$$

Among them, URL'_{Hj} is the number of URL co-occurrences after standardization, and the value is [0,1]; URL_{Hj} represents the number of co-occurrences of URLs between Huawei and enterprise j, and max is the maximum function. The panorama of competitive position is shown in Figure 4.

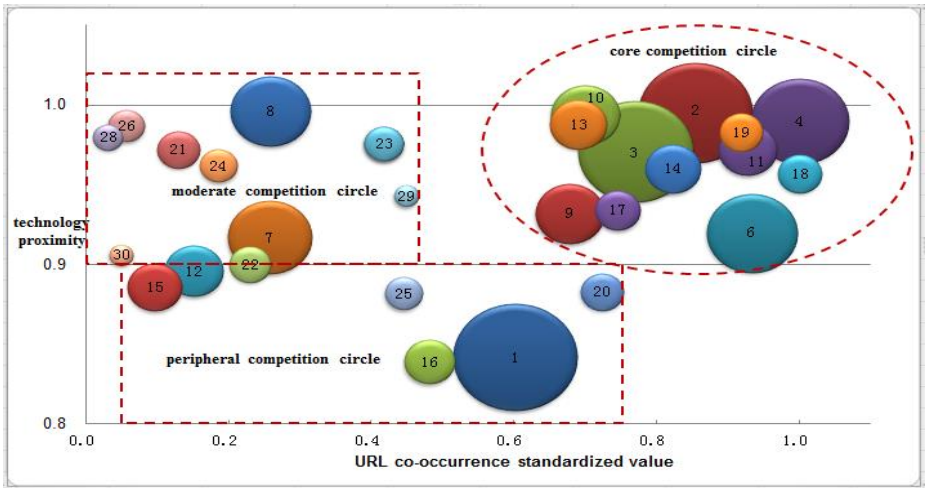

Figure 4. Panoramic analysis of Huawei's competitive position with comprehensive framwork.

3.4. Results

Through the analysis of two different and comprehensive methods of sustainable competitive position, this paper can draw four results.

Result 1: Considering from the perspective of insiders (technology competition, enterprise self-positioning), the technology proximity of these 30 mobile communication leading companies are relatively high, reflecting that the technology R&D structure of most companies is similar; that is to say, the technical competition among the leading companies in the mobile communication industry is concentrated and intense (from Table 2 and Figure 2). If the technology proximity of enterprises is high, the company's access to a sustainable competitive position mainly depends on the low cost advantage formed by economies of scale. On the contrary, the sustainability of a company's competitive position can be achieved through differentiated competition or cooperation.

Scanning the number and relative position of each node in Figure 2, it is not difficult to find that the patent scale (see enterprise number) has a certain impact on the technology competition position. According to the distance between nodes, this paper divides the technology competition relationship of 30 enterprises into four levels: core, middle, peripheral, and potential.

As can be seen from Figure 2, companies at the core competitive level include Ericsson, Nokia, Huawei, ZTE, Alcatel, and Blackberry, which represent the highest level of global mobile communication R&D and terminal manufacturing. These companies all regard digital communication technology as the focus of research and development, where the technology research and development structure is highly similar and the competition is the most intense. Companies in the middle of the competitive level include Qualcomm, Motorola, Fujitsu, NEC, MediaTek, HTC, Datang, etc., which both mobile phone manufacturers and mobile communication technology patent licensors. The diversification of enterprise types that determines the focus of organizational technology R&D structure is different, and the technology competition intensity is weaker than the core circle. For example, Qualcomm adopts a comprehensive layout strategy for mobile communication technology research and development, while HTC and Datang have shortcomings in basic communication processes and computer technology. Companies in the peripheral competition include Samsung, Apple, Intel, Interactive Digital, Panasonic, Sharp, NTT, Japan Kyocera, Mitsubishi, and so on. The differences between these companies are more obvious. Intel is mainly engaged in chip R&D and manufacturing. Interactive Digital is the pioneer of wireless communication technology. Samsung and Apple mainly develop and produce consumer electronic products, and several Japanese companies are more comprehensive. The diversification of products and technologies makes the R&D structure of these enterprises overlap and the technology competition is weaker. Companies in the potential competitive circle include LG, Broadcom, Korea Electronics and Telecommunications Research Institute, Korea Pantech, Verizon Telecom, AT&T, which includes communications operators, research institutions, and enterprises. The technology R&D structure between these organizations is large and the competition intensity is the weakest.

Result 2: Considering from the perspective of outsiders (market competition, public cognition), the co-occurrence data of the 30 mobile communication leading companies have large differences, indicating that the competition and strength of these companies vary among public cognitions (from Table 3 and Figure 3). From the perspective of public cognition, if companies want to obtain the sustainability of their competitive position, they can gain customer loyalty by enhancing their public image and brand reputation.

Different from the features of the nodes in Figure 2, the distribution in Figure 3 has obvious boundaries, except for the lower-right group, and the remaining nodes are distributed. As can be seen from Figure 3, the enterprises in the small black circle are the most competitive in the eyes of the public, such as the protagonists of the Century Patent Wars: Apple, Samsung, and Motorola, AT&T, Intel, and Japan's Fujitsu, NEC. The companies in the big black circle are also competitors in the eyes of the public, but the competition intensity is weaker than the small black circle, including Qualcomm, Ericsson, Huawei, who are the major patent and standard setters in the wireless communication field,

and mobile terminal manufacturers such as Nokia, LG, HTC, and Blackberry. In the eyes of the public, companies outside the black circle are less competitive, including companies and research institutions in China, Japan, Korea, the United States, France, and other countries.

It can be found from Figure 3 that the institutions in the public cognition center are mainly terminal communication equipment manufacturers with a high market share, important patent holders in the communications industry, and well-known consumer electronics manufacturers. In other words, the relative position of the company is related to its popularity and exposure. Thus, the competitive position presented in Figure 3 is closer to the third party's perception of the competitive position of the mobile communications industry than in Figure 2. For example, in order to cater to the aesthetics of consumers, Apple has applied for a large number of low-tech design patents, and thus is on the edge of technological competition in Figure 2, but in Figure 3, it is in the center of the industry competition. Qualcomm's comprehensive layout strategy, and LG's wireless communications and information signal transmission dual-center strategy make them far from other companies in Figure 2, but they return to the core circle in Figure 3. Enterprises outside the black circle include Interactive Digital, Datang, Pantech, Mitsubishi, MediaTek, NTT, etc. In the public cognition, the competition among these enterprises is relatively moderate. This is different from the information in Figure 2. For example, Datang, MediaTek, and ZTE are in the middle of the competition circle because they are similar to the technology research and development focus of most enterprises. However, in the public cognition, they even break away from the main battlefield of competition in the mobile communication industry.

Result 3: Insiders (enterprise self-positioning) and outsiders (public cognition) are two independent observational perspective sources that identify the sustainable competitive position of enterprises. The role of the two in the identification of the competitive position is complementary rather than substitute.

Comparing Figure 2 with Figure 3, the competitive position among mobile communication companies has produced huge differences due to the different viewing angles. Figure 2 is the result of the technical selection and resource allocation of the insiders, reflecting the sustainable competitive position of the enterprise at the front end of the industry. Figure 3 is the result of the reception and reorganization of information of the outsiders, reflecting the sustainable competitive position of the enterprise in the industrial terminal. In order to further identify the relationship between the analysis results of two perspectives, this paper normalizes the data of Tables 2 and 3, and uses the correlation analysis of the quadratic assignment procedure (QAP) to test that there is no significant correlation ($p = 0.206$). On the whole, both graphs and data tests show that insiders (enterprise self-positioning) and outsiders (public cognition) are two independent observation perspectives, and their roles in the sustainable competitive position identification are complementary rather than substitutes. Therefore, researchers should take into account these two dimensions to examine the competitive relationship between enterprises, otherwise it will be difficult to obtain the overall picture of the competition between the front end and the terminal of the mobile communication industry. As can be seen, the mobile communication industry is a typical network externality market, and the network externality effect often leads to the market pattern of "winner-take-all."

Result 4: Constructing a two-dimensional coordinate axis with technical similarity and URL co-occurrence value can simultaneously display the competitive position of a target enterprise from the perspectives of insiders (enterprise self-positioning) and outsiders (public cognition), and thus obtain valuable information (from Figure 4). From the comprehensive perspective, if Huawei wants to achieve the sustainability of its competitive position, it needs to adopt a flexible combination of different strategies, such as low-cost competition, differentiated competition, cooperation, and customer loyalty, according to different competition conditions.

According to Figure 4, Huawei's competitive position is divided into three categories: core competition circle, moderate competition circle, and peripheral competition circle. The upper right is the core circle, and its two indicators are double high (technical similarity >0.9; the standardized value of URL co-occurrence >0.6), indicating that these companies' self-positioning and public cognition

are similar to Huawei; the upper left is a moderate competition circle, and its technical similarity is high (>0.9), but the standardization value of URL co-occurrence is not high (<0.4), indicating that the technical position of these enterprises is similar to that of Huawei, but they are moderately resistant in public cognition; and the lower left is the peripheral competition circle. These enterprises are quite different from Huawei in both self-positioning and public cognition.

Specifically, Huawei's core competitors have obvious technological innovation advantages (judge from serial number), including Ericsson, Qualcomm, Nokia, and other technology creators in the communication industry, as well as high-end smart device manufacturers such as Samsung and Apple. Core competitors are the focus of Huawei's attention because they have a strong overlap with Huawei in terms of technology focus and brand image. Huawei should pay attention to the potential intellectual property risks and brand substitution risks.

The scale of technological innovation of Huawei's general competitors is in the middle-lower position (judged from serial number); companies including ZTE, HTC, Datang, and MediaTek belong to this camp. The general competitor is the object that Huawei should continue to pay attention to. This requires Huawei to be vigilant against high-intensity technology competition; on the other hand, it must adhere to the differentiation strategy and consolidate Huawei's high-end brand image.

Huawei's potential competitors include LG, Japan's Kyocera, Sharp, Broadcom, AT&T, and Verizon Telecom. Their competition with Huawei is more moderate, and there is the possibility of further cooperation, which should be paid attention to regularly.

4. Conclusions

This paper proposed to simulate the enterprise and the public to examine the competition among enterprises. Based on this, the enterprise's sustainable competitive position identification framework was constructed from the two dimensions of insiders (enterprise self-positioning) and outsiders (public cognition), and the two-dimensional perspective was also integrated in order to understand the overall situation of the enterprise's sustainable competitive position. First, this paper constructed a two-dimensional analysis framework and designed a sustainable competitive position identification method based on technology proximity and a sustainable competitive position identification method based on URL co-occurrence analysis. Next, the DII patent data and Internet URL link data were collected, and the sustainable competitive position of mobile communication enterprises was identified from the perspectives of insiders and outsiders. Finally, the two-dimensional perspective was integrated to comprehensively analyze the competitive position of Huawei in the mobile communication industry.

The study finds that the perspective of insiders (enterprise self-positioning) was to examine the industry competition from the technical side, and found that the technology proximity between leading companies was high, and the overall competition was fierce. To this end, a company's access to sustainability of a competitive position mainly depended on the low cost advantage formed via economies of scale. The perspective of outsiders (public cognition) was to examine the industry competition from the market terminal, and found that the competition between enterprises had obvious strengths and weaknesses. From this perspective, the company's access to the sustainability of a competitive position with regard to customer loyalty was held by enhancing public image and brand reputation. By comparison, the results of the analysis from the two perspectives were quite different. The QAP correlation analysis found that the above two observation angles were independent of each other, and the analysis results were complementary. Therefore, this paper found that the analysis of the sustainable competitive position from a single perspective did not fully reveal the overall picture of corporate competition. This paper superimposed the two perspectives, re-examined the competitive position of the enterprise, and obtained valuable information.

It can be seen from the research results that modern competition has made it necessary to strengthen technological innovation and meet customer needs so as to achieve the sustainability of a competitive position. The fierce competition in the industry directly challenges the management

structure established by enterprises to provide services. The technological innovation and management innovation are also restricted by the corporate governance system. The two constitute a complete system of the enterprise and form a dynamic institutional equilibrium in the process of market competition and sustainable development of the enterprise. Therefore, the improvement of competitiveness and perfect corporate governance are the basic guarantees for sustainable development of enterprises. In order to achieve the sustainability of a competitive position in the industry, enterprises must improve their management level (marketing characteristics of management and low cost advantage), have the ability to adjust and break through the governance system in a timely manner (rigid characteristics of governance), and gain the ability to create value for customers in the long run (enhancement of public cognition and public image, and customer loyalty). For the government, in the current environment, over-emphasizing market competition will make those companies with lower governance levels more disadvantageous, and this lack of governance is often not controlled by the company itself. Therefore, the key to the current government work is to further promote the reform of the intellectual property protection system and mechanism, strengthen asset restructuring and mergers and acquisitions, reduce administrative interventions, and give full play to the decisive role of market mechanisms in resource allocation. Meanwhile, the mobile communication industry is a typical network externality market. If the companies want to obtain the sustainability of competitive position in the competitive landscape, they need to manage user's expectations, expand the foundation of users, achieve extensive cooperation and alliances with manufacturers of complementary products, and improve the quality and reputation of their brands.

Several limitations of the current study provide opportunities for future studies of the competitive position and sustainable competitive advantages. First, the number of measurement indicators of technology competition and market competition are small, and exploratory research is needed, potentially including the effects of the cost, enterprise scale, market share, customer share, and so on. The second is to analyze only the static competition in the sustainable competitive position. The reasons behind this is that the competition is not overall identified, and there is no analysis of whether there is cooperation between enterprises. The third is to analyze the sustainable competitive position of the mobile communications industry by using the comprehensive framework of technology and market, and whether it can be extended to other industries requires further verification. Future studies can extend our theoretical framework into those contexts to test the suitability of the framework.

Despite these limitations, by empirically investigating the combined influence of technology and market competition, the research reported in our paper provides a finer-grained view of the nature of competition from a comprehensive perspective of a sustainable competitive position. We hope our results will encourage researchers to expand the examination of firm innovation beyond the mere consideration of market or technology to consider the dynamics of the sustainable competitive position. Follow-up research will strive to search and discover mediator variables and explore the potential relevance between insiders and outsiders. In addition, the automation of the information acquisition and analysis process is particularly important in order to continuously identify competitors. In the current dynamic environment of competition, the development of a more automated method is expected to become a major trend in the study of sustainable competitive position recognition. Finally, future work is advised to combine competitive dynamics with the sustainable competitive position perspective to explain and predict an optimum time interval with regard to technology advancements. Firms will revise their decision based on technology and market conditions [40]. This is because technology and market conditions largely affect the extent of competitive threat, and hence the payoff of advancement [41]. A sustainable competitive position may be a static "snapshot" of a given time. However, the landscapes over a period of time can function as a collection of snapshots that produce a "motion picture." A dynamic sustainable competitive position will be useful to complement earlier work in Mitchell (1989) [42] in explaining the optimal timing [43].

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