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EXAMINING THE CORE KNOWLEDGE ON FACEBOOK

Wen-Lung Shiau,
Department of Business Administration
Zhejiang University of Technology, Zhejiang, China
macshiau@yahoo.com

Yogesh K. Dwivedi
Emerging Markets Research Centre (EMaRC), School of Management
Swansea University Bay Campus, Fabian Way, Crymlyn Burrows
Swansea SA1 8EN, Wales, UK
ykdwivedi@gmail.com

He-Hong Lai,
Department of Information Management, Ming Chuan University, Taoyuan, Taiwan
hwww44@gmail.com

Abstract

Social networks have become an indispensable activity in people's lives. A number of previous studies have investigated various social networks and probed in the core knowledge of integrated social networks. While social network knowledge is general and extensive, few studies have delved into the core knowledge of individual social networks, especially Facebook, which is a social network with over 1.7 billion users worldwide. Therefore, this study aimed to elaborate on the core knowledge of Facebook. In this study, a total of 4429 relevant academic papers were collected from the Web of Science, an online electronic database. Then, citation analysis and co-citation analysis were adopted to identify 50 highly cited academic papers to form a co-citation matrix. Finally, cluster analysis and multi-dimensional scaling analysis were employed to determine the core knowledge of Facebook. The research results showed that there are six points of core knowledge: (1) the behavior analysis of users; (2) the social impact of social networks; (3) the influence and application of Facebook in universities; (4) the evaluation of use motivation and theoretical models; (5) privacy risk and interpersonal impression; and (6) the strategies of social networks. The research results could be useful for academic studies and practice in the future.

Keywords: *Facebook, Co-citation analysis; Cluster analysis; Multi-dimensional scaling analysis*

1. INTRODUCTION

In recent years, the rapid rise of the Internet has made people's lives increasingly convenient, and it has become the most frequently-used tool nowadays. On the Internet, people can obtain information and keep in touch with others, which has contributed to the rise of social networks such as Facebook, Twitter, Weibo, and MySpace. In the past decade, social media and social networks have become a part of daily life (Buccafurri et al. 2016; Dwivedi et al. 2015; 2016; 2018; Kapoor et al. 2018; Ngai et al. 2015; Shiau et al. 2017; Shareef et al. 2018; 2017), changed the way individuals acquire information and communicate with each other, government and businesses, and even changed people's lifestyles and the way they involve in political and electoral processes (Aswani et al. 2018; Dwivedi et al. 2015; Hossain et al. 2018; Kapoor et al. 2016; Kapoor and Dwivedi 2015; Kamboj et al. 2018; Rathore et al. 2016). In the past, people had to deliver archives face to face; today, delivery can be achieved at any time and at any place through social networks, which facilitates life and communication. According to the survey by We Are Social, in January 2016 the global population was 7.395 billion, with 2.307 billion active social media users and 1.968 billion active mobile social media users. Compared with January 2015, the total number of network users had increased by 332 million, the number of active users of social media had increased by 219 million, and the number of active users of mobile social media had increased by 283 million. These numbers indicate a growing number of social media users and show that social media plays an increasingly important role in daily life. Of the large number of social media platforms, Facebook is the most frequently used, and the total number of Facebook users is still growing (Duggan 2015). In January 2016, the number of active Facebook users was 1.59 billion, followed by 653 million active Qzone users, and 555 million active Tumblr users, as shown in Figure 1.
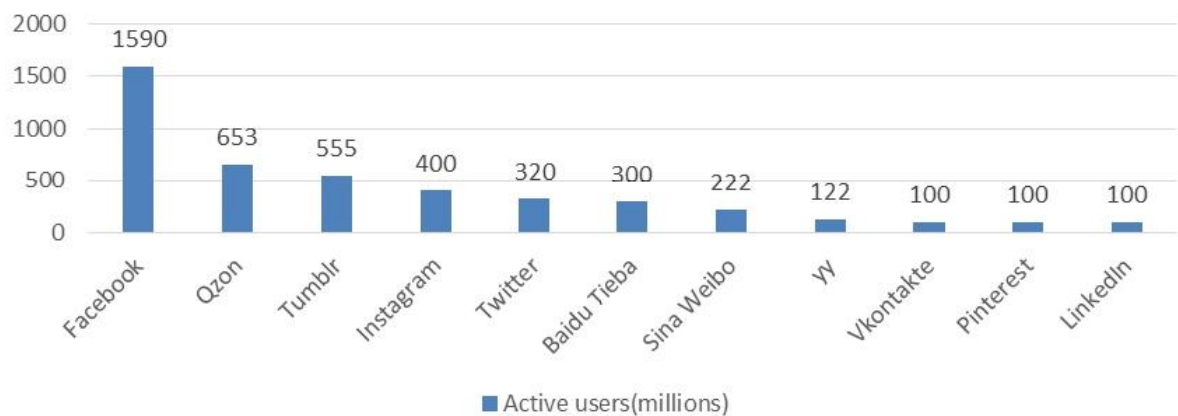
2000
1500
1000
500
0

1590
653
555
400
320
300
222
122
100
100
100

Facebook Qzon Tumblr Instagram Twitter Baidu Tieba Sina Weibo YY Vkontakte Pinterest LinkedIn

■ Active users(millions)

Figure 1: Active Users of Social Platforms in January 2016

[Source: http://wearesocial.com/uk/special-reports/digital-in-2016)

Facebook is the most popular social network worldwide today. It provides users with excellent opportunities to establish or maintain friendships with others and share information and communicate with friends (Marino et al. 2016). It is especially popular among the young (Blachnio et al. 2015), and young people use Facebook on a more regular basis than older people (Hayes et al. 2015). Of the young users, females spend more time on Facebook than males (Fardouly and Vartanian 2015). Facebook is intended to enhance social relationships, establish new relationships, and maintain friendships (Muscanell and Guadagno 2012), and users spend increasing amounts of time on it (Rainie et al. 2013). Facebook, however, does not promote social communication alone. Regarding college students, some studies have demonstrated that students use Facebook to make new friends and keep in touch with others, and that it is beneficial for their studies (Arteaga Sánchez et al. 2014). Young adults and teens favor alternative social applications (Snapchat and Instagram) over Facebook. According to the reports of eMarketer, Snapchat and Instagram are experiencing double-digit growth in the same youth demographic because they are more aligned to communicate with visual content (Bosker 2014; eMarketer 2017). Nevertheless, Facebook continues to grow as the largest social media platform. To date, Facebook has been applied to different enterprise

sectors, including human resource management, operations, and marketing. For instance, social networks have been adopted to investigate the backgrounds of employees (Roberts and Roach 2008), for advertising and marketing (Stephen et al. 2015), for tourism development (Park et al. 2016), and for social commerce adoption (Mamonov and Benbunan-Fich 2017). Facebook data has also been analyzed to collect information that is beneficial for business development (Lin et al. 2016). In addition to a having a far-reaching effect on daily life, Facebook has begun to change the way people work; thus, its growing effect on lifestyle cannot be neglected.

Many studies have been conducted on Facebook. Some have focused on the effect of Facebook on the mind or behavior of users (Lönnqvist and große Deters 2016; Sagioglou and Greitemeyer 2014; Shen et al. 2015), some have probed into the interactions between Facebook users (Brailovskaia and Bierhoff 2016; Mendes et al. 2015), and some have explored privacy or trust issues on Facebook (Junior et al. 2014; Külcü and Henkoğlu 2014; Saeri et al. 2014; Tsay-Vogel et al. 2016). It has been shown that an increasing number of scholars are seeking to discuss issues regarding Facebook. After reading the Facebook studies conducted in recent years, this paper found that the number of studies regarding the core knowledge of Facebook is few. Thus, this study delved into the core knowledge of Facebook from 2007 to 2016, with the aim of providing an important index of relevant issues for future studies. The research questions of this study were as follows: (1) What are the high-value academic papers regarding the Facebook? (2) What is the core knowledge of Facebook? This study collected academic papers on Facebook from the Web of Science, which is a well-known online electronic database. Then, citation analysis and co-citation analysis were adopted to form a co-citation matrix. Cluster and multi-dimensional scaling analysis were employed for analysis to determine the core knowledge of Facebook. The rest of this paper

proceeds as follows. The next section describes the Facebook and co-citation studies, section three details the research methods, section four shows the results of the data analysis, section five presents the discussions, and the final section offers the conclusions, implications, and limitations of this study.

2. LITERATURE REVIEW

2.1 Facebook

According to the definition of Boyd and Ellison, a social network is a network that enables users to (1) share their personal information and views in the system; (2) show their connections with other users to indicate their friendships; and (3) view the information of other users through the connections. In a network, a user can interact with other users and summarize the development of social networks (Boyd and Ellison 2007). With the rapid development of the Internet, many social networks have been established, such as Facebook, Twitter, Weibo, and MySpace. With these networks, people can create their own webpages and interact with others. As one of the services offered by the Internet, social networks have fascinated a large number of adolescents. A social network is a place where people make new friends, as well as share their latest information, photos, films, and activities (Rahman 2014). There are three main reasons why people use social networks: (1) to make new friends; (2) to keep in touch with friends; and (3) to organize common social activities (Brandtzæg and Heim 2009). As social networks help people make friends, people have become increasingly reliant on them.

Facebook was founded in 2004 by Mark Zuckerberg et al (Valenzuela et al. 2008), and to date it has over 1.3 billion users, making it the most popular social network worldwide. According to the research results of Cheung et al., most people use Facebook to maintain real-time

communications with friends; when users in a group share similar values with other group members, they will develop a sense of belonging and have stronger intentions to use Facebook (Cheung et al. 2011). The findings of Mouakket show that satisfaction is the most important factor for users to continue their use of social networks, and that Facebook enhances customer satisfaction by offering new functions; thus, users will use social networks on a regular basis and form the habit of using social networks (Mouakket 2015). People communicate with others on Facebook in a manner similar to reality, thus maintaining communications with real friends (Surma 2016). Currently, Facebook has become a social network that can be used at any time and at any place. According to the study by Bicen and Cavus, Facebook can be used at home, at school, and in cafes and restaurants. Most college students spend time on Facebook every day: 28% of students spend over two hours on Facebook every day, 16% spend three hours, and 32% spend over four hours. In most cases, students use Facebook to chat with friends and family members or enhance relationships through links and photos (Bicen and Cavus 2011).

The personalities of the users also have an effect on the use of Facebook; for instance, extroverted persons may have a larger number of groups and use Facebook as a social tool, rather than replace their social activities with it. Outgoing individuals are more willing to use new functions of Facebook, and even replace old functions with the new functions (Ross et al. 2009). Regarding gender, the main motive for females to use social networks is to entertain themselves and kill time, and they are more inclined to contact friends through groups; males seek social compensation and recognition through social networks (Barker 2009).

According to the investigation by Correa et al., extraversion and openness to experiences are positively correlated with the use of social media. Gender analysis reveals that emotional stability is negatively correlated with social media for men and is unrelated to social media

for women (Correa et al. 2010). Lin et al. (2014) investigated emotional disclosure on social network sites and found no gender effects on either positive or negative emotional disclosure. Other researches have confirmed a tendency for women to report feeling stronger and longer emotions and be willing to self-disclose more than male users (Schrock 2009). Women also seem readier than men to express (negative) emotions associated with vulnerability (Brody and Hall 2008). The overall gender differences in emotion expression vary by social context and by type of emotion.

In addition, to probe into the effect of Facebook on students' studies, White established a group on Facebook and added students into it. On a weekly basis, he asked students difficult questions and asked them to respond to these questions. The findings of the study revealed that Facebook-assisted teaching helps improve students' learning (White 2009). According to Mazer scholars, the self-disclosure of Facebook has a positive effect on the learning motive and effectiveness of students, as well as on the in-class atmosphere (Mazer et al. 2007). The results of the investigation by Arquero and Romero-Frías showed that most of the respondents believed that social networks are a learning-support tool and could improve college education. For different courses, different learning groups could be established for joint learning. Regarding the use of social networks, even new users could easily adapt to social network usage (Arquero and Romero-Frías 2013) to improve learning.

2.2 Co-Citation Analysis

Scholars have employed co-citation analysis to seek the knowledge structure of the field from academic papers. In 1973, Small was the first to propose using co-citation analysis to define the frequency of two academic papers being simultaneously cited (Small 1973). When the citation frequency is higher, the correlation between two academic papers will be stronger and the papers will be more representative and important. Liu conducted a journal co-citation

analysis of 38 representative journals from 1992 to 2002. After searching the data regarding relevant journals from Social Sciences Citation Index (SSCI), Liu adopted multi-dimensional scaling analysis, factor analysis, and cluster analysis to identify the knowledge structure of urban studies. Four knowledge structures were found: (1) mainstream urban studies; (2) regional science and urban economy; (3) transportation; and (4) real estate finance (Liu 2005). Culnan collected data from SSCI and applied author co-citation analysis and factor analysis to explore the knowledge structure of the information management system from 1980 to 1985. According to the results, the knowledge structure of the information management system from 1980 to 1985 consisted of five items: (1) the foundation of the information management system, (2) the design and use of the information management of the individual method, (3) the management of the information management system, (4) the information management design and use of the organizational method, and (5) the curriculum of the information management system (Culnan 1987). To understand the knowledge structure of production and operation management (POM), Pilkington and Liston-Heyes collected the International Journal of Operations & Production Management (IJOPM) literature from SSCI from 1994 to 1997. In the preliminary collection, 245 academic papers were gathered, and after book critiques were removed from the academic papers, 213 papers and 188 authors were retained. Then, author co-citation analysis was used to form the author co-citation matrix, and the knowledge structure of production and operation management from 1994 to 1997 was found to consist of five items: (1) manufacturing strategy, (2) the development of the manufacturing strategy, (3) Japanese management techniques, (4) efficiency measurement, and (5) the practice of optimization (Pilkington and Liston-Heyes 1999). Andrews applied author co-citation analysis to the field of medical information, and after collecting the data from the Science Citation Index (SCI) and SSCI of the Web of Science, he calculated the citation

frequency of each author and the quantity of cited academic papers from 1994 to 1998, using the top 50 research fellows as subjects. Additionally, cluster analysis, factor analysis, and multi-dimensional scaling analysis were adopted to analyze the data. According to the results, these methods helped identify the themes related to the authors with the greatest productivity and those who were simultaneously cited, which facilitated the search for important academic papers regarding specific fields (Andrews 2003). Pilkington and Meredith collected data from three journals, including Journal of Operations Management (JOM), POM, and IJOPM, and adopted citation analysis and co-citation analysis to identify the knowledge structure of production and management journals from 1980 to 2006. Moreover, multi-dimensional scaling analysis was combined with factor analysis to identify 12 knowledge structures of production and management: (1) manufacturing strategy, (2) quality and measurement standards, (3) statistical method, (4) process design, (5) service, (6) flexibility, (7) qualitative method, (8) supply chain, (9) product/service innovation, (10) resource-based view, (11) measurement/balance score card, and (12) inventory control (Pilkington and Meredith 2009).

Hsiao and Yang used literature co-citation analysis to explore the knowledge structure of the Technology Acceptance Model (TAM). Data from 1989 to 2006 were collected from the Institute for Scientific Information (ISI) Web of Knowledge. In a search where Technology Acceptance Model and TAM were taken as the keywords, 518 original academic papers were obtained. To ensure that all the adopted academic papers were important papers, academic papers that were cited more than 30 times were chosen in the preliminary selection, and 66 papers were obtained. However, most of the 66 papers were from before 2005; therefore, the requirement for academic papers after 2005 was changed to academic papers that were cited more than 20 times. Finally, 72 important academic papers were selected. Then, multi-dimensional scaling analysis was respectively combined with factor analysis and cluster

analysis for the exploration, and three main trends were detected in TAM: (1) the task-related system, (2) the e-business system, and (3) the enjoyment system (Hsiao and Yang 2011). Moreover, Shiau and Dwivedi collected data from five main electronic commerce journals: (1) *International Journal of Electronic Commerce*, (2) *MIS Quarterly*, (3) *Electronic Market*, (4) *Journal of MIS*, (5) *Information Systems Research*, and (6) *Information Systems Research*, from 2006 to 2010. Of the obtained 1662 original academic papers, 48 high-value papers were selected after citation analysis. Then, co-citation analysis was adopted to generate the co-citation matrix, and factor analysis, cluster analysis, and multi-dimensional scaling analysis were applied to determine the five core knowledge aspects of e-business: (1) trust in e-business, (2) technology acceptance and application, (3) task-oriented e-business, (4) e-malls, and (5) the features and evaluation of the information system (Shiau and Dwivedi 2012). In addition, to explore the knowledge structure of supply chain management, Shiau et al. collected academic data from the Web of Science. In the search, supply chain management was taken as the keyword, and the search period ranged from 1996 to 2013. To ensure the rigorousness of the data, books and papers of proceedings were removed from the 5034 original academic papers, and subsequently, 4,652 academic papers and 145,242 reference papers were selected. Their results showed four core themes regarding supply chain management: (1) sustainable supply chain management, (2) strategic competition, (3) information value, and (4) the development of supply chain management (Shiau et al. 2015). Three statistical methods are frequently used to explore the core knowledge including factor analysis, multi-dimensional scaling analysis, and cluster analysis. Factor analysis is a statistical technique that is used to reduce a large number of variables into fewer numbers of factors. Cluster analysis is used for classification. Multi-dimensional scaling analysis simplifies multi-space samples into low-dimensional spaces and is used to visualize the data

through a two-dimension diagram (Hsiao and Yang 2011; Shiau and Dwivedi 2012; Shiau et al. 2017). This paper summarized the co-citation studies with three statistical methods in Table 1 as follows.

Table 1 Summary of Co-Citation studies

Author	Co-citation methods	Topic	Data	Methods		
				Factor	Cluster	MDS
Culnan (1987)	Author Co-citation	MIS	1980-1985	*		
Pilkington and Liston‐Heyes (1999)	Author Co-citation	production and management	1994-1997	*		
Andrews (2003)	Author Co-citation	medical information	1994-1998	*	*	*
Liu (2005)	Journal Co-citation	urban studies	1992-2002	*	*	*
Pilkington and Meredith (2009)	Document Co-Citation	production and management	1980-2006	*		*
Hsiao and Yang (2011)	Document Co-Citation	TAM	1989-2006	*	*	*
Shiau and Dwivedi (2012)	Document Co-Citation	Electronic Commerce	2006-2010	*	*	*
Shiau et al. (2015)	Document Co-	Supply chain management	1996-2013		*	*

	Citation					

* is used; MDS：Multi-dimensional scale ; MIS：Management information system; TAM：Technology acceptance model

3. RESEARCH METHOD

To investigate the core knowledge of Facebook, this study took Facebook as the keyword in the search for academic papers on Facebook in the Web of Science. Citation analysis was used to identify highly-cited academic papers, while co-citation was employed to generate the co-citation matrix. Cluster analysis and multi-dimensional scaling analysis were then adopted to analyze the co-citation matrix to determine the knowledge structure (core knowledge) of Facebook.

The Web of Science is a well-known database with high standards, and all its journals contain the influential research achievements of a large number of research fellows and scholars. Facebook is the most popular social network in the world, and this study took Facebook as the keyword to collect relevant journals and papers. The release date of the concerned data was prior to December 31, 2016, and all the selected data were complete records and cited reference papers. In the preliminary search, 5,079 academic papers were downloaded, and then papers of proceedings and book chapters were removed. Finally, 4,429 original academic papers and 136,986 cited papers were selected. According to the sorted data regarding academic papers, the earliest papers dated back to 2007; hence, the academic papers of this study ranged from 2007 to 2016. Derived from bibliometrics (Von Wartburg et al. 2005), citation analysis has become the main analytic tool for social sciences (MacRoberts and MacRoberts 1996). By focusing on the citation relationship among academic papers, bibliometrics can identify high value research in a field. Co-citation analysis is a structural

method used in bibliometrics, which could be used to explore the core knowledge structure of Facebook.

Cluster analysis is a statistical method for classification (Punj and Stewart 1983) and is used to seek homogeneous clusters or differentiate heterogeneous clusters (Hansen and Jaumard 1997). In this study, the Euclid distance was adopted to calculate distance, which is the basis for the evaluation of correlation, in which a shorter distance between academic papers indicates stronger correlation between the two. Then, the correlation between the academic papers was explored in all clusters to determine the relationships between the clusters, as well as their implications, in order to define the names of the dimensions. In this study, Ward's method of cluster analysis, Euclid distance, and z-score standardization were used to analyze and calculate the co-citation matrix, and the analysis results were used to discuss the knowledge structure and core knowledge of the academic papers regarding Facebook.

Multi-dimensional scaling analysis simplifies multi-space samples into low-dimensional spaces for positioning, analysis, and classification, and the correlation between data is used to visualize the data through a two-dimensional diagram, which is called a perceptual map. A point on the map symbolizes important data, and a shorter distance between two points indicates a stronger correlation between them. In this study, multi-dimensional scaling analysis was applied to visualize the relationship between academic papers (Pratt et al. 2012) and identify the knowledge structure (core knowledge).

4. RESULTS

The original academic data of this study were collected from the SSCI and SCI of the Web of Science, and Facebook was taken as the keyword to identify the academic papers in the form

of articles from 2007 to 2016. After citation analysis of the collected papers, 4,429 original academic papers and 136,986 cited papers were chosen. Figure 2 shows the annual number of academic papers published from 2007 to 2016. It shows that the number of academic papers regarding Facebook increased year by year, and that the issue has attracted increasing attention.
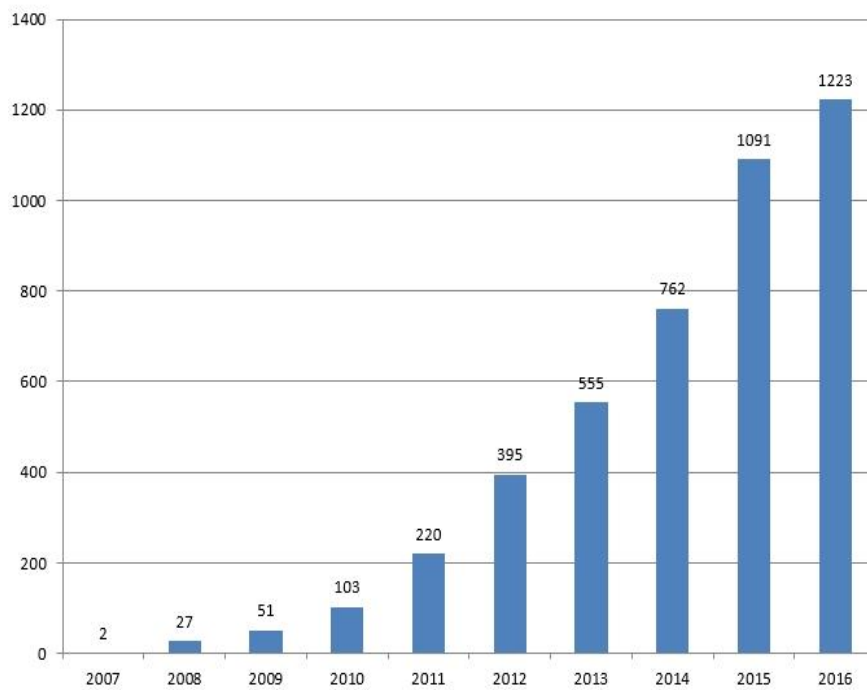

Figure 2 Annual Number of Published Original Academic Papers from 2007 to 2016

According to the journal distribution of the original academic papers, it was possible to identify the information attribute distribution and key journals of the original academic papers. This study took journals with at least 15 academic papers for the summary, and the top 30 of these journals are shown in Table 2.

Table 2 Ranking of Journals with Original Academic Papers

Journal Name	Papers
COMPUTERS IN HUMAN BEHAVIOR	488

Citation analysis was used to identify high-value and highly-cited academic papers, discuss the distribution of the journals of the 136,986 cited academic papers (Figure 3), calculate the citation frequency of the academic papers, and then rank them in descending order according to frequency. Ranking was the basis of the co-citation matrix, and high-value and highly-cited academic papers were selected from the cited papers.
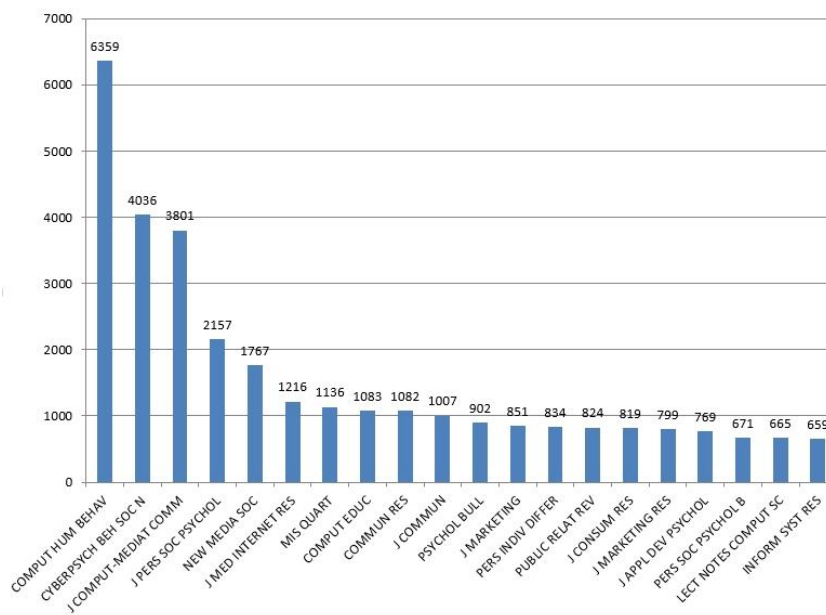
Figure 3 Distribution of the Top 20 Journals with Cited Academic Papers

In 1964, Kruskal proposed that the pressure coefficient in multi-dimensional scaling analysis could be taken as the evaluation benchmark. The pressure coefficient of (≤ 0.2) was taken as the benchmark to determine the appropriate size for the co-citation matrix. The number of highly-cited academic papers was 30, and the pressure coefficient of the co-citation matrix

was lower than 0.2 (pressure coefficient = 0.19572); however, as the number (30) of highly-cited academic papers was too small, it could fail to accurately present the core knowledge of Facebook. Therefore, this study adopted the step-by-step testing method to combine the results of multi-dimensional visualization with that of the cluster analysis to determine an appropriate number of highly-cited academic papers for the co-citation matrix. The step-by-step testing method started with 100 highly-cited academic papers, which was gradually reduced for testing. According to the results, as the number of highly-cited academic paper was reduced to 50, the results of cluster analysis could be presented in the visual diagram of the multi-dimensional scaling analysis. Hence, 50 highly-cited academic papers were chosen in this study for analysis; of these 50 academic papers, the number of citations of the highest-cited academic paper was 708, while that of the least-cited paper was 87, as shown in Appendix A.

After the 50 highly-cited academic papers were obtained, the distribution of the journals to which these highly-cited academic papers belong was achieved, as shown in Figure 4. According to the figure, the top four journals were *Computers in Human Behavior*, *Journal of Computer-Mediated Communication*, *Cyberpsychology Behavior and Social Networking*, and *Journal of Applied Developmental Psychology*. These results showed that journals related to psychology, media communication, and behavior have more important social network studies.
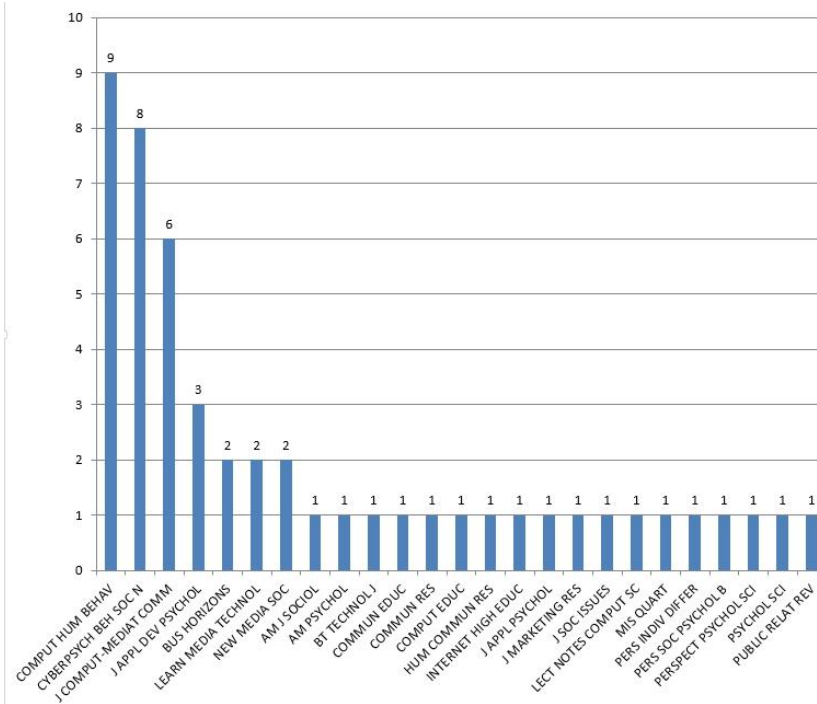
Figure 4 Distribution of the Journals Containing the 50 Highly-cited Academic Papers

This study extracted 50 high-value cited academic papers from the citation analysis, which were then used to generate a 50x50 co-citation correlation matrix. The results of the cluster analysis are presented in Figure 5, and the results of the multi-dimensional scaling analysis are shown in Figure 6. The codes of the academic papers are shown in Appendix A, and the six clusters were named as follows:
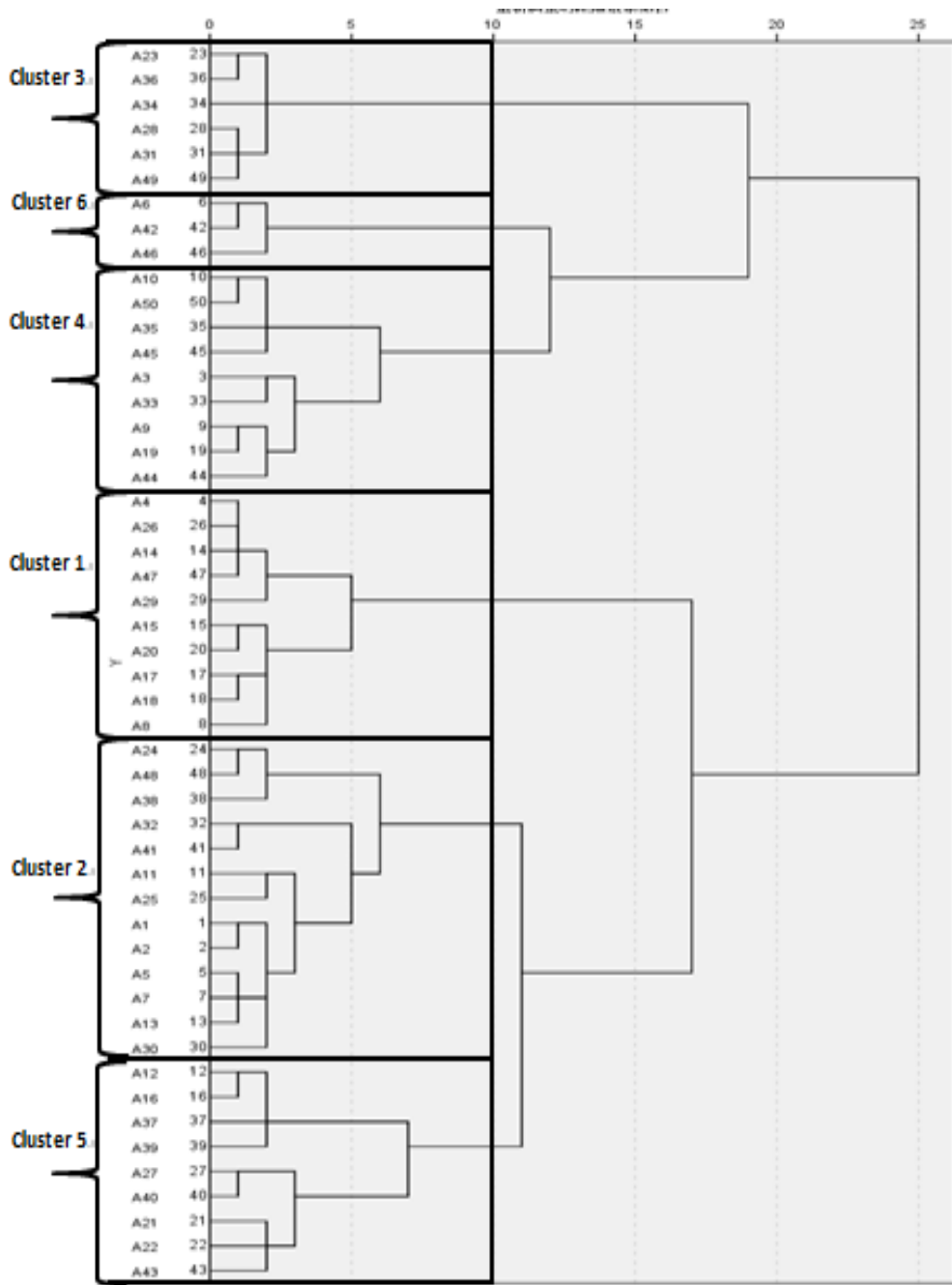
Figure 5 Results of cluster analysis
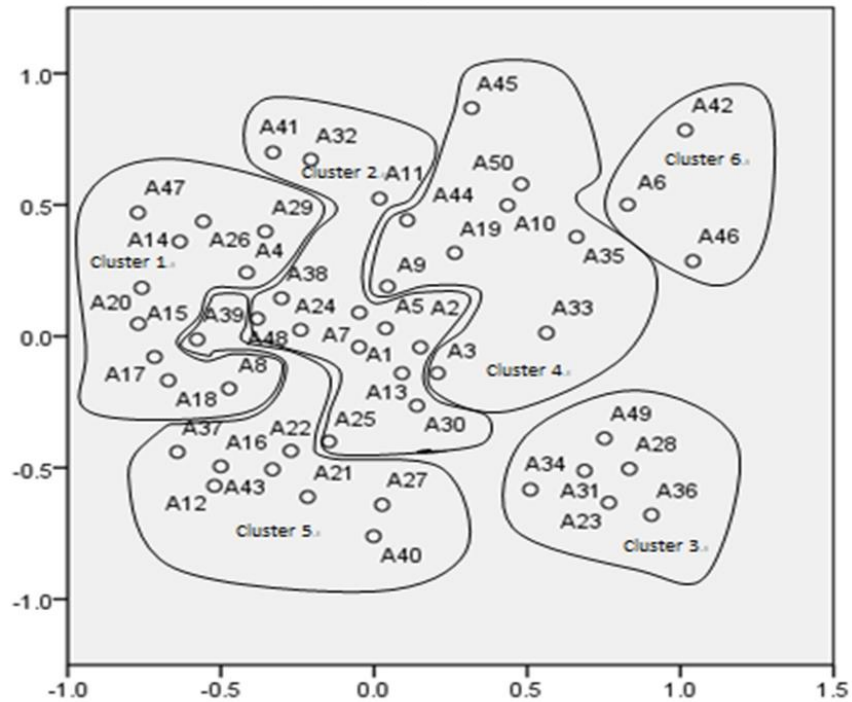
Figure 6 Results of Multi-Dimensional Scaling Analysis

Cluster 1 was named Behavior Analysis of Users. The academic papers in this cluster included A4, A8, A14, A15, A17, A18, A20, A26, A29, and A47. These academic papers probe into the personalities that will influence the use of social networks and believe there are differences in the use of social networks among users of different personalities.

Cluster 2 was named Social Impact of Social Networks. The academic papers in this cluster included A1, A2, A5, A7, A11, A13, A24, A25, A30, A32, A38, A41, and A48. These academic papers focus on the effect of social networks on people and society. For instance, social networks can help people keep in touch with each other, maintain social capital relationships, and enhance the civilian and political participation of users.

Cluster 3 was named Influence and Application of Facebook in Universities. The academic papers in this cluster included A23, A28, A31, A34, A36, and A49. These academic papers concentrate on influence and application in universities. For example, Facebook helps

students adapt to college life and helps teachers with their instruction, which shows that Facebook has some influence on students' communication and learning on college campuses.

Cluster 4 was named Use Motivation and Theoretical Model Evaluation. The academic papers in this cluster included A3, A9, A10, A19, A33, A35, A44, A45, and A50. These academic papers explore the motives for using social media, including social activities and entertainment, how to measure and evaluate different theoretical models, how to discuss social factors with the structural equation model, and the integrated technology acceptance model, which shows the positive correlation between perceived usefulness and predictions regarding future use.

Cluster 5 was named Privacy Risk and Interpersonal Impression. The academic papers in this cluster included A12, A16, A21, A22, A27, A37, A39, A40, and A43. These academic papers elaborate on the potential privacy problems and risks in the use of social networks. For instance, users may encounter privacy problems, information disclosure, and risks on social networks. There are factors and use norms that influence user impressions of social media, and those who claim to be attractive on Facebook could be regarded as insincere by other users.

Cluster 6 was named Use Strategy of Social Networks. The academic papers in this cluster included A6, A42, and A46. These academic papers discuss enterprises' evaluations of the use of social media, as well as suggestions regarding use, including how to select apps and how to improve service.

In this study, multi-dimensional scaling analysis was adopted to visualize the relationships among the 50 highly-cited academic papers, and the results of the cluster analysis were used for further discussion. In the multi-dimensional scaling analysis, the multi-dimensional method was employed to visualize the relationship among academic papers in the form of a

perceptual map. According to Figure 6, six clusters were obtained from the results of the cluster analysis and multi-dimensional scaling analysis of the high-value academic papers regarding Facebook, including: (1) behavior analysis of users, (2) social impact of social networks, (3) influence and application of Facebook in universities, (4) use motivation and theoretical model evaluation, (5) privacy risk and interpersonal impression, and (6) use strategy of social networks.

5. DISCUSSION

This study analyzed the annual distribution trends of the publications and the distribution of the journals to which the academic papers belong. According to the analysis of the annual publication trends, Facebook gained increasing attention from academic circles since 2007 and showed a trend of stable development; by 2015, over 1,000 academic papers about Facebook had been published. According to the distribution of the journals to which the academic papers belong, most articles about Facebook have been published in journals about computer science, behavioral science, and education and business. According to the results of cluster analysis and multi-dimensional scaling analysis, six aspects of core knowledge regarding Facebook were summarized: (1) behavior analysis of users, (2) social impact of social networks, (3) influence and application of Facebook in universities, (4) use motivation and theoretical model evaluation, (5) privacy risk and interpersonal impression, and (6) use strategy of social networks. The details of these six aspects are as follows:

The first aspect of the core knowledge of Facebook was behavior analysis of users, which focuses on the user personalities that would influence the behaviors on social networks. As increasing numbers of people have used various social networks such as Facebook, increasing attention has been paid to the behavior of different users on social networks. The behavior of

users on social networks can show the personalities of the users, such as extroversion and neuroticism, and can improve the functions of social networks (Hodas and Butner 2016; Mai et al. 2015; Shen et al. 2015). According to previous studies, extroverted people are more likely to use the new functions of Facebook, while those with high self-esteem are less likely to make friends with new people. Narcissism, self-esteem, and gender all have an effect on the self-presented contents and behavior on Facebook (Acar 2008; Fox and Rooney 2015; Marshall et al. 2015; Mehdizadeh 2010; Ross et al. 2009). The data regarding user behaviors can be used to evaluate the personalities of the users (Kosinski et al. 2013) and assess the differences in their behavior between the virtual and real worlds, thus helping reveal more about the reality of users. Today, social networks are not used for social connection alone; enterprises can get acquainted with the personalities of their employees, as well as the reliability of the information released by employees, by investigating the behavior of employees on social networks (Roberts and Roach 2008). Therefore, user behavior on social networks can be used as important data for user assessment. As the number of social network users continues to increase, future researchers will be able to achieve further measurement and discussion according to the behavior of social network users, as well as their personalities and influence (Ryan and Xenos 2011).

The second aspect of the core knowledge of Facebook was social impact of social networks, which concentrates on the effect of social networks between interpersonal relationships and human-society. In a society featuring globalization, social networks span spatial and temporal restrictions and satisfy demands for interpersonal interactions at any time and at any place (Wellman et al. 2001); moreover, they have a positive effect on people's sense of happiness and enhance their participation in community and social activities (Sheldon 2008a). There is a strong relationship between the use of Facebook and social capital; it has been confirmed that

social networks help people maintain their relationships with others (Ellison et al. 2007) and that users who frequently use Facebook tend to have stronger satisfaction with life and social trust, as well as civilian and political participation (Valenzuela et al. 2008). Numerous scholars have conducted studies on the social influence of social networks and have achieved abundant results. For instance, the positive use of Facebook has a positive relation with social capital, which has an effect on the development and maintenance of social correlations and enhances satisfaction with life (Ellison et al. 2014; Granovetter 2005; Grieve et al. 2013; Mahan et al. 2015; Oh et al. 2014; Verma 2014; Zhan et al. 2016). To date, this remains an important issue for discussion. Contemporary social networks have become an indispensable part of daily life, and their impact on humans and society will become ever greater. In addition to reinforcing interpersonal relationships, social networks strengthen people's social participation. Social networks are not only used to keep in touch with others; they have been applied to a wide range of purposes and have exerted an increasing impact on society. Hence, it remains essential for future researchers to constantly explore how to increase the positive effect of social networks on real life and reduce the negative impacts.

The third aspect of the core knowledge of Facebook was influence and application of Facebook in universities, which emphasizes the effect of Facebook on teachers and students in universities. Social networks have become a critical medium for young people to communicate with others and entertain themselves (Das and Sahoo 2011). In particular, students are one of the main Facebook user groups. For students, the six main motives of using Facebook include: (1) relationship maintenance, (2) passing time, (3) virtual community, (4) entertainment, (5) coolness, and (6) companionship (Sheldon 2008b). In terms of instruction, the self-disclosure of teachers on Facebook has a positive effect on the motive and effectiveness of students' learning, as well as on the in-class atmosphere (Mazer

et al. 2007). Facebook can promote interactions between teachers and students, including classroom activities and homework discussions (Munoz and Towner 2009). The positive effects on teacher-student interactions and the in-class atmosphere can enhance students' learning effectiveness. Regarding interactions among classmates, Facebook helps students adapt to college life. Numerous studies have demonstrated that Facebook has an effect on communications and classrooms, as well as the perception of and passion for learning (Duncan and Barczyk 2015; Duncan and Barczyk 2016; Irwin et al. 2012; Madge et al. 2009; McCarthy 2009). Different genders show variations in the use of Facebook; for example, males tend to use Facebook to show themselves and make new friends, while females use Facebook to discuss assignments (Horzum 2016). According to these studies, Facebook has an extraordinary effect on teachers' instruction and students' interactions on campus. With Facebook, students can accustom themselves to college life more quickly, including making new friends and participating in social activities and in-class discussions. Regarding interactions among students and between teachers and students, instruction involving Facebook has an effect. Therefore, how to effectively enhance the positive effect of Facebook on campus and reduce its negative impact is an important issue to be explored by researchers.

The fourth aspect of the core knowledge of Facebook was use motivation and theoretical model evaluation, which underlines the use motivation of social networks and provides a method to measure and evaluate the theoretical models related to social networks. As the number of social network users increases, social network developers must determine the social factors that influence the intention to use social networks (Cheung et al. 2011); for instance, how the perceived usefulness (or performance expectancy) and perceived ease of use (or effort expectancy) have an effect on the continual use of information technology (Davis 1989; Dwivedi et al. 2017ab; Rana et al. 2016;2017). This study adopted theoretical

models and a new integrated model to evaluate the intentions of use and key relationships to determine the factors that influence social media. The structural equation model and the integrated technology acceptance model were employed for exploration (Beyens et al. 2016; Choi and Land 2016; Liu et al. 2016; Marino et al. 2016), as it has been shown that these issues remain important. Only by correcting the problems of these relevant factors and enhancing the quality and appeal of social networks can social networks attract new users and motivate current users to continue to use social networks. Therefore, how to use different measurement methods, identify an appropriate theoretical model to evaluate relevant factors and usage motivations, provide better play to social networks, and attract more users will be essential components of emerging studies and the application of social media.

The fifth aspect of the core knowledge of Facebook was privacy risk and interpersonal impression, which places emphasis on the privacy of users on social networks, the potential risks in the use of social networks, the impression factors that influence users of social media, and the norms of using social networks. As the number of social network users increases with each passing day, more and more privacy problems and risks regarding social networks appear; thus, social network users pay increasing attention to personal privacy (Muise et al. 2009) and are concerned that their personal information and location could be leaked to strangers through Facebook, as the leakage of such information may increase their probability of being endangered (Acquisti and Gross 2006; Christofides et al. 2012). In recent years, numerous researchers have conducted studies on privacy and risk in a wide range of issues, such as the relationship between privacy attitude and self-disclosure, the relationship between Facebook and risk, the relationship between privacy awareness and security, and fraudulent behavior. As the use of Facebook becomes increasingly diversified and the amount of time spent using Facebook lengthens, increasing attention has been paid to issues regarding

management privacy and the risks of users (Hajli and Lin 2014; Lankton and Tripp 2013; Md Norwawi et al. 2015; Staksrud et al. 2013; Tsay-Vogel et al. 2016; Vishwanath 2015). Although the information presented on social networks, such as Facebook, helps people become more acquainted with themselves and share their information with friends, the possibility that this information may be obtained by strangers causes concern, and long-term users of social networks will pay more attention to their privacy and personal information. In particular, females are more concerned about their privacy and information disclosure than males (Fogel and Nehmad 2009). At present, an increasing number of people use social networks; thus, how to reduce the risks of privacy disclosure of social networks, and how to help users protect themselves, are issues worthy of discussion by future researchers (Gritzalis et al. 2014). Currently, social media sites are mainly communication tools, as users want to satisfy their need to communicate with others, make new friends, keep in touch with existing friends, and improve their self-image. Nevertheless, inappropriate use of social media may result in negative impacts. For instance, if a person has an excessive number of Facebook friends, his/her popularity may be doubted; if a person claims on Facebook that he/she is attractive, he/she will leave a poor impression on others (Tong et al. 2008; Walther et al. 2009). Therefore, it is essential to improve self-image and reduce negative comments from others on social networks, as these are the main purposes for using social media. According to the study by Chou and Edge (2012), the use of Facebook influences the opinions of users. Numerous scholars have analyzed the opinions of users, as well as the factors that influence the opinions on users. Some have focused on the effect of social networks on interpersonal impression; others have concentrated on improving self-image and enhancing reliability through impression management (Edwards and Harris 2016; Lillqvist and Louhiala-Salminen 2014; Oh and LaRose 2016; Park and Lee 2014; Pearce and Vitak 2015), showing that the

factors which influence interpersonal impressions on social networks, as well as the management of interpersonal impressions, are important research topics. Hence, how to improve and maintain self-image and interpersonal relationships (Walther 1996) through social media, and how to reduce negative comments to realize the original purposes of using social networks, remain an essential research direction for future researchers.

The sixth aspect of the core knowledge of Facebook was use strategy of social networks, which probed into the evaluation suggestions and use strategies of enterprises before the use of social networks, such as Facebook. With the development of globalization, many enterprises have begun to seek development through social networks. Enterprise information system/information technology (IS/IT) architecture is the foundation to use social networks with a group of IS/IT (technology) resources, including hardware, software, and management information systems, etc. Moreover, with architecture implementation, organizations are making changes to architecture in stages, not in one step. After implementation of enterprise (IS/IT) architecture, organizations can utilize IS/IT systems to enhance their ability to seek out the new information they need. In addition, enterprise IS/IT architecture supports business strategies. With a reliable, flexible, robust, and scalable enterprise IS/IT architecture, business owners can enhance their business goals, such as improving work quality, selling products, buying supplies, and managing employees, etc., as employees, suppliers, and other stakeholders interact with the system. Therefore, enterprise IS/IT architecture is viewed as a technological, organizational, and strategical resource to support business applications (Allen and Boynton 1991; Henderson and Venkatraman 1993; Duncan, 1995; Kayworth et al. 2001; Sauer and Willcocks 2002). Business owners take social media as a strategic resource to disseminate and gather information and better engage and serve their customers. By interacting with customers on social media, such as Facebook, Twitter, Instagram, and

Snapchat, they can obtain information regarding their products, and use such information to make greater adjustments and progress (Pantano et al. 2010; eMarketer 2017). Moreover, they can improve their service to satisfy consumer needs (Waters et al. 2009) and close the gap between enterprises and customers, which helps improve the performance and reputation of enterprises and reduce costs (Dijkmans et al. 2015; Heller Baird and Parasnis 2011), or they can use Facebook to publicize their brands and products (Schivinski and Dabrowski 2016) and manage their relationships with customers (Kumar et al. 2016). As enterprises aim to enhance their competitiveness through the influence of social media, how to make effective use of social media is an important research topic.

Regarding previous articles about Facebook, only Wilson et al. (2012) conducted a literature review of Facebook; however, they merely selected academic papers about Facebook that had been reviewed by peer scholars, while unpublished scripts and theses were excluded. Based on the results of this comparative study, the academic papers reviewed by Wilson et al. contained 412 papers that had been reviewed by peer scholars, while the 4429 academic papers about Facebook in this study were collected form the Web of Science. Regarding the publication time of academic papers, Wilson et al. focused on the period from 2005 to 2011, while this study concentrated on papers from 2007 to 2016. In terms of the research results, Wilson et al. offered research achievements regarding five aspects: (1) the narrative analysis of users, (2) the use motivation of Facebook, (3) identity presentation, (4) the role of Facebook in social interaction, and (5) privacy and information disclosure, while this study offered six aspects: (1) behavior analysis of users, (2) social impact of social networks, (3) influence and application of Facebook in universities, (4) use motivation and theoretical model evaluation, (5) privacy risk and interpersonal impression, and (6) use strategy of social networks. According to the comparative study, the narrative analysis of users and identity

presentation in the study by Wilson et al. were related to behavior analysis of users in this study, while the use motivation of Facebook and the role of Facebook in social interaction in the study by Wilson et al. were related to social impact of social networks in this study. In addition, privacy and information disclosure in the study by Wilson et al. was related to privacy risk and interpersonal impression in this study. Therefore, the new aspects of the core knowledge, as identified in this study, were influence and application of Facebook in universities, use strategy and theoretical model evaluation, and use strategy of social networks. Influence and application of Facebook in universities emphasizes the effect of Facebook on teachers and students in universities; use motivation and theoretical model evaluation underlines the use motivation of social networks and a method to further measure and evaluate the factors of theoretical models; use strategy of social networks probes into the evaluation suggestions and use strategies of enterprises before the use of social networks, such as Facebook.

This study explored the core knowledge of Facebook. However, there is no guarantee of the future success of Facebook forever. According to a well-known report of eMarketer, teens and tweens are migrating from Facebook to Snapchat and Instagram (Bosker 2014; eMarketer 2017). Snapchat is a multimedia messaging app in which pictures and messages are only available for a short time. Instagram is a photo and video sharing social networking application that can be edited with various filters and organized with tags and information. Both social network applications capture young adults and teens' eyes and mind in the use of video and photos. Facebook may need to put more effort into understanding the need for cool functions of young people. By seeking these aspects of core knowledge, this study could be an important basis to study and refer to for future studies.

6. CONCLUSION, IMPLICATIONS AND LIMITATIONS

The main contributions of this study are the identification of the core knowledge of Facebook from 2007 to 2016 and the comparison with previous studies. Facebook is currently the most popular social network worldwide and has quickly become a field of study for researchers. As few previous studies delved into the core knowledge or knowledge structure of Facebook, this study explored the core knowledge of Facebook to identify its core knowledge and development trends. In this study, literature citation analysis, co-citation analysis, cluster analysis, and multi-dimensional scaling analysis were adopted to analyze the development trends and research topics of Facebook. The findings showed six aspects of core knowledge: (1) behavior analysis of users, (2) social impact of social networks, (3) influence and application of Facebook in universities, (4) use motivation and theoretical model evaluation, (5) privacy risk and interpersonal impression, and (6) use strategy of social networks. According to the discussions of these six aspects of core knowledge, most Facebook studies have focused on the value and influence of social networks, the personalities of users, motivation needs, privacy risks, the efficacy of Facebook in universities, and the Facebook evaluations and applications of enterprises. The applications of social networks, such as Facebook, have spread from interpersonal interactions to enterprises, which shows that the influence of social networks is increasing and that social networks are being applied to a greater number of fields. Therefore, following the development of Facebook has become a focus of researchers and enterprise managers. While wider applications have highlighted the importance and diverse development of Facebook in different subjects, such a wide range of subjects should be taken into consideration by researchers and business managers.

Implications for Academics and Practitioners

With the core knowledge of Facebook, researchers can quickly become acquainted with the

past research developments and issues of Facebook. The 50 high-value academic papers, as summarized in this study, could serve as reference information for future studies of Facebook. Academically, earlier studies of Facebook focused on computer behavior and social media subjects, as well as the effects of Facebook on humans, society, and personalities that influence the use of Facebook. As the applications of Facebook have become increasingly wide, it has gradually spread to other subjects, such as psychological issues and medicine. Facebook is no longer confined to interpersonal communication. A number of scholars have begun to study how to improve the performance and evaluation of enterprises through Facebook; thus, the application and influence of Facebook have become increasingly extensive. The implications for academics are as follows. First, the analysis of user behavior on social networks could help reveal information about users and their personalities. Second, regarding social implications, the influence of social networks is no longer confined to social connections; the effects of social networks on individuals, groups, enterprises, and society cannot be ignored, and there is the trend of growth. Next, regarding efficacy in universities, social networks have an increasing effect on universities, and appropriate use of social networks could improve teacher-student relationships and enhance learning effectiveness. In addition, getting acquainted with use motivation could lead to new functions, solve problems, and attract more social network users. Finally, privacy disclosure has always been an important issue in social networks. Beyond the management and restriction of social networks, users must manage the information presented on social networks, in order to prevent their information from being misused.

The implications for practitioners are that Facebook has become one of the most popular social networks and an indispensable part of daily life; however, due to its close ties with daily life, its influence has become far-reaching and its effects have gradually spread from

personal communications to groups and enterprises. For users, privacy and risk, as well as interpersonal impressions, are issues worthy of attention. Identifying the potential risks of social networks could reduce the danger to users, and the factors that influence self-image could enable users to have secure use of social networks and realize their original intention. For enterprises, the core knowledge of Facebook is an issue worthy of attention from managers; in particular, the use strategy, collection, analysis, and application of user information could show user needs and application strategies, which could help provide users with the information they need in an effective and appropriate manner. Moreover, it could improve products, functions, corporate image, and improve organizational performance. For instance, its application in information transmission and personnel management could enhance the competitiveness of enterprises, meaning this issue is practical and essential.

Limitations

This study had a number of research limitations. First, only academic papers from the Web of Science were collected for this study, and other important journals and articles regarding Facebook were not included. Second, the co-citation analysis adopted in this study had the problem of time delay; thus, some high-value academic papers that were dated outside the chosen period, as well as some new papers, were excluded from this study due to the issue of citation frequency. In the future, more journals and academic papers or a longer period can be considered in discussions of the future development of the core knowledge of Facebook, in order to obtain richer core knowledge through a wider literature evaluation. Third, only research articles related to Facebook were studied. Young adults and teens favor Snapchat and Instagram over Facebook. Future studies may investigate the core knowledge of Snapchat and Instagram in order to better understand the social media usage of the young generation.

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Appendix A. **50 High cited papers**

No.	Title	Year	Cited Times
A1	The benefits of Facebook "friends:" Social capital and college students' use of online social network sites.	2007	708
A2	Social network sites: Definition, history, and scholarship.	2007	539
A3	College students' social networking experiences on Facebook.	2009	286
A4	Personality and motivations associated with Facebook use.	2009	260
A5	Is there social capital in a social network site?: Facebook use and college students' life satisfaction, trust, and participation.	2009	256
A6	Users of the world, unite! The challenges and opportunities of Social Media.	2010	240
A7	Social capital, self-esteem, and use of online social network sites: A longitudinal analysis.	2008	206
A8	Identity construction on Facebook: Digital empowerment in anchored relationships.	2008	199
A9	MySpace and Facebook: Applying the uses and gratifications theory to exploring friend-networking sites.	2008	194
A10	Evaluating structural equation models with unobservable variables and measurement error.	1981	177
A11	The strength of weak ties.	1973	166
A12	The role of friends' appearance and behavior on evaluations of individuals on Facebook: Are we known by the company we keep?	2008	157
A13	Connection strategies: Social capital implications of Facebook-enabled communication practices.	2011	154
A14	Who uses Facebook? An investigation into the relationship between the Big Five, shyness, narcissism, loneliness, and Facebook usage.	2011	148
A15	Self-presentation 2.0: Narcissism and self-esteem on Facebook.	2010	139
A16	Too much of a good thing? The relationship between number of friends and interpersonal impressions on Facebook.	2008	135

A17	Facebook profiles reflect actual personality, not self-idealization.	2010	134
A18	A review of Facebook research in the social sciences.	2012	134
A19	Being immersed in social networking environment: Facebook groups, uses and gratifications, and social outcomes.	2009	131
A20	Narcissism and social networking web sites.	2008	131
A21	Taking risky opportunities in youthful content creation: teenagers' use of social networking sites for intimacy, privacy and self-expression.	2008	129
A22	Information disclosure and control on Facebook: are they two sides of the same coin or two different processes?	2009	128
A23	Facebook, social integration and informal learning at university:'It is more for socialising and talking to friends about work than for actually doing work'.	2009	128
A24	Friend networking sites and their relationship to adolescents' well-being and social self-esteem.	2006	124
A25	Public displays of connection.	2004	119
A26	Who interacts on the Web?: The intersection of users' personality and social media use.	2010	118
A27	Facebook and online privacy: Attitudes, behaviors, and unintended consequences.	2009	117
A28	Findings on Facebook in higher education: A comparison of college faculty and student uses and perceptions of social networking sites.	2010	112
A29	Why do people use Facebook?	2012	111
A30	Online and offline social networks: Use of social networking sites by emerging adults.	2008	107
A31	Facebook® and academic performance.	2010	107
A32	Internet paradox: A social technology that reduces social involvement and psychological well-being?	1998	105
A33	Online social networks: Why do students use facebook?	2011	102

A34	I'll see you on "Facebook": The effects of computer-mediated teacher self-disclosure on student motivation, affective learning, and classroom climate.	2007	100
A35	Perceived usefulness, perceived ease of use, and user acceptance of information technology.	1989	100
A36	Faceworking: exploring students' education‐related use of Facebook.	2009	99
A37	Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction.	1996	98
A38	The relationship between Facebook and the well-being of undergraduate college students.	2011	96
A39	The faces of Facebookers: Investigating social enhancement and social compensation hypotheses; predicting Facebook™ and offline popularity from sociability and self‐esteem, and mapping the meanings of popularity with semantic networks.	2008	96
A40	Imagined communities: Awareness, information sharing, and privacy on the Facebook.	2006	95
A41	Internet paradox revisited.	2002	93
A42	Social media? Get serious! Understanding the functional building blocks of social media.	2011	90
A43	More information than you ever wanted: Does Facebook bring out the green-eyed monster of jealousy?	2009	90
A44	Facebook as a toolkit: A uses and gratification approach to unbundling feature use.	2011	89
A45	Common method biases in behavioral research: a critical review of the literature and recommended remedies.	2003	89
A46	Engaging stakeholders through social networking: How nonprofit organizations are using Facebook.	2009	88
A47	Social network use and personality.	2010	88
A48	The Facebook paths to happiness: Effects of the number of Facebook friends and self-presentation on subjective well-being.	2011	88

A49	The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement.	2012	87
A50	Why people use social networking sites: An empirical study integrating network externalities and motivation theory.	2011	87