Cognition and emotion in the information systems field: A review of twenty-four years of literature

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ABSTRACT

Cognition and emotion play important roles in information systems (IS) research, yet existing studies have not provided a comprehensive picture of these issues in the IS field. The current work is devoted to identifying the influential papers and intellectual structure of this domain. A citation network including 2061 related academic papers published between 1996 and 2019 is established to achieve this goal. Two novel indicators are proposed, through which 57 influential papers are identified, namely annual average degree centrality (AADC) and annual average betweenness centrality (AABC). A backward search process is performed preceding the co-citation analysis to develop an exhaustive collection of co-citation data. Finally, integrating multidimensional scaling analysis with clustering analysis, six core knowledge groups are revealed: (1) information technology use and information processing, (2) online shopping, (3) human-computer interaction, (4) customer service and negotiation, (5) organizational capability development, and (6) individual performance. Such core knowledge can help scholars obtain a clear understanding of IS cognition and emotion research in a limited amount of time. In addition, scholars can use the future research directions provided in this study to identify valuable and promising research opportunities.

Keywords: cognition; emotion; citation analysis; co-citation analysis; information

systems research

Cognition and emotion play important roles in information systems (IS) research, yet existing studies have not provided a comprehensive picture of these issues in the IS field. In this study, a citation network including 2,061 related academic papers published between 1996 and 2019 is established. Two novel indicators are proposed, through which 57 influential papers are identified, namely annual average degree centrality (AADC) and annual average betweenness centrality (AABC). A backward search process is performed preceding the co-citation analysis to exhaustively collect co-citation data. Finally, integrating multidimensional scaling analysis with clustering analysis, six core knowledge groups are revealed.

1. Introduction

Cognition and emotion both play decisive roles in the process of human judgment and decision-making (JDM) (Västfjäll and Slovic 2013). Information systems (IS) are ubiquitous in this digital age, and according to Duclervil and Liou (2019), the information system development life cycle (SDLC) consists of several distinct work phases, including planning, requirement analysis, design, coding, testing, and maintenance, each of which contains tasks that must be fulfilled through the JDM process. Therefore, it is necessary to consider cognition and emotion when researching fulfilling assignments in the SDLC with high quality and efficiency (Al-Emran et al. 2018; Novielli and Serebrenik 2019; Rezvani and Khosravi 2019). Fully understanding user requirements is crucial for system design and gaining user acceptance during implementation (Bevan and Nigel 2002). However, determining what users prefer and need is difficult, especially because users often cannot identify their own needs and wants. Cognition and emotion provide solutions for the user requirements dilemma. Many studies have analyzed user needs from cognitive and emotional perspectives to explain IS usage intentions and behavior (Bridges 2018; Dou et al. 2019; Mainardes et al. 2020). Information technology applications have significantly expanded from scientific computing to commerce, communication, education, manufacturing, medicine, and transportation. Researchers have done much work in exploring effective solutions that can identify and adapt to human cognitive and emotional features in those fields (Chen et al. 2018; Kim et al. 2020; Nimala and Jebakumar 2019).

Due to the fundamental roles that cognition and emotion play in the IS field, many related studies have been conducted, extending far beyond system development and IS usage issues. For example, some scholars have focused on IS users' work performance from cognitive and emotional perspectives (Hendriks et al. 2016; Pacauskas and Rajala 2017), some explored the factors that affect online shopping intentions (Chi 2018; Lin et al. 2018), and some probed the information privacy concerns of IS users (Carpenter et al. 2018; Yu et al. 2020). These studies provide useful suggestions and important references for future IS cognition and emotion research, and promote knowledge accumulation in this domain; however, they tend to be limited to certain business contexts or few topics. The whole picture is still unknown. To our best knowledge, existing studies have not systematically reviewed IS cognition and emotion research or explored its knowledge structure. In view of the significant theoretical and practical effects that cognition and emotion possess in the IS field, a systematic review of relevant research is an urgent request. Taking cognition and emotion as parallel systems that affect the behavior of IS stakeholders, the current study aims to uncover the key themes latent in articles about IS cognition and emotion applications as well as identify

future research opportunities. Two research questions need to be answered to achieve our goal: (1) what are the influential research papers on IS cognition and emotion? and (2) what is the core knowledge structure of IS cognition and emotion research?

Many existing literature review studies adopt the subjective analysis method, which depends on the authors' experience in a particular domain. Although researchers' experience and opinions cannot be excluded when conducting a literature review (Wang et al. 2016), relying purely on subjective analysis would affect the reliability and validity of the results, as this method is unsystematic, opaque, and irreproducible (Cook et al. 1997). The bibliometric methodology has been widely adopted to measure scientific progress, especially for clarifying research branches and intellectual structures and mitigating the disadvantages of subjective analysis (Sanguri et al. 2020; Sun and Zhai 2018; Yu and Sheng 2020). We use citation and co-citation analyses to complement and verify subjective judgments in this study. Inevitably, the results of a bibliometric analysis still require interpretation by researchers, nevertheless subjective reviews and objective methods are complementary to each other in that combining them helps explore the core knowledge structure (Verma 2018). In short, the hybrid uses of citation analysis, social network analysis, and co-citation analysis, which are proven as effective measures to classify research studies and formulate various knowledge clusters, are applied to enhance the objectivity in the review process. By doing so, research studies in the field of IS cognition and emotion can be analyzed to generate various knowledge clusters so as to derive insights for future research.

The main contributions of our findings lie in discovering core knowledge of IS cognition and emotion research, as well as helping scholars who are less familiar with this domain obtain a clear understanding of IS cognition and emotion research in a limited amount of time. In the era of industry 4.0, building cognition and emotion in ISs, particular in cyber-physical systems, has drawn considerable attention so as to effectively achieve system adaptability. Consequently, this review study comprehensively bridges IS research together with cognition and emotion so as to facilitate the future IS cognition and emotion research. The rest of this paper is arranged as follows: Section Two reviews the literature on cognition, emotion, and IS cognition and emotion; Section Three introduces the research methods, Section Four provides the research results and discussion (suggestions for future research are also provided in this section), Section Five gives the implications and limitations of this study, and the last part is conclusions.

2. Literature review

Cognition and emotion are two separate, but interacting mechanisms of the human brain. Cognition refers to various psychological processes of knowledge discovery, such as perception, reasoning and judgment (De Houwer et al. 2018). Emotion is a short-term but strong state of feeling (e.g., sadness, anger, joy, surprise) stimulated by particular external events (Henle and Gross 2014). As an inner characteristic of human beings, cognition is subjective or individualized, and others cannot directly observe it. Mental representation is a central concept of cognitive theories that we apply as the main way to access external reality (Davern et al. 2012). Like cognition, different people may generate disparate emotions when faced with the same event because emotion is subjective. Although both cognition and emotion greatly affect the JDM process, the resulting outcomes are different; cognition usually leads to rational behavior, and in contrast, emotion-driven behavior may not comply with rational rules (Woodward 2016). As a developing interdisciplinary area, IS research has introduced cognition and emotion from psychology to explain phenomena in multiple subfields, such as IS adoption, software development (SD), and human-computer interaction (HCI). Table 1 summarizes typical IS cognition and emotion research.

Table 1 Typical IS cognition and emotion research

Author	Topic	Cognition and/or emotion	Author	Topic	Cognition and/or emotion
McGrath 2006	IS adoption	emotion	Bridges 2018	IS adoption	cognition and emotion
Ma and Wang 2009	IS adoption	emotion	Colomo-Palacios et al. 2018	SD	cognition
Shi et al. 2009	HCI	cognition	Graziotin et al. 2018	SD	emotion
Rauniar et al. 2014	IS adoption	cognition	Graziotin and Fagerholm 2019	SD	emotion
Chaudron 2017	SD	cognition	Jiang et al. 2019	HCI	emotion
Hibbeln et al. 2017	HCI	emotion	Novielli and Serebrenik 2019	SD	emotion
Rani 2017	SD	cognition	Mainardes et al. 2020	IS adoption	cognition
Al-Emran et al. 2018	SD	cognition			

As a cognitive factor, rationalism exerts a profound impact on IS adoption. The theory of reasoned action (TRA) indicates that behavioral intentions are functions of

beliefs about the outcome of undertaking a particular behavior (Madden et al. 1992). Several theories based on TRA have been proposed to explain users' IS acceptance and usage intentions. The mere formation of an intention cannot predict users' behavior effectively; thus, Ajzen proposed the theory of planned behavior (TPB), where the perceived behavioral control factor is incorporated to extend the application range of the TRA (Paul et al. 2016). Based on the TPB, Mainardes et al. (2020) investigated the antecedent and consequent factors in the non-adoption behavior of e-commerce. The technology acceptance model (TAM) is the most popular and effective model for predicting IS adoption. Using the TAM, Rauniar et al. (2014) examined the individual adoption behavior of the most popular social networking site, Facebook, and found that the intentions of social networking usage rely on its perceived usefulness (PU) and trustworthiness (TW). Because emotion also affects our behavior, the dominant routine of the rational process has frequently been shown to be inadequate for handling complicated IS issues (McGrath 2006). IS scholars have begun to incorporate emotional components to explain complicated IS usage behavior and solve this dilemma. For example, based on the appraisal-tendency framework (ATF), Ma and Wang (2009) indicated that positive emotion could increase the use intention of online decision aids. Bridges (2018) found that hedonic factors are equally as important as traditional utilitarian motives in interactive shopping environments. The combination of cognitive and emotional factors supports comprehensive understanding of the determinants of IS adoption.

According to Davern et al. (2012), cognitive psychology plays an important role in addressing IS questions related to software development. One basic idea is that proper tools and techniques can improve software developers' performance by reducing their cognitive load when conducting a task. Various methods and tools, such as the waterfall model, spiral model, incremental model, agile model, and unified modeling languages (UML), have been proposed (Chaudron 2017; Rani 2017). Another cognitive research concern related to SD is that of knowledge management (KM) issues. Colomo-Palacios et al. (2018) proved that KM practices are the main enablers of continuous software engineering success. Al-Emran et al. (2018) systematically reviewed studies related to KM in the IS field and found that knowledge sharing is the most frequent KM process, followed by knowledge acquisition and application processes. As an intellectual activity, SD also requires creativity and problem-solving skills, which are influenced by emotional states (Novielli and Serebrenik 2019), and the number of studies about emotion and SD is growing. Graziotin et al. (2018) studied what happens when software developers are happy or unhappy when engaging in development activities. Graziotin and Fagerholm (2019) investigated the correlation between task

productivity and real-time emotion that results from a software development task. Considering the cognitive and emotional aspects of SD activities facilitates developers' work performance and fosters project success.

Human-computer interface (HCI) research is dedicated to improving communication between humans and computers. To be specific, the design of computer systems considers multidisciplinary research on human factors and cognitive science which are incorporated into typical computer science research (Man et al., 2021). Humans interact with computers through information flow, which involves generating, using, and manipulating representations; therefore, cognition is crucial in HCI (Davern et al. 2012; Yoo et al., 2021). Early HCI studies tried to establish effective interfaces from a cognitive perspective. For example, Shi et al. (2009) established a cognition-adaptive multimodal interface for a large metropolitan emergency management system that enables users to complete tasks efficiently with minimized cognitive workloads. Emotion plays a key role in human and computer interaction, and much of the research attention has transferred from the cognitive perspective to emotional issues in recent years. For example, Hibbeln et al. (2017) found that mouse cursor movements could be real-time indicators of negative emotions, enabling researchers to create systems with unobtrusive affective and adaptive abilities. Johnson et al. (2015) investigated the role of social cues on user reactions in system interfaces, which enriched the HCI research. Jiang et al. (2019) proposed a novel deep neural structure for automatic speech emotion recognition. Therefore, cognition and emotion are found to be essential in the on-going research of HCI.

Overall, the preceding literature review demonstrates that both cognition and emotion have been widely applied in the IS field and have proven to be crucial parts of IS research. But is that all there is? This study delves more deeply into the academic literature related to IS cognition and emotion and answers this question.

3. Methodology

We adopt multiple methods, including citation analysis, social network analysis (SNA), and co-citation analysis, in this study. The research process is divided into four phases, as shown in Figure 1. The following paragraphs explain the rationale and purpose of each method that we use.
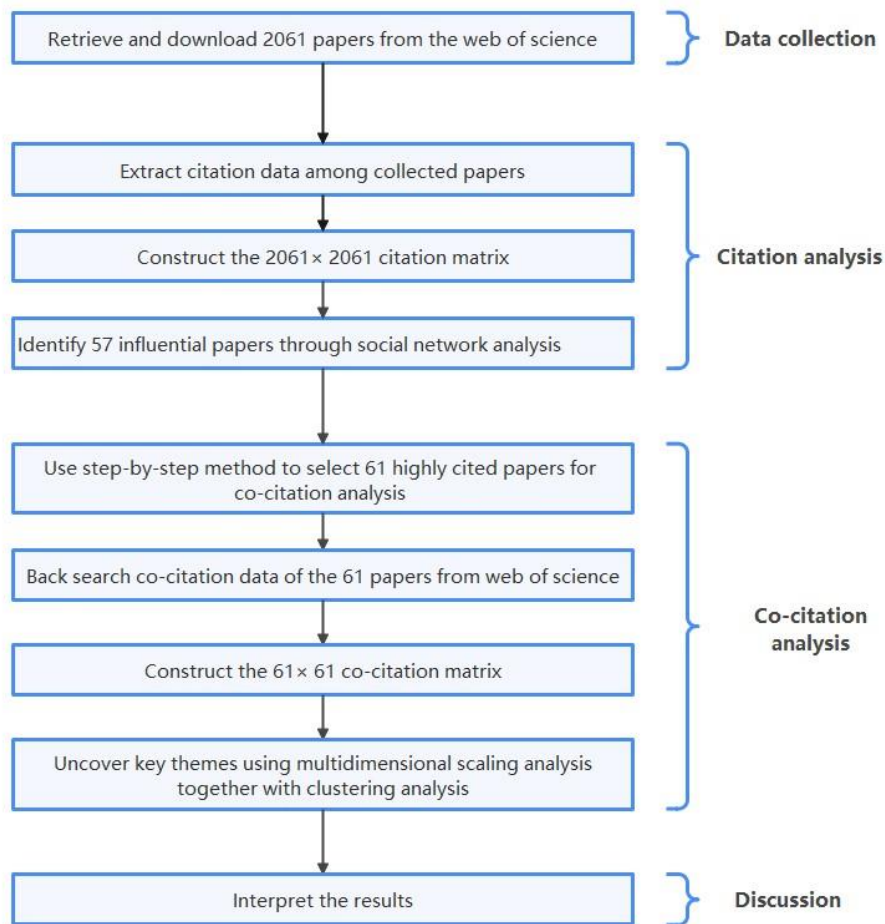
Fig. 1 Research process of this study

3.1 Citation analysis

A citation is an acknowledgment that one document receives from another when the document is referenced or mentioned (Smith 1981; Shiau 2016; Singh 2019; Khanra et al. 2020). Scientific documents do not stand alone; almost all papers, notes and comments published in scientific journals contain citations (Garfield and Merton 1979). Generally, a citation denotes the existence of a formal and clear connection between the cited document and the citing document. As shown in Figure 2a, Document A cites Document B (this stands for a citation relationship), and Document B cites Document C which was published the earliest. Citation analysis can, therefore, identify the influential papers, research hotspots and trends of that discipline because a high citation count reflects the merits and wide acceptance of any given paper by peers in a specific discipline. Citation analysis has been widely used to explore the intellectual structures of various disciplines (Wang et al. 2016).
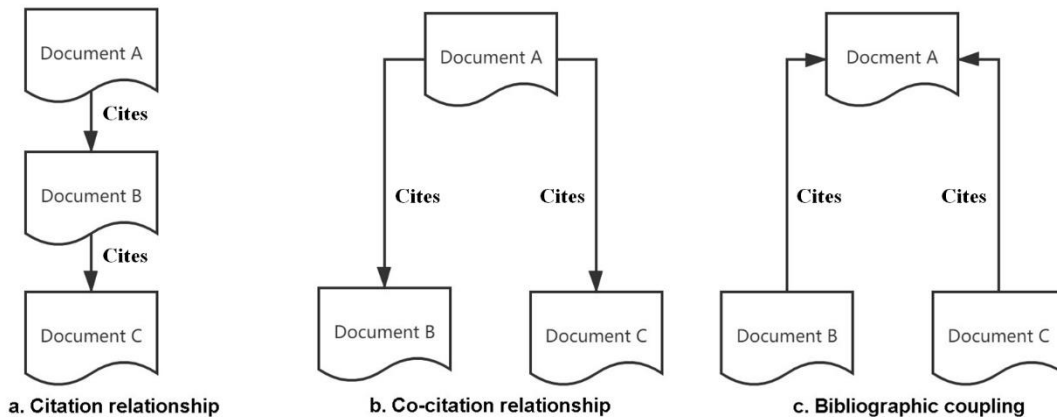
Fig. 2 Relation types between documents

3.2 Co-citation analysis

Small (1973) first proposed co-citation analysis, which can reflect the closeness of the relationship between two articles according to the frequency with which they are cited jointly by others. As shown in Figure 2b, Document B and Document C which were published first are co-cited by Document A; thus, Document B and Document C have a co-citation strength of one. The more the two papers are co-cited, the stronger their semantic relationship is (Small 1973). Highly co-cited articles reflect key constructs, methods and philosophies in a particular research area (Ng et al., 2018; Singh, 2019; Shiau et al. 2019; Tsang et al., 2021). A similar concept to co-citation is bibliographic coupling; two documents are bibliographically coupled when they cite the same documents. The more cited papers two documents share, the stronger their coupling relationship is (Wang et al. 2016). As shown in Figure 2c, Document B and Document C both cite Document A which was published first; thus, Document B and Document C have a bibliographic coupling relation with a strength of one. Bibliographic coupling analysis only uses past information, and this means that the strength of the coupling relation never changes once it is created. Therefore, bibliographic coupling is a retrospective similarity measure (Boyack and Klavans 2010). Co-citation analysis can overcome this problem by adding new citations to update the similarity relation between two papers. The co-citation measure reflects the thoughts of many peer researchers, which means it is a highly persuasive indicator of similarity (Wang et al. 2016). For these reasons, we prefer co-citation analysis to bibliographic coupling analysis when exploring IS cognition and emotion core knowledge.

3.3 Social network analysis (SNA)

SNA is a method through which researchers examine the interactions among social actors in the social sciences (Freeman 2004). To be specific, SNA formulates a social

network that takes social actors as its nodes and the relations between social actors as its edges. With the fusion of mathematics, graph theory and computer science, SNA can support the measurement, evaluation and visualization of relationships and relation structures (Wang et al. 2016). SNA is not only confined to the study of human social relationships, but is also applied to investigate the data from a specific information network. Combined with bibliometric techniques, including citation and co-citation analyses, we can further explore the information exchanged between documents to effectively reveal knowledge spreading patterns and establish the intellectual structure of a particular discipline. Compared with existing studies (Iftikhar and Khan, 2020; Nam and Kabutey, 2021), the concept of the social network is further extended in the review methodology. Similar to identifying key social actors in the network, the SNA can be extended to examine the key research studies in a domain-specific publication network.

We apply citation analyses combined with SNA to identify influential papers. The importance of a paper is determined by its position in a citation network. There are two ways to judge a given paper: one uses degree centrality, and the other uses betweenness centrality (Verma 2018). Degree centrality is based on the degree of a node, namely, the number of edges directly connected to it (Zhang et al. 2011). The more arcs a node has, the more important it is. Because a citation network is a directed network, distinguishing between in-degree centrality and out-degree centrality is necessary; the former measures the number of papers that cite a particular paper, while the latter measures the number of papers that a particular paper cites. In-degree centrality is more suitable for illustrating a paper's importance than out-degree centrality, as it reflects the recognition of peer scholars. According to the work of Wasserman and Faust (1994), let g be the number of nodes (papers) in a citation network, $d(n_i)$ be the number of edges that point to node n_i, $g - 1$ be the total number of possible edges incident upon node n_i, and $C_D(n_i)$ be the in-degree centrality of n_i; then:

$$C_D(n_i) = d(n_i)/g - 1 \tag{1}$$

Betweenness centrality expresses the importance or influence of individual nodes in a graph through the fraction of the shortest paths that pass through them (Riondato and Kornaropoulos 2016). It accounts for the number of times a node acts as the bridge in the shortest path between two other nodes; the more times a node acts as a mediator, the larger the betweenness centrality it has. Betweenness centrality can help identify important nodes that control information flows between separate parts of a network (Alahakoon et al. 2011). As a citation network is a directed graph, we follow the procedure of White and Borgatti (1994) to calculate the betweenness centrality of 2061 papers in this study. Let g_{ik} be the number of geodesics from node p_i to node p_k,

$g_{ik}(p_j)$ be the number of geodesics that contain node p_j as the mediator in the geodesics from p_i to p_k, and $b_{ik}(p_j) = g_{ik}(p_j)/g_{ik}$ be the proportion of geodesics from node p_i to node p_k that pass through p_j. For a network that contains g nodes, $d_{ij}^* = \sum_{k=1}^{g} b_{ik}(p_j)$ $(i \neq j \neq k)$, which defines to what extent p_i depends on p_j to transfer messages to others. $C_B(p_j)$ is the betweenness centrality of p_j; thus:

$$C_B(p_j) = \sum_{i=1}^{g} d_{ij}^* \qquad (2)$$

Compared with recently published papers, papers published earlier are more likely to be cited by others and act as mediators between other papers. In other words, earlier papers usually have higher in-degree centrality and betweenness centrality, and this means that some of the latest, possibly momentous, studies may be ignored if we only use in-degree centrality and betweenness centrality to evaluate the importance of papers. Therefore, to identify influential papers, we propose two novel centrality indicators that take the influence of time into account based on in-degree centrality and betweenness centrality. For a paper n_i in a citation network, let $C_D(n_i)$ be the in-degree centrality of n_i, $C_B(n_i)$ be the betweenness centrality of n_i, and $Y(n_i)$ be the number of years that have elapsed since the publication year of n_i. Then, we define the annual average degree centrality (AADC) and annual average betweenness centrality (AABC) of n_i by Formulas (3) and (4). Note that our centrality metrics do not change the essence of in-degree centrality and betweenness centrality but simply distribute their values evenly over the years since the publication date of a paper. Thus, AADC and AABC can be effective indicators of influential papers while alleviating the time-lag problem of citation analysis.

$$\text{AADC}(n_i) = C_D(n_i)/Y(n_i) \qquad (3)$$
$$\text{AABC}(n_i) = C_B(n_i)/Y(n_i) \qquad (4)$$

4. Results and discussion

4.1 Data collection

The academic papers considered for analysis are retrieved from the Web of Science (WoS), one of the world's most popular online citation databases (Verma 2018). The articles listed in this database can well represent research progress in specific fields. We adopt a list of over 100 IS journals that appear in the MIS Journal Rankings published by the Association for Information Systems (AIS). Because our study is not

about the underlying computer technology, papers published in ACM- and IEEE-related journals (13 journals) are excluded because articles in these journals often refer to technological realizations. Peer-reviewed articles can ensure the quality of this study; therefore, the document type is limited to articles only.

To obtain an exhaustive list of the relevant literature, we use an inclusive search query: Topic search (TS) = ("cognition" or "cognitions" or "emotion" or "emotions"), and the journals listed in the MIS Journal Rankings are used as filters. The time span is set from 1996 to 2019, as the WoS itself was established in 1997, and that one additional year can ensure data integrity. The search is conducted on May 23, 2020, and 2061 relevant academic papers are obtained. The annual distribution of the 2061 papers is shown in Figure 3. Despite a few fluctuations, we can see a significant increase from 1996 to 2019, indicating that cognitive and emotional issues have attracted increasing attention from IS scholars in recent years. Figure 4 shows the distribution of papers related to IS cognition and emotion across various publication sources.
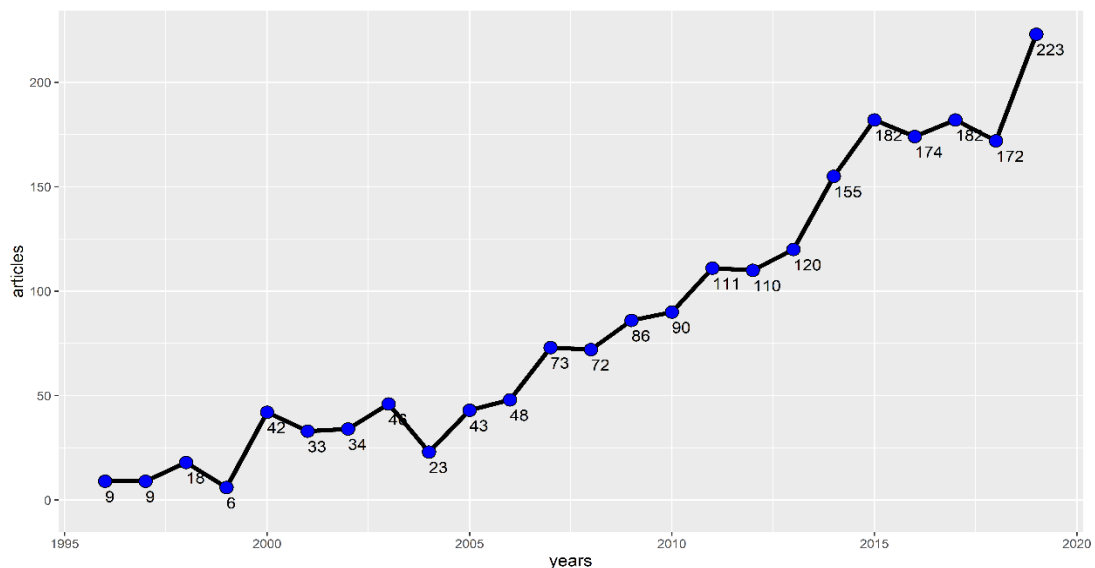

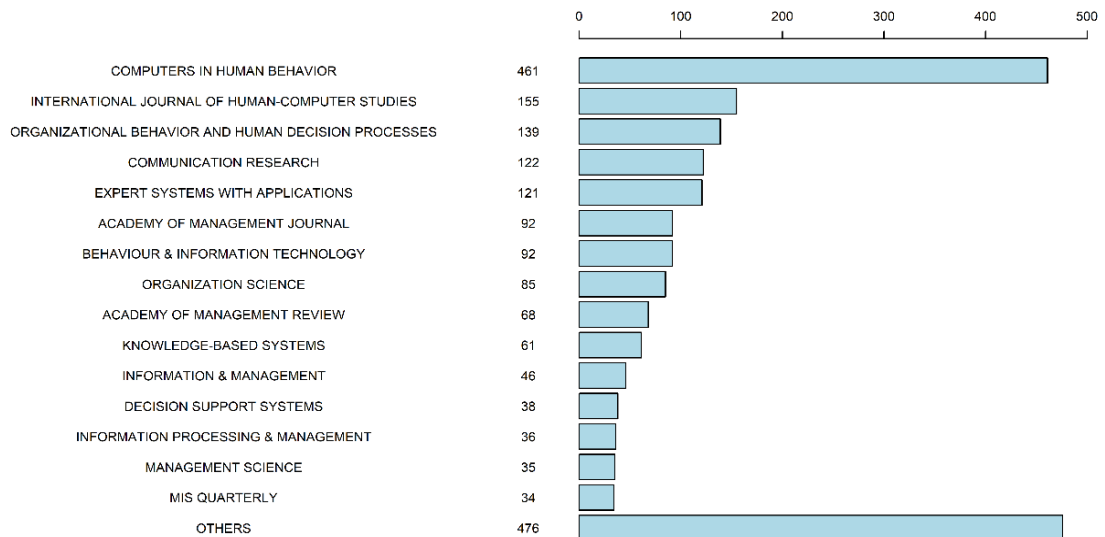**Fig. 3** Annual distribution of IS cognition and emotion papers

Source	Count
COMPUTERS IN HUMAN BEHAVIOR	461
INTERNATIONAL JOURNAL OF HUMAN-COMPUTER STUDIES	155
ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES	139
COMMUNICATION RESEARCH	122
EXPERT SYSTEMS WITH APPLICATIONS	121
ACADEMY OF MANAGEMENT JOURNAL	92
BEHAVIOUR & INFORMATION TECHNOLOGY	92
ORGANIZATION SCIENCE	85
ACADEMY OF MANAGEMENT REVIEW	68
KNOWLEDGE-BASED SYSTEMS	61
INFORMATION & MANAGEMENT	46
DECISION SUPPORT SYSTEMS	38
INFORMATION PROCESSING & MANAGEMENT	36
MANAGEMENT SCIENCE	35
MIS QUARTERLY	34
OTHERS	476

Fig.4 Source distribution of IS cognition and emotion papers

4.2 Citation analysis

This study applies citation analysis to achieve the first research goal of determining the most influential papers on IS cognition and emotion. Leveraging the references extracted from the 2061 collected papers, we first establish a 2061×2061 citation matrix. Then, we conduct SNA and MPA analysis successively based on the citation matrix.

4.2.1 Citation network

The study extracts citation relationships from the cited references of the collected papers; although a total of 135,610 cited references are identified, only 2144 records belong to the internal citation relationships among the 2061 papers. Then, a 2061×2061 citation matrix is constructed using the interrelations between the 2061 papers. Next, we load the citation matrix into the NetDraw software and draw the citation network comprising 2061 nodes and 2144 links, as shown in Figure 5. In the graph, each node stands for a single paper while each link arrow represents a citation relation, and the size of a node is determined by the in-degree centrality of that paper. Because there are too many nodes to make the graph clear and readable, only 1136 nodes of the largest component of the citation network are set to be visible. Graph density, which represents the number of actual edges divided by the maximum possible number of edges (Sewell 1998), serves as the connectedness indicator of a citation network; any graph with a density index below 0.5 indicates low density (Abrahamson and Rosenkopf 1997). In this study, the graph density is 0.0005, and after 699 isolated nodes are removed, the number increases to 0.0012. The low graph density indicates that relevant studies are not closely linked; cognition and emotion are still developing topics in the IS field, and much remains to explore.
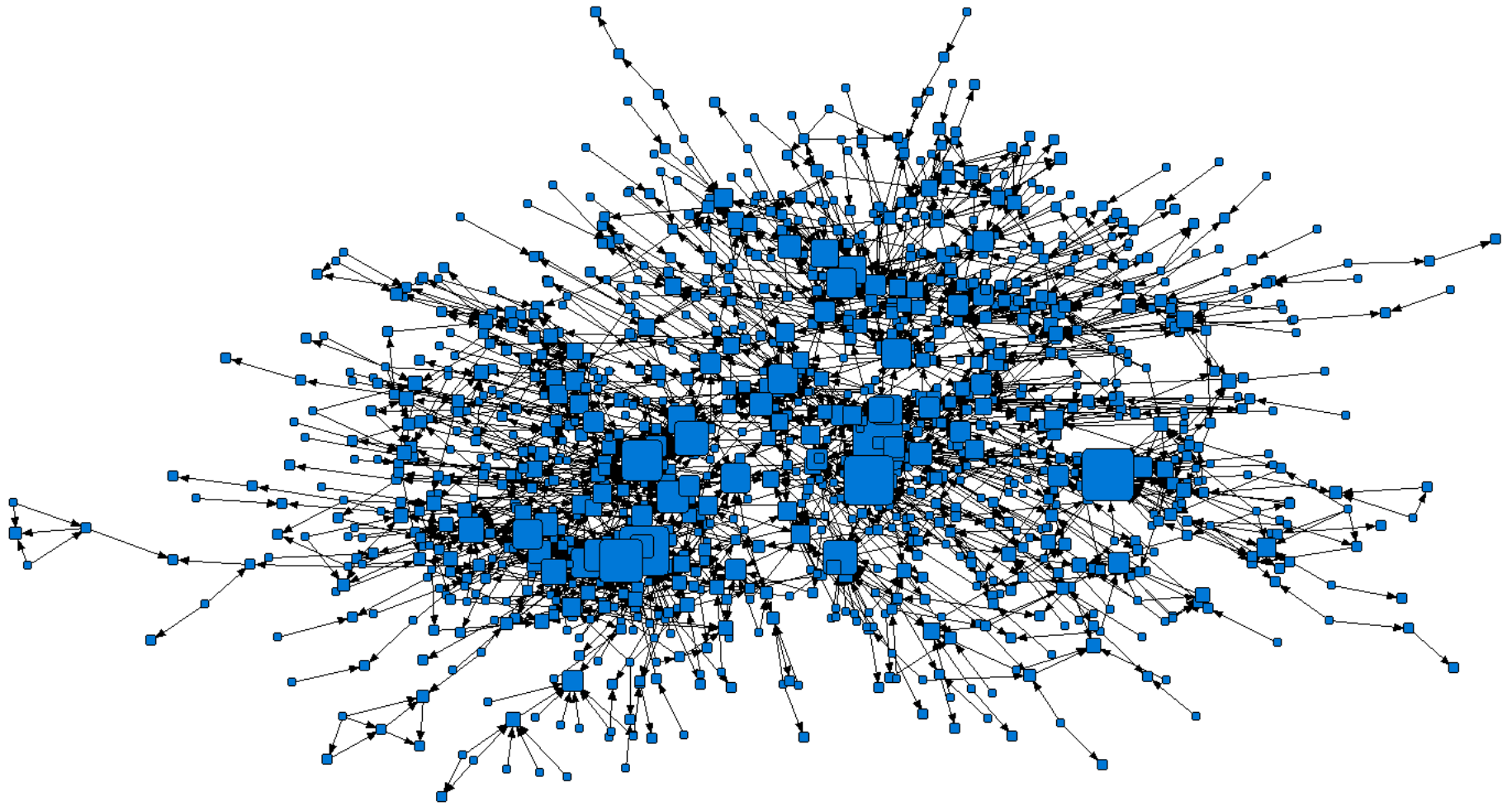
Fig.5 The largest component of the citation network

4.2.2 Influential papers

Combining betweenness centrality with in-degree centrality can find influential papers (Wang et al. 2016) better than using in-degree centrality alone. As mentioned before, papers with high AADC are the primary sources of knowledge in a research field, and papers with high AABC are crucial for spreading knowledge because they act as bridges between other papers. Therefore, we collectively employ AADC and AABC as substitutes for in-degree centrality and betweenness centrality in order to identify influential papers. The average AABC and AADC of the non-isolated nodes are 0.19 and 0.62, respectively. We choose the papers with AADC above one or AABC above five as influential papers because many peer scholars must review and cite them each year. A list of 57 papers is selected (see Table 2; more details are provided in the Appendix). Focusing on these influential papers helps reduce the complexity of data analysis without losing the most valuable information. The *Academy of Management Review*, *Computers in Human Behavior*, *International Journal of Human-Computer Studies*, *Journal of Management Information Systems*, *Academy of Management Journal* are currently the top five outlets for IS cognition and emotion studies, involving eight, seven, seven, seven, and six influential papers, respectively. The 57 papers are of four research types: 49% of the influential papers are non-empirical studies (17 conceptual and 11 modeling papers); 51% report empirical studies (23 quantitative and 6 qualitative papers). Cognition and emotion are mature concepts introduced from psychology. Yet, the balanced situation suggests that even if the importance of cognitive and emotional applications in the IS field have been widely recognized, some detailed concepts and mechanisms are worth clarification and further development in this domain.

Table 2 57 influential papers identified by citation analysis

Research Type	No.	Author	AADC	AABC
	588	Hariharan et al. 2016	0.25	8.00
	615	Elhai et al. 2016	1.75	0.00
	656	Lebel 2016	0.25	14.75
	687	Koopman et al. 2016	1.00	11.50
Quantitative	792	Lin and Utz 2015	1.20	8.10
	864	Stein et al. 2015	1.60	18.70
	932	Yu et al. 2015	0.40	7.20
	981	Pappas et al. 2014	0.33	8.50

Research Type	No.	Author	AADC	AABC
	1001	Choi and Toma 2014	1.33	0.00
	1022	Law et al. 2014	0.33	5.17
	1041	Gregor et al. 2014	1.50	21.28
	1053	Li et al. 2014	0.50	14.75
	1128	Verhagen et al. 2013	0.29	5.43
	1184	Stieglitz and Dang-Xuan 2013	3.86	6.14
	1349	Cheshin et al. 2011	0.44	5.83
	1384	Li et al. 2011	1.11	0.00
	1419	Flavián-Blanco et al. 2011	0.44	11.44
	1526	Charlton 2009	0.36	6.18
	1708	Kim et al. 2007	1.08	4.77
	1736	Gong 2007	0.15	8.12
	1758	Fong 2006	1.00	5.57
	1833	Prendinger et al. 2005	0.20	5.97
	1907	Grandey 2003	1.29	2.10
	315	García-Magariño et al. 2018	0.50	7.00
	527	Cropanzano et al. 2017	0.67	10.17
	528	Rothman and Melwani 2017	0.67	6.73
	534	Lebel 2017	0.67	21.23
	576	Piryani et al. 2017	0.33	13.00
	657	Voronov and Weber 2016	1.75	5.77
	846	Healey et al. 2015	0.40	19.80
	1003	Douglas Creed et al. 2014	2.50	2.22
Conceptual	1032	Dane and George 2014	0.83	17.22
	1055	vom Brocke and Liang 2014	0.83	18.39
	1310	Voronov and Vince 2012	2.00	0.00
	1320	Dimoka et al. 2011	1.67	0.00
	1358	Ocasio 2011	1.11	7.23
	1541	Beale and Creed 2009	0.55	16.05
	1820	Weick et al. 2005	1.87	2.64
	1893	Chin et al. 2003	1.59	0.00
	1965	Davis 2001	1.53	0.00
	331	Wong and Kwong 2018	0.50	6.00
	578	Perez-Gaspar et al. 2016	1.00	13.04
Modeling	596	Zhang et al. 2016	0.50	5.75
	752	Alonso et al. 2015	0.20	5.20

Research Type	No.	Author	AADC	AABC
	910	Zhang et al. 2015	0.80	5.87
	972	Ooi et al. 2014	0.50	5.50
	1058	Li and Xu 2014	1.33	0.00
	1093	Astor et al. 2013	1.00	16.31
	1385	Nunamaker et al. 2011	0.78	20.83
	1551	Chanel et al. 2009	0.82	8.64
	2002	Gavetti and Levinthal 2000	1.15	0.00
	405	Fan and Zietsma 2017	1.00	15.50
	494	Toubiana and Zietsma 2017	1.67	1.00
	560	Wright et al. 2017	1.67	1.00
Qualitative	697	Vuori and Huy 2016	1.50	53.54
	1545	Rerup 2009	0.91	5.87
	1930	Huy 2002	0.89	5.33

4.3 Co-citation analysis

We apply co-citation analysis to achieve the second research goal: classifying and elucidating the core knowledge of IS cognition and emotion research. Papers that are frequently co-cited address research issues that are largely related to each other; thus, they constitute a knowledge group. The core knowledge structure is established when knowledge groups of different aspects and their relationships in a specific field are identified.

In contrast with SNA, in-degree centrality is used separately to select the target papers for co-citation analysis, as this method relies on the number of times a paper is co-cited by others. Highly co-cited papers are frequently cited separately; thus, we take in-degree centrality values above five as the filter condition, and 96 highly cited papers are selected from 2061 papers. The internal citation relationships among the 2061 papers are so sparse that they may not be sufficient to reasonably distinguish knowledge groups yet. Note that documents outside the original scope also co-cite some pairs of the 96 papers, considering that comprehensive co-citation relationships are conducive to exploring the core knowledge. Therefore, we conduct a backward search process to gather the citation data for each of the 96 highly cited papers from the WoS Core Collection one by one. A total of 19,238 citations are obtained, which are contributed by 16,376 citing articles (including the 2061 original papers). Then, a 96×96 co-citation matrix is generated based on the 19,238 citation relationships for further analyses.

This study follows the process of Hsiao and Yang (2011) to explore the core knowledge of IS cognition and emotion. Through calculating the squared Euclidean

distance between papers, multidimensional scaling (MDS) analysis can show the papers' correlations and proximities with a two-dimensional spatial perception graph. To judge the goodness of fit of MDS analysis, Kruskal (1964) suggested that the stress value should be below 0.2. We apply this criterion to determine the scope of co-citation papers; the initial stress value of MDS analysis for 96 papers is 0.34, and it did not satisfy the criterion until we finalize the size of the co-citation matrix which contains 15 papers.

However, 15 papers are insufficient to uncover the core knowledge. To solve the problem, the stepwise test approach, which combines MDS analysis with hierarchical clustering analysis (HCA), is adopted in this study. HCA is a clustering method that attempts to establish the hierarchical structure of a collection of objects; it uses either a top-down or bottom-up approach to recursively construct the clusters. The final classification result is a dendrogram representing the similarities of nested groups of objects (Rokach and Maimon 2005). In this study, Ward's method of clustering analysis, squared Euclidean distance, and z-score standardization are used to generate the classification results, which are later displayed on the MDS spatial perception graph. Starting from 96, we gradually reduce the number of co-cited papers until we reach 61, at which point the composite graph of HCA and MDS is readable. Therefore, we take the top 61 highly cited papers as our final co-citation analysis targets and generate a 61×61 co-citation matrix. Among the 61 articles, the highest reference frequency is 1988, and the lowest is 85 (see the Appendix for more details).

Figure 6 shows the distribution of these papers across journals, and the results indicate that as interdisciplinary concepts, IS cognition and emotion contain valuable knowledge that exists in a variety of subfields.
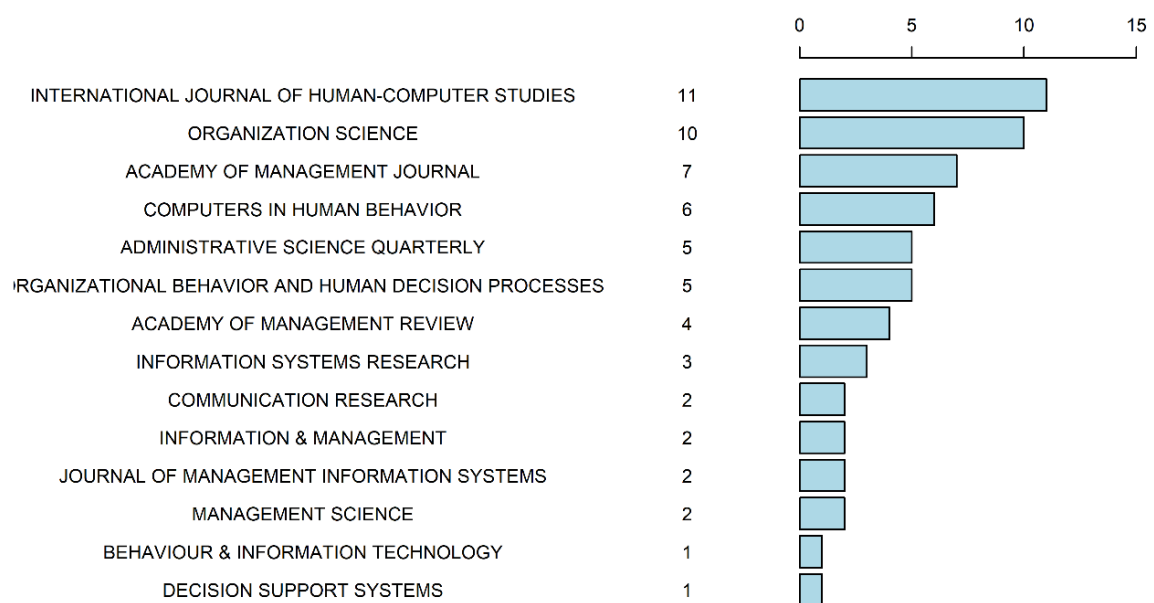

Fig. 6 Distribution of the journals that contain the 61 highly cited papers

The 61 papers are classified into six knowledge groups through HCA, as Figure 7 shows. Figure 8 reveals the six knowledge groups of papers and their relationships in the MDS spatial perception graph.
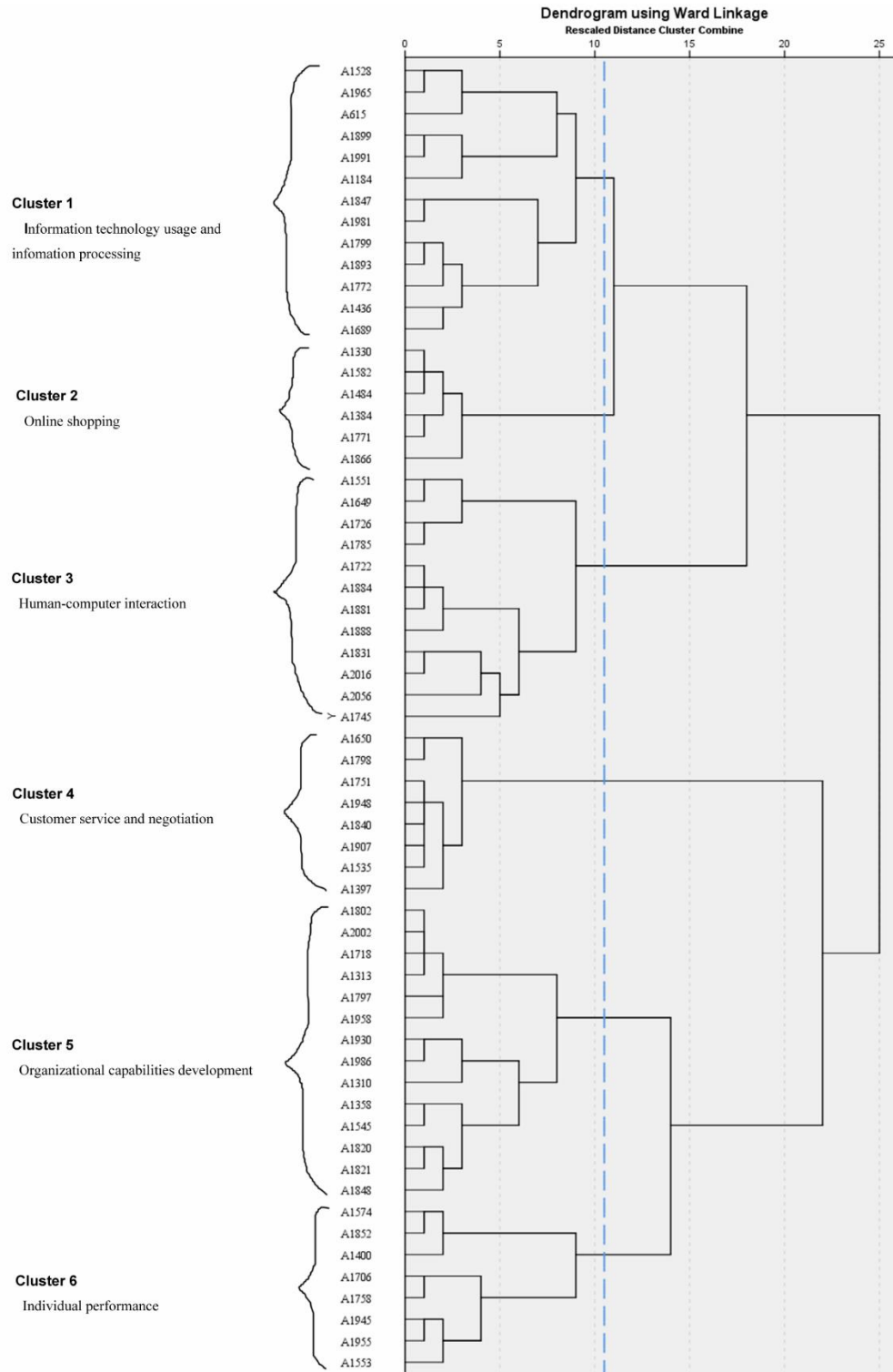
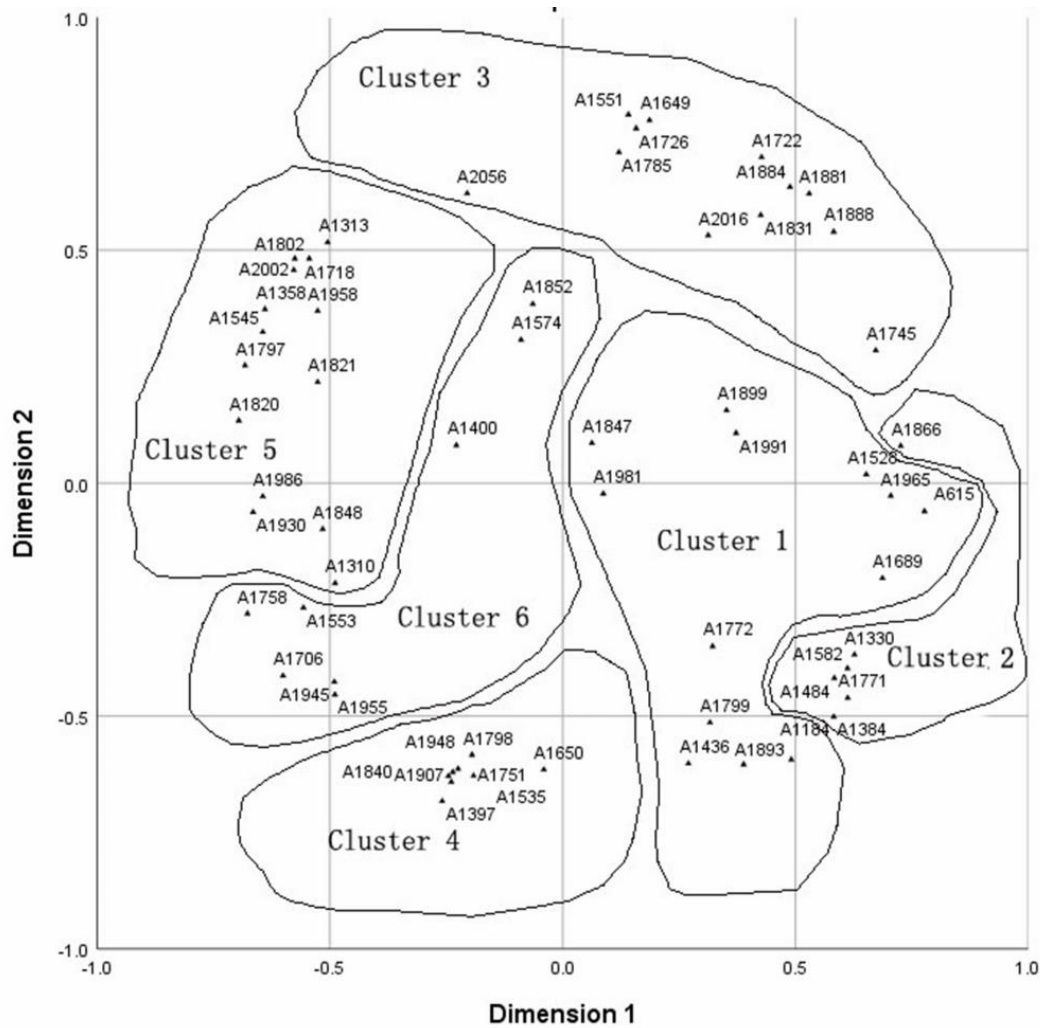

Fig. 7 Results of clustering analysis

Fig. 8 Results of MDS analysis

4.3.1 Information technology usage and information processing

The first knowledge group, Cluster 1, includes 13 academic papers on information technology usage and information processing. By facilitating information processing, information technologies promote the individuals' quality of life (QoL) and work (QoW) and open a world of insights and possibilities for enterprises to effectively understand their employees and customers. The parts of this knowledge group are two sides of the same coin; the former mainly concerns the IS users, while the latter focuses on issues that IS helps to handle.

Due to the tremendous impact that IS exerts on individuals and organizations, researchers have tried to understand the psychological factors that affect IS use. They have found that different cognitive elements exert disparate effects on IS users' intentions. Bagozzi and Dholakia (2006) demonstrated that user attitudes toward a technology positively affect its use intention, yet technostress caused by the inability to handle IS use, resulting in reduction of the individual involvement with information

technology (Tarafdar et al. 2010). From an emotional perspective, Chin et al. (2003) suggested that emotion has a more than substantial direct effect on use intention, as a strong interaction effect exists that leads to a decrease in the impact of cognitive appraisal on intention. Interestingly, automatic IS use results from the force of habit or automaticity rather than cognitive appraisal or emotion (Kim et al. 2005). Just as a rose has its thorns, humans are at high risk of pathological Internet use (PIU), which results from problematic cognitions (Davis 2001); overuse of or addiction to the Internet causes negative emotions, such as depression and anxiety (Liu and Peng 2009; Elhai et al. 2016).

Information processing accounts for the collection, manipulation, storage, retrieval, display, and dissemination techniques used to deal with information. Emotion has a major effect on how information is presented, the perspectives implied in messages, and the responses of individuals to messages (Dillard and Peck 2000; Nabi 2003; Stieglitz and Dang-Xuan 2013). Walther (2007) alleged that computer-mediated communication makes selective self-presentation possible for facilitating desired goals by reallocating cognitive resources. In organizations, expertise information enables experts to be contacted to provide support when needed, and groups that assign responsibility for information based on expertise are found to perform better than those that do not (Brandon and Hollingshead 2004; Faraj and Sproull 2000). In summary, information technology usage and information processing are two enduring topics in the IS domain. As novel information technologies and business models are constantly emerging, discussing their usage patterns and information processing mechanisms is a must. This knowledge group will continue to be a fruitful research direction.

4.3.2 Online shopping

The second knowledge group, Cluster 2, includes six academic papers, and we name it "online shopping," a form of electronic commerce that allows people to buy merchandise from a seller over the Internet. Online shopping has become a common practice worldwide that has grown into a multibillion-dollar industry. The papers in this knowledge group concentrate on cognitive and emotional issues in the context of online shopping. Two subtopics come to light after we examine these papers carefully: online shopping environments and online privacy.

Online shopping environments play an important role in attracting customers, and studies suggest that good environmental designs positively affect consumers' cognitive appraisals and emotions, which subsequently stimulate purchasing intentions (Kim et al. 2003; Éthier et al. 2006; Koo and Ju 2010). Scholars have also found that task-relevant and mood-relevant website cues positively influence both the likelihood and

magnitude of online impulse buying (Parboteeah et al. 2009; Verhagen and van Dolen 2011). Despite the benefits of online shopping, the privacy problem is a major concern of online shopping consumers. Initial emotions resulting from overall website impressions are found to act as obstacles to information disclosure (Li et al. 2011). Online shopping has become an inevitable part of our daily life; with new forms of e-commerce such as social commerce and TikTok, live commerce becomes ever more popular. How cognition and emotion affect these new scenarios needs to be further explored.

4.3.3 Human-computer interaction

The third knowledge group, Cluster 3, which consists of 12 academic papers, is labeled "human-computer interaction." Regardless of which specific information technology application we use, the first issue to address is how we can interact with computers efficiently. Researchers have made great progress in this field, and their interests have varied from a cognitivist perspective that seeks to align computer interfaces with a human mental model to a post-cognitivist perspective that is concerned with emotional and sociocultural values.

Graphical user interfaces (GUIs) are user-friendly interfaces that facilitate cognitive tasks during interactions between humans and computers (Scaife and Rogers 1996). Dehn and Van Mulken (2000) investigated the effects of GUIs or animated interface agents on users' attitude and performance and concluded that the results differ according to specific applications. Brave et al. (2005) found that computer agents' empathic emotional expressions influence users' feelings, such as trusting and liking the agents. More emoticons were used in social-emotional online communication contexts than in task-oriented situations (Derks et al. 2007). The idea of human emotion recognition has fostered the advent of highly intelligent HCI systems, such as vehicles capable of playing music aligned with drivers' moods. A variety of technologies and methods, including facial feature extraction, electroencephalographic (EEG) signal processing, machine learning, neural networks, and fuzzy logic models, are applied for recognizing human emotions (Bailenson et al. 2008; Camurri et al. 2003; Chanel et al. 2009; Mandryk and Atkins 2007; Mandryk et al. 2006). Furthermore, information systems capable of processing emotional information and adapting to user responses have been created (Breazeal 2003).

Beyond informational approaches that regard emotion as another kind of information that can be transmitted or measured, scholars have also integrated the anthropological and historical cues of emotion, which help guide the creation of affective systems by which people can fully experience emotions with complexity and

ambiguity (Boehner et al. 2007; Hudlicka 2003). In summary, to improve the usability of HCI systems, human cognition and emotion must be considered in HCI designs. Because computers are now ubiquitous, research on developing intelligent HCI systems capable of adapting to human cognition and emotion is of great application value.

4.3.4 Customer service and negotiation

Cluster 4 is composed of eight academic papers, and we title it "customer service and negotiation." Whether serving a customer or negotiating with a business partner, we inevitably communicate our feelings with others, and the communication outcomes are affected by the emotions we display and share.

Traditionally, customer service is a face-to-face interaction that requires the provider and recipient to be present at the same time. Displaying positive emotion is positively associated with a customer's evaluation of service quality and the following positive affect (Barger and Grandey 2006; Pugh 2001), but this is not always the case; subsequent research reveals more complex mechanisms. There are two kinds of emotional displays: deep acting (changing inner emotions) and surface acting (changing facial expressions). While an authentic positive display of emotion influences the impression of a service provider and overall satisfaction with the encounter, surface acting is negatively related to customer ratings (Grandey 2003; Grandey et al. 2005; Groth et al. 2009). Wang et al. (2011) proved that negative affectivity exacerbates employees sabotaging customers, actions that are triggered by customer mistreatment, yet employees' self-efficacy for emotional regulation alleviates this effect. Currently, online services are all the rage, bringing increased convenience to individuals. However, online service also brings new emotional communication problems to solve. Byron (2008) developed a model to explain emotion miscommunication in emails, arguing that receivers often misinterpret emotions conveyed in emails. It is accepted that negotiation outcomes mainly depend on cognition, yet Kopelman et al. (2006) claimed that displaying positive emotion helps achieve the set negotiation goal. In summary, this knowledge group emphasizes the importance of the strategical display of emotion in customer service and business negotiation scenarios. Delivering good customer service or possessing strong negotiation abilities is crucial to ensure the core competitiveness of enterprises; hence, we suggest that researchers pay attention to emotional communication issues.

4.3.5 Organizational capability development

Cluster 5 contains 14 academic papers, and we name this group "organizational capability development." To create competitive advantages over others, enterprises

must develop organizational capabilities that enable them to sense changes in the market and proactively adapt to those changes. Organizations are composed of individuals; organizational ability cannot be developed in isolation from understanding human cognition and emotion at the individual level.

Superior organizational performance results from complex individual-level mechanisms for decision making and action taking. Cognitive representation, experiential wisdom, organizational hierarchy, and emotion should be incorporated into the evolution of these capabilities to spawn reasonable choices and develop organizational capabilities (Gavetti 2005, 2012; Gavetti and Levinthal 2000; Gavetti et al. 2007). Research has shown that the real-time, short-term learning type of improvisation affects long-term organizational capabilities such as technological innovation (Miner et al. 2001). Rerup (2009) proved that weak cues are signals that indicate potential threats or opportunities for organizations; thus, these external contextual cues must be thoroughly understood to induce necessary responses. However, whether to frame discontinuous change as an opportunity or a threat is a major problem. Opportunity framing usually fails to generate adequate organizational commitment; threat framing evokes commitment but creates deep organizational rigidities (Gilbert 2006). To address such ambiguity, individuals seek meaning and plausibility through the sense-making process (trying to explicitly comprehend the situation), and the interpretation of environmental cues affects actions (Rafaeli and Vilnai-Yavetz 2004; Weick et al. 2005).

To explain effective cognitive processes in organizations, such as innovation and strategic thinking, Elsbach et al. (2005) proposed the concept of situated cognitions as interactions between cognitive schemas and specific contexts. Organizations must respond to environmental changes and make the necessary adaptations to maintain competitive advantages. Unfortunately, employees usually resist changes in enterprise systems, work procedures, and the environment which are not clearly beneficial to them. The maintenance, disruption and creation of institutions in organizations cannot be explained only by rational choices but is a complicated system with emotion as an intrinsic component (Huy 2002; Ocasio 2011; Piderit 2000; Voronov and Vince 2012). In summary, developing organizational capabilities can help companies gain advantages over others; given that cognition and emotion play important roles in organizational capability development and that we are in an era of fierce competition. This research branch is especially worthy of further study.

4.3.6 Individual performance

Eight academic papers in Cluster 6 constitute the sixth knowledge group, described as "individual performance," and two subtopics involving cognition and emotion are identified by carefully reviewing the papers in this group. The first topic is work performance, which refers to performance with regard to the particular requirements of a workplace role. Decision making involves identifying and choosing a solution from a list of alternatives, and the performance of decision makers varies to a great extent depending on multiple factors, including their mental states.

Although excellent work performance will often result in good outcomes, the two concepts are different. Work performance is not a single unified construct; it involves many different standards, such as role engagement and creativity. Research found that emotion plays an important role in shaping work attitude and role engagement (Rothbard 2001; Brockner and Higgins 2001). Creativity is one of the most important aspects of work performance. It has been demonstrated that both positive and negative emotions are valuable, and their combination leads to a high level of creativity (Fong 2006; George and Zhou 2007). Entrepreneurial passion is an intense positive feeling that people experience during entrepreneurial activities. It is consistent with goal-directed cognition and behavior when pursuing entrepreneurial effectiveness (Cardon et al. 2009). Decision making is a multifactor problem-solving task, and antecedents such as cognitive beliefs, emotional states, and external environments affect the results of decision making. Scholars pay attention to the underlying rationale of making optimal decisions; rationalism is the most common approach for making sound decisions, yet it may cause unethical behaviors and inhibit altruistic motives (Zhong 2011). Emotions have been proven to have a continuous influence on decision making, even if those emotions fade away (Andrade and Ariely 2009). When making risk decisions, anger increases risk taking in men, while disgust decreases risk taking in women (Fessler et al. 2004). In summary, individual performance, especially decision-making performance, is one of the most basic applications of cognition and emotion research. IS scholars can benefit from this knowledge group by learning about the rationale of cognition and emotion.

4.4 Future directions

Cognition and emotion are ubiquitous in IS scenarios; they are integral parts of designing interactive systems. They affect people's intentions and behavior in using information technology, they bring about productive communication outcomes such as customer satisfaction, and they are indispensable factors used by organizations to gain competitive advantages. In addition to these insights obtained from the co-citation

analysis, we see an ever-changing world that raises new research questions as new information and communication technologies (ICT) emerge and bring about corresponding impacts. First, innovative technologies and products, for example big data (Hossain and Muhammad, 2019), mixed reality (Flavián et al., 2019), and fintech (Susilo et al., 2019), call for understanding how cognitive and emotional factors affect their adoption and usage. Since typical TAM is relatively simple and merely considers perceived usefulness and ease of use on the intention to use and usage behavior, it lacks consideration of such cognitive and emotional factors. Subsequently, TAM studies suffer from certain criticism nowadays. In other words, there is a room for further improvements on existing theoretical models in order to comprehensively evaluate the cognitive and emotional factors in IS research. Second, given that online shopping is being reshaped by artificial intelligence and big data, it is necessary to investigate whether and how the mechanism by which cognition and emotion influence consumers' online purchasing intentions changes under this new situation. Psychological capital characteristics should be further investigated to understand customers' shopping behavior in e-commerce environment, for example using fuzzy-set qualitative comparative analysis (Pappas et al., 2016) and the cognition-affection-conation framework (Lim and Kim, 2020). Third, future work may design and develop robust machine learning and deep learning algorithms, for example deep neural networks and deep reinforcement learning, to improve the accuracy of emotion recognition. EEG signals are comparatively sensitive to obtain the emotional states, while physiological signals, such as sadness, happiness, and a neutral state, can be effectively classified (Domínguez-Jiménez et al., 2020; Zhang et al., 2020). Fourth, with many exciting new technologies, such as social media, being applied in customer service, attention should be paid to customer emotions and satisfaction in ICT-based customer service scenarios, such as chatbot. This motivates a growing research trend to investigate cognitive and emotional experiences on the customer service outcome (Alnawas and Hemsley-Brown, 2018). Moreover, the cognitive and emotional behavior can be embedded into intelligent customer service systems to enhance the effectiveness of human-computer interaction (Ciechanowski et al., 2019). Fifth, new industries, such as "we-media", have changed economic transactions and created flexible organizational forms, and the roles that cognition and emotion play in organizational capability development need re-examination. Particularly, emotional foundations of capability development require further attention, which may lead to business survival and evolution (Kars-Unluoglu and Kevill, 2021). Finally, due to COVID-19, many organizations now implement flexible practices such as work-from-home; examining how the different emotional states of team members may complement each other and yield excellent performance

under such conditions is an interesting research topic. These detailed suggestions postulate a robust near future for IS cognition and emotion research, and scholars will benefit by identifying the most valuable and promising research opportunities.

5. Implications and limitations

5.1 Academic implications

Cognition and emotion have great effects on shaping our attitudes and behavior associated with IS, and they have fundamentally influenced information technology and industry. The current study makes several contributions to the IS body of knowledge. First, it provides an overview of IS cognition and emotion research published in various high-quality journals, extending existing reviews. It goes beyond a single method-based approach and integrates network analysis, bibliometric review, and inductive review to understand key themes underlying the academic papers. Second, the citation network shows that relationships among papers are loose, indicating IS cognition and emotion research is still a developing field with many research opportunities. Third, we propose two new indicators (AADC and AABC) that are capable of identifying influential papers and alleviating the time-lag problem of citation analysis, and 57 important papers are identified. These papers are classified into four different research types through careful examination. Almost half are non-empirical studies, which indicates that even if the importance of cognitive and emotional applications in the IS field has been widely recognized, some detailed concepts and mechanisms remain to be clarified and further developed in this domain. Fourth, through document co-citation analysis, we identify six core knowledge groups that cover a wide range of research areas, ranging from studies focusing on the design of more effective information systems to investigating the effect that cognition and emotion play in various scenarios involving people. These knowledge groups are meticulously summarized and can give a comprehensive picture of the detailed topics, helping scholars who are less familiar with this field have an in-depth understanding in a limited amount of time. Overall, this study can help researchers understand the current state of IS cognition and emotion and develop an appreciation of this research area and the different issues considered worthy of research and publication.

In regard to enterprise information systems (EIS), a solid foundation for the cognitive and emotional IS research has been established through this review study. The incorporation of cognition and emotion in EIS may result in better HCI in the enterprise scenarios so as to deepen the understanding on workers' cognition and emotion. It results in revamping multi-disciplinary EIS functions, such as workflow

modelling and supply chain management, with the cognitive and emotional signals so as to enhance cost-effectiveness, business sustainability, and service quality. Consequently, the EIS eco-system can be further enriched through this study.

5.2 Practical implications

The results of this study also have important roles in practice. First, the analysis of information technology use and information processing gives us a comprehensive understanding of IS user requirements and interpersonal communication mechanisms, guiding enterprises to produce better products and services. Second, with regard to business practices, the applications of cognition and emotion have been extended to customer satisfaction, online sales, and business negotiations; thus, practitioners can benefit from this study's findings in achieving their business goals. Third, a detailed introduction to creating effective HCI that can address human cognition and emotion is provided in this paper. This introduction can help industries to improve the quality of the interactions between humans and computers. Fourth, because organizations are composed of individuals, the effects of individual cognition and emotion on organizational capability development cannot be ignored, and the relevant mechanisms that we uncovered can enhance enterprise competitiveness. Finally, by understanding the roles played by cognition and emotion in decision making and work, individuals can make more reasonable choices, reduce decision risk, and improve their work performance.

5.3 Limitations

There are several limitations to this study. First, we collect articles from journals listed in the MIS Journal Rankings because articles in these publications effectively represent research progress in this field. Some valuable works of IS cognition and emotion published outside this scope might be missed. Second, due to the restrictions imposed by co-citation analysis, this study suffers from the time delay problem, and some newly-published papers with low numbers of citations are excluded such that deviations might exist between the core knowledge and the actual research advances. In the future, researchers may focus on the newly published and important papers to cover the latest influential research. Third, the MDS and HCA methods provide statistics but no content meanings; the results of co-citation analysis are interpreted through manually reviewing and summarizing the content of each paper. Eliminating human opinions from a literature review is impossible, yet future research may develop more reasonable solutions to balance objectivity and human opinion.

6. Conclusions

Cognition and emotion are fundamental factors that influence human behavior, and research on their applications in the IS field is fruitful but lacks systematic summarization. Motivated by this premise, in this study, we adopt multiple quantitate analysis methods to objectively explore the research progress of IS cognition and emotion. This approach helps enhance the validity and reliability of a literature review, as objective citation relationships can reveal the authors' potential prejudice. Therefore, our results can effectively identify the actual research advance in IS cognition and emotion. In this study, we collect 2061 relevant academic papers from 1996 to 2019, and through citation and co-citation analysis, two research questions we previously proposed are answered. In the citation analysis, 57 influential papers are identified and serve as crucial reference information for future IS cognition and emotion research. Using a backward search process and stepwise test method in the co-citation analysis, we generate a 61×61 co-citation matrix. Finally, six core knowledge groups of IS cognition and emotion are discussed: (1) information technology usage and information processing, (2) online shopping, (3) human-computer interaction, (4) customer service and negotiation, (5) organizational capability development, and (6) individual performance. Suggestions for future research are provided to identify important opportunities in this promising but not-yet-fully cultivated research territory. Overall, this review study contributes to IS research in the aspect of cognition and emotion, while structure knowledge clusters are explicitly stated so as to summarize the merit from the existing studies. Furthermore, the insights for future research in IS cognition and emotion research are outlined to facilitate the effective incorporation of cognition and emotion in contemporary ISs in the recent industry 4.0 era.

Availability of data and material

Data can be found at: https://doi.org/10.5281/zenodo.4320804

Code availability

Code can be found at: https://doi.org/10.5281/zenodo.4320804

Appendix

A list of acronyms used in this paper are summarized in Table 3 for easy referencing.

Table 3 A List of acronyms

Acronyms	Full Forms
AABC	Annual average betweenness centrality
AADC	Annual average degree centrality
AIS	Association for Information Systems
GUIs	Graphical user interfaces
HCA	Hierarchical clustering analysis
HCI	Human-computer interaction
ICT	Information and communication technologies
IS	Information systems
JDM	Human judgment and decision-making
KM	Knowledge management
MDS	Multidimensional scaling analysis
MMOG	Massively multiplayer online games
PIU	Pathological Internet use
QoL	Quality of life
QoW	Quality of work
SD	Software development
SDLC	System development life cycle
SNA	Social network analysis
TAM	Technology acceptance model
TPB	Theory of planned behavior
TRA	theory of reasoned action
TS	Topic Search
UML	Unified modeling languages
WoS	Web of Science

On the other hand, details of important papers identified by citation and co-citation analysis are summarized in Tables 4 and 5, as follows.

Table 4 Details of 57 influential papers identified in citation analysis

No.	Title
315	Bodily sensation maps: Exploring a new direction for detecting emotions from user self-reported data (García-Magariño et al. 2018)
331	Resolving the judgment and decision-making paradox between adaptive learning and escalation of commitment (Wong and Kwong 2018)
405	Constructing a shared governance logic: The role of emotions in enabling dually embedded agency (Fan and Zietsma 2017)

No.	Title
494	The message is on the wall? Emotions, social media and the dynamics of institutional complexity (Toubiana and Zietsma 2017)
527	Affective events and the development of leader-member exchange (Cropanzano et al. 2017)
528	Feeling mixed, ambivalent, and in flux: The social functions of emotional complexity for leaders (Rothman and Melwani 2017)
534	Moving beyond fight and flight: A contingent model of how the emotional regulation of anger and fear sparks proactivity (Lebel 2017)
560	Maintaining the values of a profession: Institutional work and moral emotions in the emergency department (Wright et al. 2017)
576	Analytical mapping of opinion mining and sentiment analysis research during 2000–2015 (Piryani et al. 2017)
578	Multimodal emotion recognition with evolutionary computation for human-robot interaction (Perez-Gaspar et al. 2016)
588	Think, feel, bid: The impact of environmental conditions on the role of bidders' cognitive and affective processes in auction bidding (Hariharan et al. 2016)
596	Intelligent facial emotion recognition using moth-firefly optimization (Zhang et al. 2016)
615	Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use (Elhai et al. 2016)
656	Overcoming the fear factor: How perceptions of supervisor openness lead employees to speak up when fearing external threat (Lebel 2016)
657	The heart of institutions: Emotional competence and institutional actor hood (Voronov and Weber 2016)
687	Integrating the bright and dark sides of OCB: A daily investigation of the benefits and costs of helping others (Koopman et al. 2016)
697	Distributed attention and shared emotions in the innovation process: How Nokia lost the smartphone battle (Vuori and Huy 2016)
752	New approach in quantification of emotional intensity from the speech signal: emotional temperature (Alonso et al. 2015)
792	The emotional responses of browsing Facebook: Happiness, envy, and the role of tie strength (Lin and Utz 2015)
846	When teams agree while disagreeing: Reflexion and reflection in shared cognition (Healey et al. 2015)
864	Coping with information technology: Mixed emotions, vacillation, and nonconforming use patterns (Stein et al. 2015)
910	Adaptive 3D facial action intensity estimation and emotion recognition (Zhang et al. 2015)

No.	Title
932	Role of affect in self-disclosure on social network websites: A test of two competing models (Yu et al. 2015)
972	A new approach of audio emotion recognition (Ooi et al. 2014)
981	Shiny happy people buying: The role of emotions on personalized e-shopping (Pappas et al. 2014)
1001	Social sharing through interpersonal media: Patterns and effects on emotional well-being (Choi and Toma 2014)
1003	Swimming in a sea of shame: Incorporating emotion into explanations of institutional reproduction and change (Douglas Creed et al. 2014)
1022	Attitudes towards user experience (UX) measurement (Law et al. 2014)
1032	Unpacking affective forecasting and its ties to project work in organizations (Dane and George 2014)
1041	Neuroscience and a nomological network for the understanding and assessment of emotions in information systems research (Gregor et al. 2014)
1053	Enhancing user-game engagement through software gaming elements (Li et al. 2014)
1055	Guidelines for neuroscience studies in information systems research (vom Brocke and Liang 2014)
1058	Text-based emotion classification using emotion cause extraction (Li and Xu 2014)
1093	Integrating biosignals into information systems: A NeuroIS tool for improving emotion regulation (Astor et al. 2013)
1128	Negative online word-of-mouth: Behavioral indicator or emotional release? (Verhagen et al. 2013)
1184	Emotions and information diffusion in social media-sentiment of microblogs and sharing behavior (Stieglitz and Dang-Xuan 2013)
1310	Integrating emotions into the analysis of institutional work (Voronov and Vince 2012)
1320	Research commentary—NeuroIS: The potential of cognitive neuroscience for information systems research (Dimoka et al. 2011)
1349	Anger and happiness in virtual teams: Emotional influences of text and behavior on others' affect in the absence of non-verbal cues (Cheshin et al. 2011)
1358	Attention to attention (Ocasio 2011)
1384	The role of affect and cognition on online consumers' decision to disclose personal information to unfamiliar online vendors (Li et al. 2011)
1385	Embodied conversational agent-based kiosk for automated interviewing (Nunamaker et al. 2011)
1419	Analyzing the emotional outcomes of the online search behavior with search engines (Flavián-Blanco et al. 2011)
1526	The determinants and expression of computer-related anger (Charlton 2009)

No.	Title
1541	Affective interaction: How emotional agents affect users (Beale and Creed 2009)
1545	Attentional triangulation: Learning from unexpected rare crises (Rerup 2009)
1551	Short-term emotion assessment in a recall paradigm (Chanel et al. 2009)
1708	A balanced thinking-feelings model of information systems continuance (Kim et al. 2007)
1736	Is happy better than sad even if they are both non-adaptive? Effects of emotional expressions of talking-head interface agents (Gong 2007)
1758	The effects of emotional ambivalence on creativity (Fong 2006)
1820	Organizing and the process of sensemaking (Weick et al. 2005)
1833	Using human physiology to evaluate subtle expressivity of a virtual quizmaster in a mathematical game (Prendinger et al. 2005)
1893	A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study (Chin et al. 2003)
1907	When "the show must go on": Surface acting and deep acting as determinants of emotional exhaustion and peer-rated service delivery (Grandey 2003)
1930	Emotional balancing: The role of middle managers in radical change (Huy 2002)
1965	A cognitive-behavioral model of pathological Internet use (Davis 2001)
2002	Looking forward and looking backward: Cognitive and experiential search (Gavetti and Levinthal 2000)

Table 5 Details of 61 papers for co-citation analysis

No	Title	Year	Cited Times
615	Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use	2016	101
1184	Emotions and information diffusion in social media-sentiment of microblogs and sharing behavior	2013	333
1310	Integrating emotions into the analysis of institutional work	2012	139
1313	Toward a behavioral theory of strategy	2012	155
1330	The influence of online store beliefs on consumer online impulse buying: A model and empirical application	2011	97
1358	Attention to attention	2011	258
1384	The role of affect and cognition on online consumers' decision to disclose personal information to unfamiliar online vendors	2011	108
1397	Daily customer mistreatment and employee sabotage against customers: Examining emotion and resource perspectives	2011	184

1400	The ethical dangers of deliberative decision making	2011	94
1436	Impact of technostress on end-user satisfaction and performance	2010	104
1484	The interactional effects of atmospherics and perceptual curiosity on emotions and online shopping intention	2010	103
1528	Cognitive and psychological predictors of the negative outcomes associated with playing MMOGs (massively multiplayer online games)	2009	86
1535	Customer reactions to emotional labor: The roles of employee acting strategies and customer detection accuracy	2009	234
1545	Attentional triangulation: Learning from unexpected rare crises	2009	102
1551	Short-term emotion assessment in a recall paradigm	2009	146
1553	The nature and experience of entrepreneurial passion	2009	350
1574	The enduring impact of transient emotions on decision making	2009	110
1582	The influence of website characteristics on a consumer's urge to buy impulsively	2009	197
1649	Real-time classification of evoked emotions using facial feature tracking and physiological responses	2008	131
1650	Carrying too heavy a load? The communication and miscommunication of emotion by email	2008	97
1689	Selective self-presentation in computer-mediated communication: Hyper personal dimensions of technology, language, and cognition	2007	262
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1772	Open source software user communities: A study of participation in Linux user groups	2006	267
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1831	Computers that are care: Investigating the effects of orientation of emotion exhibited by an embodied computer agent	2005	152
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1847	Transactive memory systems in organizations: Matching tasks, expertise, and people	2004	208
1848	Emotion as a connection of physical artifacts and organizations	2004	91
1852	Angry men and disgusted women: An evolutionary approach to the influence of emotions on risk taking	2004	105
1866	Designing emotionally evocative homepages: An empirical study of the quantitative relations between design factors and emotional dimensions	2003	99
1881	To feel or not to feel: The role of affect in human-computer interaction	2003	146
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1888	Recognizing emotion from dance movement: comparison of spectator recognition and automated techniques	2003	151
1893	A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study	2003	1988
1899	Exploring the framing effects of emotion: Do discrete emotions differentially influence information accessibility, information seeking, and policy preference?	2003	203

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1965	A cognitive-behavioral model of pathological Internet use	2001	769
1981	Coordinating expertise in software development teams	2000	636
1986	Rethinking resistance and recognizing ambivalence: A multidimensional view of attitudes toward an organizational change	2000	446
1991	Affect and persuasion: Emotional responses to public service announcements	2000	143
2002	Looking forward and looking backward: Cognitive and experiential search	2000	665
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