

Methodological Interdisciplinarity in Contemporary Hadith Studies: A Case Study of Social Network Analysis of the Transmitters of Ibn Babawayh's *Kamal al-Din wa Tamam al-Ni'ma*

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Abstract

The proper and comprehensive use of hadiths, alongside the Qur'an, requires familiarity with a wide range of sciences, some of which had already emerged under the rubric of hadith studies from the earliest centuries of Islam. With the expansion of social needs, the advent of new research methods, and the emergence of fresh scholarly questions in the present era, hadith scholars have, in addition to relying on traditional sciences, increasingly drawn on interdisciplinary approaches within the humanities. One particularly effective approach in analyzing human relations is Social Network Analysis (SNA). Despite the significance of this method, no systematic and comprehensive study has yet been conducted in Shi'i sources to examine the role of early hadith transmitters (*rāwī*) and the process by which narrations (*riwāya*) were transmitted across generations. Seeking to address this gap, the present research investigates the network of hadith transmitters in Ibn Babawayh's *Kamal al-Din wa Tamam al-Ni'ma*. In this study, by analyzing the chains of transmission (*isnād*), the transmitters' social network was mapped and examined through network analysis metrics at both macro and micro levels. At the macro level, criteria such as density, clustering coefficient, and community structure were analyzed; at the micro level, measures such as degree centrality, betweenness centrality, and closeness were employed. The findings demonstrate that, based on centrality measures, a list of influential transmitters—including companions of

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the Prophet Muhammad (PBUH) and subsequent generations—was identified and ranked. Furthermore, twenty-six communities were discovered within the chains of transmission, each comprising clusters of prominent transmitters who played pivotal roles in the circulation of hadiths.

Keywords: hadith, Ibn Babawayh (al-Shaykh al-Saduq), *Kamal al-Din wa Tamam al-Ni'ma*, Social Network Analysis, methodological interdisciplinarity

1. Introduction

1.1. Problem Statement

In the contemporary world, hadith studies are pursued through a variety of approaches. Alongside currents that continue the Islamic tradition, there have also emerged inquiries influenced by Western scholarship, which employ modern methods from the humanities and social sciences in order to gain a deeper understanding of hadiths. One of these newer approaches is Social Network Analysis (SNA), which has only recently been applied within Islamic studies.

Throughout human history, social networks have played a crucial role in the transmission of ideas and information. Among such communicative networks are the narrative networks that hold particular significance in the circulation of Islamic hadiths. Hadiths, which encompass the sayings and actions of the Prophet Muhammad and the Shi'i Imams, were first transmitted orally before being recorded in writing. Each hadith consists of two components: the chain of transmission (*sanad*) and the content of the hadith (*matn*). The reliability of any given hadith depends largely on the trustworthiness of its transmitters (*rāwī*). Given the structure of hadith transmission chains, it is possible to model them as networks, the analysis of which reveals features such as centrality and the influence of specific transmitters.

Despite the extensive application of Social Network Analysis in fields such as citation networks and co-authorship studies, its use in hadith scholarship remains limited—particularly in Shi'i sources, where the present research represents a pioneering effort. In traditional *rijāl*¹ studies, the focus has been on the individual transmitter or on the bilateral teacher–student relationship. However, such approaches do not provide researchers with a comprehensive method for understanding the complex relationships within the entire network. Social Network Analysis, originating in the social sciences and data mining, offers precisely this possibility: it enables the identification of communicative patterns among transmitters and facilitates the analysis of hadith transmission.

This research seeks to address this gap by analyzing the network of transmitters in Ibn Babawayh's *Kamal al-Din wa Tamam al-Ni'ma*. Using SNA metrics, the structure of the narration (riwāya) network is examined and key transmitters are identified. The findings of this study also create the possibility of comparative analysis with other hadith sources, such as *al-Kāfī*², and provide a more precise insight into the process of hadith transmission.

1.2. Ibn Babawayh and His Hadith Legacy

Imami hadith scholars, generation after generation, have borne the responsibility of transmitting the legacy of the Ahl al-Bayt. Within this continuum, Ibn Babawayh (al-Shaykh al-Saduq) (d. 991 CE) played a decisive role in preserving this heritage and ensuring its transmission among the Imami Shi'a. He is considered one of the most prominent Shi'i hadith transmitters. Biographical scholars and compilers of bibliographical catalogues, such as al-Najashi and al-Tusi, both praised him while providing detailed lists of his works, emphasizing his unparalleled preservation and abundance of narrations (Najashi 1984, 389; Tusi 1972, 442). Although Ibn Babawayh authored a large number of works, most of them have not survived. Nevertheless, the extant works, when compared with those of other early Imami hadith transmitters, remain highly significant. Among his writings is *Man la yahduruhu al-faqih*, which is counted among the Four Books of Shi'i hadith.

One of the most distinctive features of Ibn Babawayh—setting his hadith scholarship apart from that of other transmitters—was his numerous scholarly travels (*al-rihlāt al-ḥadīthiyya*) to various regions of the Islamic world. He journeyed to areas in the eastern Islamic lands such as Greater Khurasan, Transoxiana, Nishapur, Tus, Sarakhs, Balkh, and Samarqand. For this reason, the number of his teachers (*mashāyikh*) has been estimated, at a minimum, to be around two hundred. He resided in Qom and Ray and is considered a representative of the Qom Hadith School (Pakatchi 1995, 48).

Kamal al-Din wa Tamam al-Ni'ma is also among Ibn Babawayh's hadith works, comprising 621 narrations. The book was composed to explain the dimensions of the doctrine of occultation (*ghayba*) and to respond to objections concerning it. Ibn Babawayh begins with rational (*al-'aqlī*) and transmitted (*al-naqlī*) arguments affirming the necessity of a divine proof³, the obligation of obedience to him, his infallibility, and his designation by God. He then addresses the objections posed by the Kaysāniyya⁴, Wāqifiyya⁵, Zaydiyya⁶, atheists, and other opponents. In the following section, he presents accounts of the occultation of previous prophets, including Idris⁷,

Noah, Salih⁸, Abraham, Joseph, Moses, and Jesus. He further discusses those who, during the interregnum between Jesus and Prophet Muhammad, represented divine proof and awaited the mission of the Prophet Muhammad. Thereafter, he turns to narrations about the Imam al-Mahdi, first citing narrations from the Prophet Muhammad, then from the Imam Ali, and subsequently from the other Imams. With narrations from Imam al-Baqir concerning the Imam al-Mahdi, the first volume concludes; the second volume begins with a very brief sermon, followed by narrations from Imam al-Sadiq about the Imam al-Mahdi, and then narrations from the remaining Imams. After the narrations of the Ahl al-Bayt, several additional chapters address various dimensions of the doctrine of Mahdism. All narrations in this book are transmitted with complete chains of transmission. Owing to its importance, the book has been published in multiple editions, and, in addition to full translations, abridgments have also been produced and circulated independently (for detailed information on editions, translations, and selections, see Madani Bejestani 2006, 365).

1.3. Literature Review

Scholars examining historical texts—especially those with complex narrative structures—are increasingly employing the framework of Social Network Analysis (SNA). This approach makes it possible to analyze relationships among individuals, events, and ideas, offering valuable insights into the structural features of such texts. Despite several studies in this area, network-based analysis of hadith texts still requires more comprehensive research.

In one such study, the structure of the transmitters of *Sahih Muslim*⁹ was examined. By constructing a narrative network, the researchers analyzed interaction patterns and the characteristics of chains of transmission, identifying key figures through centrality measures. This study also introduced a ranking system for transmitters, thereby presenting the pivotal figures within the network (Saeed et al. 2021).

In another study, Ahmad (2013) analyzed the transmitter network of *Sahih Bukhari*¹⁰. Using metrics such as in-degree, out-degree, PageRank, and betweenness centrality, he identified prominent transmitters. His goal was to assess the extent to which historically significant transmitters corresponded to those identified as central within the network analysis.

Alam and Schneider (2021) likewise investigated the social network of *Sahih Bukhari* through SNA. They produced a list of influential transmitters from among the Prophet's companions (*aṣḥāb*) and subsequent generations, demonstrating that while

transmitters were initially concentrated in Mecca and Medina, over time their centrality shifted to Kufa, Baghdad, and Central Asia.

Another study traced the routes of hadith transmission, showing that transmitters such as Shu'ba b. al-Ḥajjaj and Muhammad b. Muslim b. 'Ubayd Allah held high centrality, and that cities such as Basra, Kufa, and Medina functioned as primary centers of transmission (Dini et al. 2017).

The present research applies Social Network Analysis to Shi'i hadith sources for the second time, following the first publication by the same authors on *'Ilal al-Sharā'i'*¹¹. By employing SNA techniques, including centrality measures, it identifies influential transmitters and introduces new tools for understanding the structure and dynamics of hadith transmission networks.

1.4. Methodology

This research employed Social Network Analysis (SNA) to examine the structure of the hadiths in Ibn Babawayh's *Kamal al-Din wa Tamam al-Ni'ma*. The chains of transmitters were represented as a narrative graph, in which each node corresponded to a transmitter and each edge denoted the transfer of a hadith between them. The data for this study were extracted from two software platforms: *Dirayat al-Noor 3* and *Sheikh Saduq Documents*. Given the variation in the names of transmitters across manuscripts, these programs standardized multiple designations of each transmitter by assigning them a uniform reference.

To construct the graph, the list of transmitters and their relationships was utilized to design a directed and weighted network. The nodes represented transmitters, while the edges depicted the flow of hadiths from one transmitter to another. The weight of the edges indicated the frequency of hadith transmission. In this network, transmitters with an in-degree of zero were those who heard narrations directly from the Prophet Muhammad or the Imams, while those with an out-degree of zero transmitted narrations to Ibn Babawayh. Moreover, since a transmitter cannot report a hadith to himself, self-loops were absent in the network.

The analysis was conducted using metrics such as degree centrality (to identify influential transmitters based on the number of their connections), betweenness centrality (to measure the role of intermediaries in hadith transmission), closeness centrality (to evaluate the speed of transmission), and community detection (to identify historically or geographically related groups). Finally, the network was visualized using *Gephi* software to highlight the key transmitters and major centers of hadith transmission.

2. Theoretical Framework of Social Network Analysis of Hadith Transmitters

The social network analysis of hadith transmitters is an interdisciplinary approach that, through the tools of network analysis, investigates the relationships among transmitters and the mechanisms of hadith knowledge transmission. This perspective views the social network as a dynamic structure through which information and resources are conveyed via ties between individuals. Within this framework, the primary focus is on the relationships among transmitters rather than merely on their individual attributes. Such an analysis enables scholars to understand how hadith communities were formed, to what extent transmitters exercised influence, and how narrations spread.

Social networks play a crucial role in the transmission of knowledge, since the relational structure among transmitters affects the acceptance, dissemination, and legitimacy of hadiths. In particular, key individuals who occupy central positions within the network have pivotal roles in the diffusion of hadith. Their position enhances their influence and allows them to affect many other transmitters (Granovetter 1973, 1367–1368). Thus, the social and relational status of transmitters significantly impacts whether narrations are accepted or rejected.

Studies of historical networks of hadith transmitters show that these connections often extended beyond geographical boundaries. For example, the hadith networks in Medina, Kufa, Baghdad, and Levant, despite geographical distance, were interconnected through a small number of key intermediaries. This pattern strongly resembles “small-world networks,” in which individuals are linked through a limited set of intermediaries and typically interact via short paths (Watts and Strogatz 1998, 440–441). These connections indicate that the routes of hadith transmission were shaped by teacher–student relations, family affiliations, religious loyalties, and even political alliances. Transmission of hadith, therefore, was not simply an individual act but one embedded within complex social and networked relationships.

Transmitters who occupied central positions within the network held the largest share in the transmission of hadith. In SNA, such individuals are identified through measures such as degree centrality, betweenness centrality, and closeness centrality. Their central position enabled hadiths to be transmitted more rapidly and widely. Some transmitters, despite geographical distance, were able to exert substantial influence on the development of hadith due to their key positions in the network. Moreover, the social and network position of individuals shaped their behavior and

performance, since a person's location in the network directly affected their credibility and authority in hadith transmission (Burt 1992, 18–22).

SNA also assists in identifying hadith communities and in examining how they contributed to the dissemination of narrations. These communities often emerged on the basis of geographical location, scholarly affiliation, or family relations. For instance, transmitters in Medina played a key role in shaping the earliest hadith compilations, whereas transmitters in Kufa and Baghdad were involved in later stages of dissemination. Studying these networks reveals how hadith knowledge was transmitted across different groups and how social dynamics shaped the preservation and transformation of narrations.

Network analysis not only makes it possible to identify influential individuals but also provides a deeper understanding of the legitimacy and authenticity of hadith narrations. In hadith communities, the authenticity of a narration depended both on its content and on the social and network position of its transmitters. Hadith scholars assessed the validity of narrations by considering the transmitters' social relations, granting reliability only to those who maintained strong ties with trusted transmitters. Some transmitters, owing to their prominent positions within the network, exerted disproportionate influence on the circulation of hadith. This demonstrates that in every network, certain individuals achieve greater authority due to their location. Adopting this network-based approach enables scholars to identify the key figures in the spread of hadith and to analyze the structural patterns that facilitated the preservation and dissemination of narrations. Such an approach enriches our understanding of hadith transmission and clarifies how social networks contributed to the formation of authenticity and legitimacy in Islamic texts.

3. Social Network Analysis of Hadiths in *Kamal al-Din wa Tamam al-Ni'ma*

After the data-cleaning process and the removal of duplicate hadiths, the social network of transmitters in *Kamal al-Din wa Tamam al-Ni'ma* was designed and constructed. For this purpose, *Gephi* software was employed, resulting in a network consisting of 1864 edges and 1156 nodes. This represents a narrative network in which the nodes correspond to transmitters of hadiths and the edges indicate relationships or transfers of hadith between two transmitters. The subsequent analysis focuses on the key structural features of this narrative network, offering a comprehensive examination of various social network measures as applied to the domain of narrative transmission. These analyses facilitate a deeper understanding of the network's structure and the ways transmitters are interconnected.

This section highlights several characteristics of the narrative hadith network as follows:

- The transmitter network naturally takes the form of a directed multigraph.
- The network is formed by linking transmitters who act as senders and receivers. Since each transmitter may both receive and transmit hadiths, the network does not constitute a bipartite graph.
- It is further evident that this network is neither a complete graph nor strongly connected in terms of connectivity.
- The number of strongly connected components in the network is 1135, which is ten fewer than the total number of transmitters. This indicates that certain transmitters are not connected, either directly or indirectly, through other transmitters.
- The density of the network is only 0.001, and the average shortest path length between two nodes is 4.73.
- The network diameter is 16; in other words, in the worst case no two nodes are separated by more than 16 steps.

4. Ranking of Hadith Transmitters

4.1. Ranking Based on In-Degree Centrality

The in-degree measure provides a more precise perspective on the structure of the transmitter network. In-degree and out-degree indicate the number of direct connections that influential nodes (i.e., transmitters) maintain with others (McLevey, Scott, and Carrington 2024, 27). In this study, the in-degree reflects the number of hadiths a transmitter received from his teachers, while the out-degree indicates the number of hadiths transmitted by that transmitter.

Table 1 presents the list of the top ten transmitters based on in-degree. The results show that these ten individuals received the largest number of hadiths from other transmitters. When the in-degree of a transmitter is zero, this signifies that he directly heard narrations from the Prophet or the Imams.

According to the results presented in Table 1, Sa'd b. 'Abdullah occupies the first rank. He was one of the leading hadith transmitters of the third (AH)/ninth (CE) century and is recorded to have been in the presence of two Imams, al-Hasan al-'Askari and al-Mahdi. Both al-Tusi and al-Najashi mention him with great respect, describing him as eminent (*jalil al-qadr*) and reliable (*thiqa*) (al-Tusi, *al-Rijal*, 431; al-Najashi, *al-Rijal*, 401). After him, Muhammad b. Abi 'Umayr holds the highest in-

degree, indicating that he received the greatest number of hadiths after Sa'd b. 'Abdullah. Ibn Abi 'Umayr was counted among the *aṣḥāb al-ijma'*¹² and directly heard hadiths from three Imams: al-Rida, al-Jawad, and al-Kazim. Although he was able to transmit numerous hadiths directly from the Imams, he also reported many narrations of Imam al-Sadiq indirectly, since he was not among that Imam's companions. This circumstance explains the increase in his in-degree score.

Table 1. Top Ten Transmitters Based on In-Degree

No.	Name of Transmitter	In-Degree
1	Sa'd b. 'Abdullah al-Qummi	55
2	Muhammad b. Abi 'Umayr Ziyad	33
3	'Abdullah b. Ja'far al-Himyari	32
4	Muhammad b. 'Isa b. 'Ubayd	24
5	Ibrahim b. Hashim al-Qummi	24
6	Muhammad b. al-Husayn b. Abi al-Khattab	24
7	Ahmad b. Muhammad b. 'Isa al-Ash'ari	23
8	Muhammad b. Yahya al-'Attar	19
9	al-Hasan b. Mahbub al-Sarrad	18
10	Muhammad b. Mas'ud al-'Ayyashi	16

Within the transmitter network of *Kamal al-Din wa Tamam al-Ni'ma*, 225 nodes have an in-degree of zero. In other words, 16.5 percent of the transmitters in this network did not receive any hadith from others but narrated hadiths directly from the Prophet or an Imam. Furthermore, 671 nodes have an in-degree of one, which shows that 49.4 percent of the transmitters received only a single hadith from another transmitter. In total, only 58 transmitters received more than five hadiths. Thus, the majority of narrations in *Kamal al-Din* were transmitted by individuals who had received just one hadith from others. Ultimately, only 4.2 percent of the transmitters received and transmitted more than five hadiths.

4.2. Ranking Based on Out-Degree Centrality

Another measure that contributes to a better understanding of the social network is out-degree centrality. This metric indicates how many hadiths a transmitter passed on to other transmitters. Table 2 presents the ten transmitters who transmitted the largest number of hadiths to others. The highest in-degree, too, belongs to Ibn Abi 'Umayr, which further underscores his significant position in *Kamal al-Din wa Tamam al-Ni'ma*.

Within the transmitter network of *Kamal al-Din*, 84 transmitters have an out-degree of zero. In other words, 6.1 percent of the transmitters occupy the endpoint of the chain of transmission, passing hadiths directly to Ibn Babawayh. Furthermore, 773 transmitters possess an out-degree of one, meaning that 56.92 percent of the transmitters conveyed only a single hadith to others. Altogether, considering only those transmitters who transmitted five or more hadiths, this group accounts for merely 4.49 percent of the transmitters.

Table 2. Top Ten Transmitters Based on Out-Degree

No.	Name of Transmitter	Out-Degree
1	Muhammad b. Abi 'Umayr Ziyad	21
2	Thabit b. Dinar Abu Hamza al-Thumali	19
3	Yahya Abu Basir al-Asadi	19
4	al-Hasan b. Mahbub al-Sarrad	14
5	Muhammad b. Sinan al-Zahiri	12
6	al-Hasan b. 'Ali b. Faddal al-Taymi	12
7	Muhammad b. al-Husayn b. Abi al-Khattab	11
8	Ahmad b. Muhammad b. Khalid al-Barqi	10
9	'Abdullah b. al-'Abbas b. 'Abd al-Muttalib	10
10	Muhammad b. 'Isa b. 'Ubayd	9

4.3. Ranking Based on Betweenness Centrality

Betweenness centrality measures how often a node lies on the shortest paths between other pairs of nodes in the network. Put simply, this index identifies the transmitters who serve as connectors between otherwise separate parts of the network. Table 3 presents the ten leading transmitters according to this measure.

Betweenness centrality highlights the nodes that act as connectors between subnetworks. The higher the value of this measure for a node, the greater its importance in linking other nodes and facilitating the flow of information across the network. According to the available data, 319 nodes scored zero in this measure. This indicates that 23.4 percent of the transmitters in the network lacked effective connections with others and functioned relatively in isolation. By contrast, 76.6 percent of the transmitters maintained stronger ties, which accelerated the dissemination of information throughout the network.

Table 3. Top Ten Transmitters Based on Betweenness Centrality

No.	Name of Transmitter	Betweenness Centrality
1	‘Abdullah b. Ja‘far al-Himyari	13208.19205
2	Sa‘d b. ‘Abdullah al-Qummi	10313.28513
3	Muhammad b. Abi ‘Umayr Ziyad	8210.558281
4	Muhammad b. Ja‘far al-Asadi al-Kufi	7763.423315
5	Muhammad b. ‘Abdullah b. Ja‘far al-Himyari	7372.476833
6	‘Ali b. Mahziyar	6106.751571
7	Muhammad b. al-Husayn b. Abi al-Khattab	5750.740388
8	Muhammad b. Hammam b. Suhayl	5274.771827
9	Muhammad b. ‘Isa b. ‘Ubayd	4865.521139
10	Ahmad b. Muhammad b. ‘Isa al-Ash‘ari	4692.355516

As shown in Table 3, the most prominent intermediary in the network is ‘Abdullah b. Ja‘far al-Himyari. He was one of the greatest Shi‘i scholars and hadith transmitters of the third and fourth centuries (AH)/ ninth and tenth (CE), living during the Imamate of Imam al-Hadi and Imam al-Hasan al-‘Askari, and present also in the period of the Minor Occultation¹³. He is reported to have been among the earliest teachers in the *hawza* of Karbala. According to al-Tusi, al-Himyari authored seventeen works, of which only one has survived. He played a crucial role in transmitting hadiths from the transmitters of Qom, and his name appears frequently in the chains of transmission of scholarly narrations reported by Shi‘i transmitters in Kufa and other regions. This intermediary position—connecting otherwise separate nodes—granted him a decisive role in managing and expanding the flow of information.

For a more precise analysis of the transmitter network, it is essential to focus on the structure of the communities within it. Community detection identifies groups of nodes (i.e., transmitters) that are densely connected internally but maintain fewer ties with nodes outside the group (Porter et al. 2009, 1086). To this end, the modularity index was employed to identify the network structure. Modularity refers to a set of nodes in which each node—in this context, each transmitter—is connected to others in the group either directly or indirectly through edges. Based on the results, the network consists of 28 distinct communities. In this study, communities containing fewer than twenty nodes were excluded from the analysis. Table 4 presents the data on the 18 identified communities, highlighting the most important transmitter in each according to the measure of betweenness centrality. These transmitters, due to their high betweenness values within their communities, act as key connectors and serve as bridges linking different communities.

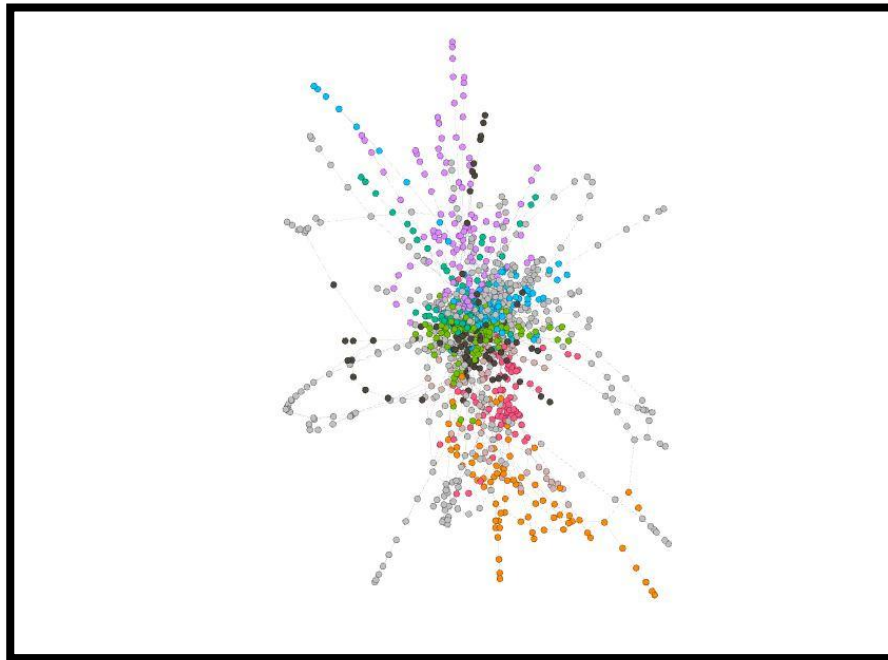


Figure 1. The overall transmitter network and its communities

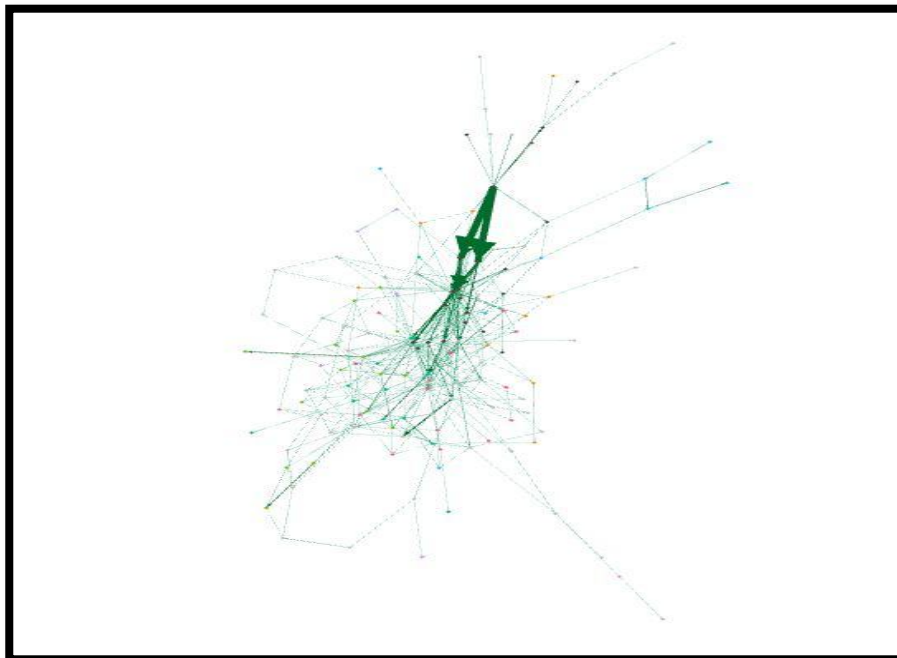


Figure 2. The transmitter network including only nodes with a degree higher than five

Figure 1 illustrates the structure of the entire network and its twenty-eight constituent communities, each distinguished by a different color. Figure 2, by contrast, depicts only those nodes with a degree higher than five.

Table 4. Identified Communities and Key Transmitters Based on Betweenness Centrality

No.	Key Transmitter	Highest Betweenness Centrality	No. of Nodes	Density	No. of Edges	Edge-to-Node Ratio
1	Ahmad b. Muhammad b. 'Isa al-Ash'ari	4692.355516	102	0.012	635	6.23
2	Muhammad b. 'Abdullah b. Ja'far al-Himyari	7372.476833	40	0.028	81	2.03
3	Muhammad b. Abi 'Umayr Ziyad	8210.558281	64	0.016	220	3.44
4	Ahmad b. Muhammad b. Khalid al-Barqi	2530.932716	42	0.026	195	4.64
5	Muhammad b. Hammam b. Suhayl	5274.771827	115	0.009	250	2.17
6	al-Rabi' b. Muhammad al-Musalli	220.813523	31	0.043	112	3.61
7	'Abdullah b. Ja'far al-Himyari	13208.19205	101	0.014	1269	12.56
8	Muhammad b. Mas'ud al-'Ayyashi	2644	48	0.023	218	4.54
9	Ahmad b. Masrur	2491	21	0.048	32	1.52
10	Muhammad b. Sinan al-Zahiri	1896.732958	39	0.030	188	4.82
11	'Ali b. Muhammad 'Allan al-Kulayni	2910.541667	43	0.025	138	3.21
12	Muhammad b. Ja'far al-Asadi al-Kufi	7763.423315	74	0.015	359	4.85
13	Hammad b. 'Isa al-Juhani	2406.646945	52	0.021	341	6.56
14	al-Hasan b. 'Ali b. Faddal al-Taymi	2450.047775	33	0.031	251	7.61
15	Sulayman b. Mihran al-A'mash	258.003968	76	0.014	123	1.62
16	'Amir b. Sharahil al-Sha'bi	742.081169	55	0.020	104	1.89
17	al-Fadl b. Shadhan al-Nisaburi	1156.100499	58	0.018	112	1.93
18	'Ali b. Mahziyar	6106.751571	82	0.014	283	3.45

As shown in Table 4, the fifth community is the largest in the network, consisting of 115 nodes. Within this community, Muhammad b. Hammam b. Suhayl attained the highest betweenness centrality score, indicating his outstanding influence in the dissemination and circulation of information within this group. In addition, the eighth community, with a density of 0.048, recorded the highest level of density among the communities and comprised nearly twenty transmitters. With regard to the edge-to-node ratio—which measures the intensity and extensiveness of interactions among members of a community—the seventh community, with 101 transmitters and 1269 edges, displayed the greatest degree of connectivity. This reflects the complexity of the relationships among the members of that community.

4.4. Ranking Based on Closeness Centrality

In network analysis, the concept of closeness centrality measures the distance of a node from all other nodes. This distance is calculated as the average of the shortest possible paths. The measure is particularly useful for evaluating the speed with which information (hadiths) can flow through each node (i.e., transmitter) (Alhajj and Rokne 2014, 194). In the transmitter network, where hadiths are connected through shared transmitters, closeness centrality identifies those transmitters who maintain close relationships with others. A transmitter with high closeness centrality means that other transmitters can reach him quickly and easily. This typically indicates the influence and central role of that transmitter in the overall process of knowledge transmission within the network.

It is noteworthy that the transmitter network is directed; therefore, the accessible paths are more limited than in an undirected network. The analysis of the transmitter network in *Kamal al-Din wa Tamam al-Ni'ma* revealed that 104 transmitters occupied the closest possible position relative to all others. This finding is unusual, since in most social networks only a small number of nodes attain a perfect closeness score. What complicates the matter further is that in almost all of these cases the in-degree and out-degree values of these transmitters equal one—that is, they either received only a single hadith from another transmitter, or they themselves transmitted only a single hadith. Yet this occurred because, across the entire network, these individuals typically passed the hadith to just one other person, or when they transmitted it to several others, those recipients did not pass it on further except to Ibn Babawayh. Consequently, all possible paths for these nodes were accessible in just one step, which resulted in a perfect score.

This observation raises an important question: why were these individuals connected to only one transmitter, particularly when many of them were regarded as reliable transmitters? If a transmitter is *jalil al-qadr* (eminent), should he not have transmitted his legacy to a broader range of individuals? To answer this question, it is necessary to examine the hadiths of Ibn Babawayh across his other works, as well as in the wider Shi'i and Sunni corpora, in order to assess the true transmission capacity of such transmitters.

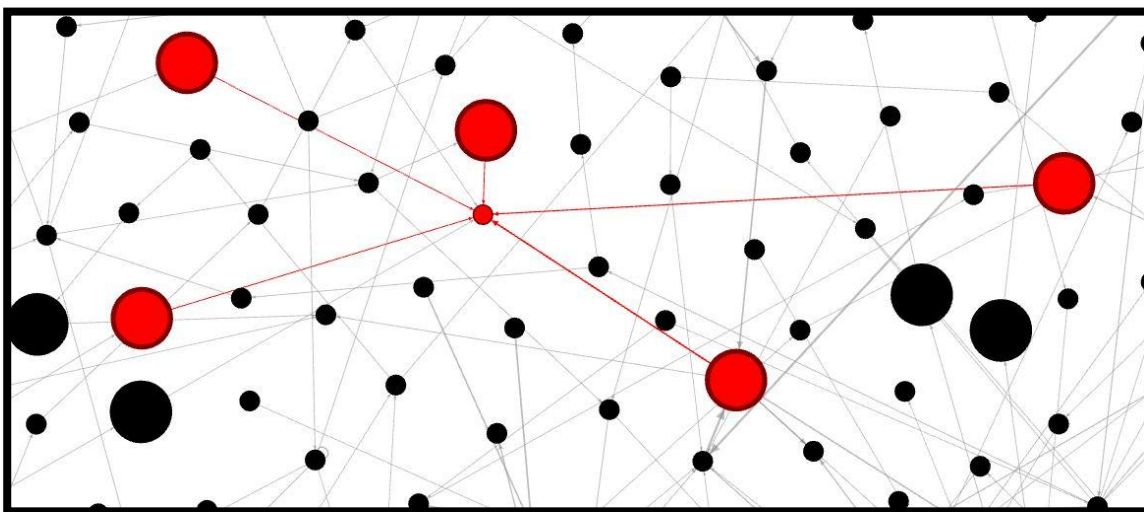


Figure 3. The network of al-Qattan's teachers

As an example, Figure 3 illustrates the network of one of Ibn Babawayh's teachers (*mashāyikh*), Aḥmad b. al-Ḥasan al-Qattan. In this network, the five red nodes represent al-Qattan's teachers, each of whom has a closeness centrality score of one. As can be observed, the edges run from the teachers toward al-Qattan. Since al-Qattan is directly connected to Ibn Babawayh, his own node does not appear in the graph. Thus, the point is that certain individuals were connected exclusively to al-Qattan, and when they were connected to another person, that individual too was directly connected to Ibn Babawayh.

The noteworthy issue is that a number of Ibn Babawayh's transmitters were Sunnis, yet no trace of them is found in Sunni sources. In one study, 42 Sunni teachers of Ibn Babawayh were identified (Sarbandi 2022). Therefore, the teachers of these Sunni transmitters are not connected to other individuals in the network.

Table 5 introduces ten transmitters who achieved a perfect score (one) in closeness centrality. This group of transmitters also holds the highest betweenness scores among the other 104 transmitters.

Table 5. Top Ten Transmitters with Perfect Closeness Centrality (Score = 1)

No.	Name of Transmitter	Closeness Centrality
1	Ali b. Ibrahim b. Hashim	1
2	Muhammad b. Ya'qub al-Kulayni	1
3	Ahmad b. Idris al-Qummi	1
4	Ahmad b. 'Isa al-Washsha' al-Baghdadi	1
5	Abu 'Ali b. Muhammad b. Ja'far al-Asadi al-Kufi	1
6	al-Muzaffar b. Ahmad al-Qazwini	1
7	Ahmad b. Yahya b. Zakariyya al-Qattan	1
8	'Ali b. Muhammad b. Qutayba al-Nisaburi	1
9	Ahmad b. Muhammad b. Sa'id Ibn 'Uqda	1
10	Ja'far b. Muhammad b. Mas'ud al-'Ayyashi	1

4.5. Ranking Based on the PageRank Algorithm

The PageRank algorithm, originally developed by Google to determine the importance of web pages based on the hyperlinks among them, can also be applied to the analysis of hadith networks. In a network such as that of hadith, which consists of the sayings and actions of the Prophet Muhammad and the Imams, PageRank serves as an effective tool for assessing the relative importance or authenticity of narrations. Just as web pages are ranked according to the number and quality of links pointing to them, hadiths may likewise be ranked according to the interconnections among transmitters in the network.

Table 6. Top Ten Transmitters Based on PageRank Algorithm

No.	Name of Transmitter	PageRank
1	Sa'd b. 'Abdullah al-Qummi	0.022574
2	Muhammad b. al-Hasan b. Ahmad b. al-Walid	0.014505
3	'Abdullah b. Ja'far al-Himyari	0.013735
4	Muhammad b. Mas'ud al-'Ayyashi	0.013527
5	Muhammad b. Yahya al-'Attar	0.013178
6	Ali b. al-Husayn b. Babawayh	0.012959
7	Muhammad b. Ibrahim b. Ishaq al-Taliqani	0.011803
8	Muhammad b. Musa b. al-Mutawakkil	0.00939
9	Ahmad b. Muhammad b. 'Isa al-Ash'ari	0.008734
10	Ibrahim b. Hashim al-Qummi	0.00806

Accordingly, PageRank identifies transmitters who occupy more prominent positions in terms of scholarly significance and inter-transmitter relations, thereby offering deeper insight into the transmission of knowledge and the distribution of

authenticity in hadith sources. Based on the results of this algorithm, presented in Table 6, Sa'd b. 'Abdullah emerges as the most important transmitter in the network.

5. Conclusion

This study, by focusing on the Social Network Analysis (SNA) of hadith transmitters in *Kamal al-Din wa Tamam al-Ni'ma*, introduced a novel approach to understanding and examining the dissemination of hadiths and the interactions among transmitters. The findings derived from applying social network measures highlight distinctive characteristics in the structure of relationships and the flow of transmission. The results reveal that 49.4 percent of the transmitters received only one hadith, while only a small proportion of transmitters (about 11.2 percent) played a more significant role in the transmission of hadiths. This suggests that the transmission network in *Kamal al-Din* was shaped largely in a limited fashion, with a relatively small group of transmitters responsible for the broader distribution of information.

Moreover, the analysis of structural features such as low density, a diameter of sixteen, and an average path length of 4.74 demonstrates that the transmitter network in *Kamal al-Din* lacked optimal connectivity. In fact, fragmentation and the presence of disconnected components reduced accessibility and limited direct connections among certain transmitters. These findings provide new insights into the dynamics of hadith transmission and the challenges inherent in narrative networks.

The results regarding betweenness centrality show that 23.4 percent of the transmitters maintained no strong ties with others in the network and functioned independently. This measure, therefore, serves as an indicator for identifying transmitters who played no significant role in the circulation of information. Furthermore, by employing modularity to simulate the community structure, it was found that the network consists of 28 communities, of which only 18 contained more than 20 nodes (i.e., transmitters). These communities are characterized by the presence of transmitters with higher betweenness centrality, underscoring their pivotal role in connecting different clusters and facilitating the spread of hadiths.

The analysis also demonstrated that 104 transmitters occupied the closest possible positions to others—an uncommon phenomenon in social networks. The complexity of this finding lies in the fact that their in-degree and out-degree values were almost always equal to one, meaning each transmitter received or transmitted only a single hadith. This occurred because these transmitters were typically connected to just one other individual, or when they did transmit a hadith to several people, those recipients transmitted it exclusively to Ibn Babawayh without further dissemination.

To evaluate this issue more thoroughly, the transmitter networks in Ibn Babawayh's other works—as well as in broader Shi'i and Sunni sources—must be analyzed.

Overall, this research demonstrates that the application of SNA provides a comprehensive and structural depiction of the process of hadith transmission in *Kamal al-Din*. Such an approach can serve as an effective tool for scholars in hadith studies and historiography. Unlike traditional methods, which cannot easily capture transmitter relationships at the macro level, this method enables such analysis. Social Network Analysis at this scale reveals important structural features and offers a deeper understanding of the scope of hadith dissemination. In addition, it provides objective and quantitative criteria for evaluating and ranking transmitters. Extending this analysis to Ibn Babawayh's other works in the future can further clarify the role of these transmitters across different hadith compilations and contribute to a deeper understanding of religious traditions in Islamic societies.

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Notes

1 *Ilm al-rijāl* (biographical evaluation) is the traditional Islamic discipline concerned with assessing the reliability of hadith transmitters, focusing on their character, credibility, and scholarly connections.

2 *Al-Kāfī* is the most comprehensive Shi'i hadith collection by al-Kulayni (d. 941 CE), consisting of three sections—*al-Uṣūl*, *al-Furū'*, and *al-Rawḍa*—covering theological, legal, and ethical narrations.

3 The term *ḥujja Allah* ("divine proof") denotes the person who embodies God's authority on earth. In Shi'i theology, it refers to the Imam whose existence is seen as necessary for the preservation of religion and divine guidance.

4 An early Shi'i sect that emerged after the martyrdom of Imam Husayn b. 'Ali (680 CE), attributing the imamate to Muhammad b. al-Hanafiyya.

5 A Shi'i faction that halted the line of the Imamate with the seventh Imam, Musa al-Kazim (d. 799 CE), rejecting the legitimacy of his successors.

6 A Shi'i branch tracing the imamate to Zayd b. 'Ali (d. 740 CE), emphasizing uprising against unjust rulers and maintaining theological proximity to Sunni jurisprudence.

7 In biblical tradition, he is generally identified with Enoch.

8 He is often compared to biblical figures such as Shelah or Melchizedek, though no direct counterpart is explicitly established in the Bible.

9 *Sahih Muslim*, compiled by Muslim b. al-Hajjaj (d. 875 CE), is one of the two most authoritative Sunni hadith collections, renowned for its rigorous criteria of authenticity.

10 *Sahih Bukhari*, compiled by Muhammad b. Isma'il al-Bukhari (d. 870 CE), is widely regarded as the most authentic Sunni hadith collection and a foundational source in Islamic jurisprudence and theology.

11 Salmannejad, Morteza. and Shahbazi, Amin. 2025. "Methodical Interdisciplinary Approach in Contemporary Islamic Hadith Studies: A Case Study of Social Network Analysis of Hadith Narrators in 'Elal al-Sharayee". *Islamic Studies and Quranic Research in the Contemporary World*, 4(1): 169-197. doi: 10.22034/iscw.2025.2054206.1146

12 The *ashāb al-ijma'* ("consensus transmitters") are a group of early Shi'i hadith transmitters identified in the *rijāl* tradition as unanimously reliable. Later Shi'i scholars considered their narrations authoritative without the need for further evaluation of their chains of transmission.

13 The *al-ghayba al-ṣughra* ("Minor Occultation," 874–941 CE) refers to the first phase of the occultation of the Twelfth Imam in Shi'i belief, during which the Imam was hidden from the public yet maintained contact with his followers through four successive agents (*nuwwāb*).