Araştırma Makalesi / Research Article

Analysis of Book-borrowing Network using Complex Network Analysis

Volkan TUNALI[1*], Candan TÜMER[2]

[1]*Maltepe University, Department of Software Engineering, Istanbul*
[2]*Ardahan University, Department of Computer Technologies, Ardahan*
(ORCID: 0000-0002-2735-7996) (ORCID: 0000-0002-9592-7110)

Abstract
In this study, we analyzed the book-borrowing network that we constructed from the database of the libraries of Ardahan University by using complex network analysis techniques. After the construction of the bipartite reader-book relationship network, we constructed reader-reader and book-book networks via one-mode projection. We performed an exploratory complex network analysis on these networks. We found that both networks revealed scale-free and small-world network properties like most real-world networks from diverse origins and of diverse sizes. In addition, we identified the most central books in the book-book network using several centrality measures. These were generally the works from both Turkish and world literature that were in the reading lists of many readers. We also performed community analysis and identified the communities embedded in the networks visually. We identified and presented the essential genres of the books inside the communities of the book-book network.

Keywords: Network Science, Complex Network Analysis, Bipartite Network, Library.

Karmaşık Ağ Analizi Kullanılarak Kitap Ödünç Alma Ağının Analizi

Öz
Bu çalışmada, karmaşık ağ analizi teknikleri kullanarak, Ardahan Üniversitesi kütüphanelerinin veritabanından oluşturduğumuz kitap ödünç alma ağını analiz ettik. İki parçalı okuyucu-kitap ilişkisi ağını oluşturduktan sonra, tek modlu projeksiyon ile okuyucu-okuyucu ve kitap-kitap ağlarını oluşturduk. Bu ağlar üzerinde keşif türünden bir karmaşık ağ analizi gerçekleştirdik. Farklı kökenlerden ve farklı büyüklüklerde çoğu gerçek-hayat ağı gibi, her iki ağın ölçekten-bağımsız ve küçük-dünya ağı özellikleri sergilediğini gösterdik. Ek olarak, çeşitli merkezilik ölçütleri kullanarak, kitap-kitap ağındaki en merkezi kitapları tespit ettik. Bunlar genellikle pek çok okuyucunun okuma listesinde yer alan hem Türk hem de dünya edebiyatından eserlerdi. Ayrıca, topluluk analizi gerçekleştirdik ve ağda yerleşik toplulukları görsel olarak tespit ettik. Kitap-kitap ağındaki topluluklarda yer alan kitapların temel türlerini belirledik ve sunduk.

Anahtar kelimeler: Ağ Bilimi, Karmaşık Ağ Analizi, İki Parçalı Ağ, Kütüphane.

1. Introduction

University libraries are an important source of knowledge for university students and academics. Although there has been a rapid digital transformation in publications like e-books and other types of digital publications, physical book lending is still the most important service that university libraries provide to readers.

The book lending process generates very special kind of data where each book lending transaction links a specific reader to a specific book. Using these transactions, it is possible to create a book-borrowing network, which is a bipartite network. In this type of network, a reader is linked to one or more books that s/he has borrowed from the library, but s/he is not linked to any other reader. Similarly, a book is linked to one or more readers that have borrowed it, but it is not linked to any other

*Corresponding author: volkan.tunali@gmail.com
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book. Analysis of this kind of reader-book relationship requires special techniques, and can provide very precious insights about the readers and books in a macro scale.

Complex networks have been an active subject studied for more than two decades by network researchers from diverse fields including mathematics, physics, statistics, biology, computer science, and sociology [1]. Since the discovery of the small-world phenomenon by Watts et al. [2] and the proposal of the scale-free network model by Barabasi et al. [3] in the late 1990s, lots of empirical research have been conducted on networks in many domains, such as social [4, 5], economical [6, 7], technological [8, 9], and biological networks [10, 11]. These studies generally suggest that most real-world networks independent of their origin are complex networks with small-world and scale-free properties.

There are only a few studies in the literature that analyzed book lending process from a complex network analysis perspective. Li and Zhang topologically analyzed the bipartite book-borrowing network of library in Shangai, and they proposed a personal book recommendation system using the network data [12]. Yan et al. analyzed the factors that affected the book borrowing behaviors of readers using both network analysis and data mining techniques, using the book loan history of the library of Peking University [13]. In a very recent work, Han et al. studied the online reading behavior in university digital libraries via complex network analysis [14]. They showed that the degree distribution of their book-borrowing networks followed the exponential distribution, and that the small-world phenomenon was also observed in the networks.

In this study, we used complex network analysis tools and techniques to explore and analyze the book-borrowing network constructed from the database of the libraries of Ardahan University, a public university in Ardahan, Turkey. Complex network analysis renders possible the analysis of the data in terms of the global structure of linked entities as well as in terms of local individual entities. In addition, network visualization techniques allow us to analyze the data and perceive the patterns visually. We took an exploratory approach in this study to answer the following research questions:

RQ1: What are the statistical characteristics of the reader-reader and book-book networks constructed from the book-borrowing network?

RQ2: Do these networks exhibit scale-free property?

RQ3: Is small-world phenomenon observed in these networks?

RQ4: Can we identify the most important book titles in book-book network?

This paper is organized as follows. In Section 2, we give the details of the material and the method we used for our study. In Section 3, we present and discuss our findings. Finally, we conclude the paper and give some directions for future research in Section 4.

2. Material and Method

Our research methodology consists of three distinct phases: data collection, network modeling and construction, and complex network analysis. Details of each phase are given under their respective sub-sections in this section.

2.1. Data Collection

The data used in this study were obtained as a single Microsoft Excel file from the library database of Ardahan University, a public university in Ardahan, Turkey. The data file contained 48,806 book lending records of six different libraries of the university from February 2010 to November 2018. Each record contained fields like Library ID, Reader ID, Book ID, Borrow Date, Return Date, Book Title and Author Info, and some other fields related to the lending process. In the data, there were 4,588 unique Reader IDs and 17,183 unique Book IDs. This means that a reader borrowed 10.64 books on the average, and a book was borrowed 2.84 times on the average. From these data, we extracted only Reader ID and Book ID fields, which were the only data pieces to construct a bipartite network structure.

2.2. Network Modeling and Construction

The book borrowing relationship between readers and books can be modeled as a bipartite network (R-B network) where the network has two types of nodes rather than one. Here, for example, the network

has reader nodes and book nodes, and readers are linked to books that they have borrowed. However, in this type of network, no reader is linked to any other reader, and similarly, no book is linked to any other book. Such networks are also called two-mode networks [15]. Most complex network analysis techniques are not directly applicable to two-mode networks, and therefore, a two-mode network is usually projected onto two one-mode networks by a process called one-mode projection [16]. Then, the one-mode networks are analyzed separately.

In a one-mode network, all nodes are of the same type. For example, from a book-borrowing bipartite reader-book (R-B) network, we can create a reader-reader (R-R) network containing only the reader nodes, where two reader nodes are linked by an edge if they have read at least one same book. Similarly, we can create a book-book (B-B) network containing only the book nodes, where two book nodes are linked by an edge if they both have been read at least by one same reader.

First, we created the bipartite R-B network from the extracted Reader ID and Book ID pairs. Then, we created the R-R and B-B networks using one-mode projection. Both R-R and B-B networks had 284 connected components most of which had only 1 to 2 nodes. The existence of these singletons in the projected R-R network indicates that there are some readers who have borrowed some books that nobody else has ever borrowed from the library, and therefore these readers are not connected to any other reader over a book. Similarly, the existence of very small components indicates that there are a few readers who have borrowed only some specific books that have not ever been borrowed by the rest of the readers, and therefore these readers form the isolated and disconnected components of the whole network. A similar inference can be made for the singletons and very small components in the B-B network as well. For example, there are some books that have been borrowed by readers who have never borrowed any other book from the library, and therefore these books are not connected to any other book over a reader. Following the common approach in network analysis, we simply ignored the small components and extracted only the giant components of the networks for further analysis. Therefore, after this filtering, the R-R network had 4,244 nodes instead of 4,588, and the B-B network had 16,731 nodes instead of 17,183.

2.3. Complex Network Analysis

Complex Network Analysis is a set of techniques that explore the statistics, the structure and the function of large and complex networks [16]. It uses theories and methods from several disciplines such as mathematics, physics, statistics, computer science, and sociology. A complex network analysis study usually comprises the following steps once a network representation of the complex phenomenon of interest is produced. First, the network is visualized and patterns are sought out visually. Then, the topological analysis is carried out to understand the general characteristics of the network as a whole. For instance, structural measures like node degree distribution, clustering coefficient, average path length, and diameter provide us with important information about the network. Third, centrality analysis is performed, where structurally the most central and important nodes are identified. Finally, community analysis is applied to reveal the transitive relationships between nodes to detect the clusters in the network [17].

3. Results and Discussion

Using the above mentioned network analysis tools, we analyzed the R-R and B-B networks in four distinct phases. First, we visualized the networks to see their general structure and layout. Then, we performed topological network analysis on the networks. Next, centralities of the nodes were analyzed. Finally, we tried to reveal the communities embedded in the networks.

3.1. Visual Analysis

In complex network analysis, the network is visualized using an appropriate layout algorithm that enables one to see the organization of the nodes and their relationships with each other as clearly as possible. Accordingly, we visualized the R-R and B-B networks using Yifan Hu layout algorithm, which is a fast and effective force-directed layout algorithm that usually produces a clear view of the network. The visualizations of the networks are shown in Figure 1. The nodes were colored according to the

community they belonged to. Details of the community analysis is given in Section 3.2.5. Additionally, the nodes were resized proportionally to their degrees.

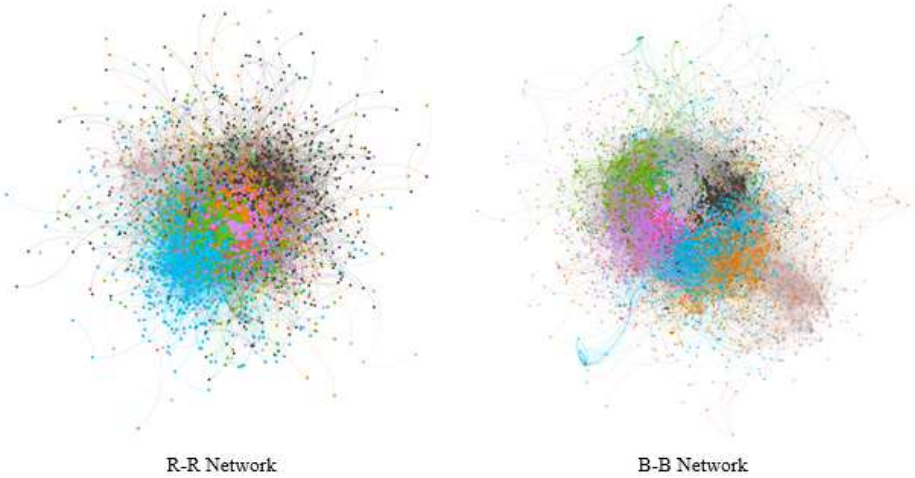

Figure 1. Visualizations of R-R and B-B Networks

3.2. Topological Analysis

3.2.1. General Topological Measures

We obtained the general topological measures of the R-R and B-B networks, such as clustering coefficient, characteristic path length, density, and diameter. These measures are presented in Table 1.

Table 1. Topological measures of the R-R and B-B networks

Measure Name	R-R	B-B
Nodes	4,244	16,731
Edges	103,562	790,210
Clustering coefficient	0.45	0.734
Characteristic path length	2.872	2.923
Density	0.012	0.006
Avg. num. of neighbors	48.804	94.461
Diameter	9	9

Clustering coefficient is the measure of the degree to which nodes in a network show tendency to form dense groups together called clusters [2]. It takes a value between 0 and 1, and a higher value indicates that the high density of links is due to the clusters rather than being established randomly. Characteristic path length is the average of the shortest path lengths for all possible pairs of nodes in the network [17]. Clustering coefficient and Characteristic path length values in Table 1 are interpreted in Section 3.2.3 with respect to small-world phenomenon.

Density of a network is the ratio of the number of existing edges (links) in a network to the number of possible edges considering all pairs of nodes [17]. The density values in Table 1 show that both R-R and B-B networks are highly sparse. This is the indication that readers on the average have only borrowed a very small subset of all the books that the rest of the readers have borrowed. Therefore, readers are connected to only a small number of other readers. Similarly, books on the average have only been borrowed by a very small subset of all the readers that have borrowed the rest of the books. Thus, books are connected to only a small number of other books. The values of Average number of neighbors per node given in Table 1 support these findings.

Diameter of a network is defined as the shortest distance between two most distant nodes in the network [17]. It usually gives a general idea about the connectedness of the network. In general, as a network becomes larger and denser, its diameter becomes smaller due to the construction of shorter paths as new edges are added between nodes. Both R-R and B-B networks have a relatively small

diameter value of 9, which means that any two readers or any two books can be linked to each other over 9 edges at most.

3.2.2. Scale-free Analysis

We created the degree distribution charts of the networks shown in Figure 2 and fit the distributions with Power Law distribution [17, 18]. According to Power Law, the probability of a node that has degree k (p_k) is defined by the relation $p_k = ak^{-b}$, where b is the Power Law Scaling Factor, and a is the Power Law Intercept. In network analysis, for a network to have scale-free property, it is usually expected to have a scaling factor in the range $1 \leq b \leq 3$ [19]. Scaling factors for Power Law distributions of the R-R and B-B networks are found 1.220 and 1.426, respectively.

Visual inspection of the degree distribution charts and the values of scaling factors suggest that the networks exhibited Power Law degree distribution. This distribution is usually observed in most real-world networks regardless of the type and size of the network [17]. It also indicates that most of the nodes have a relatively low degree (number of neighbors) while a few nodes have a very high degree. We showed that the R-R and B-B networks had the scale-free property [3].

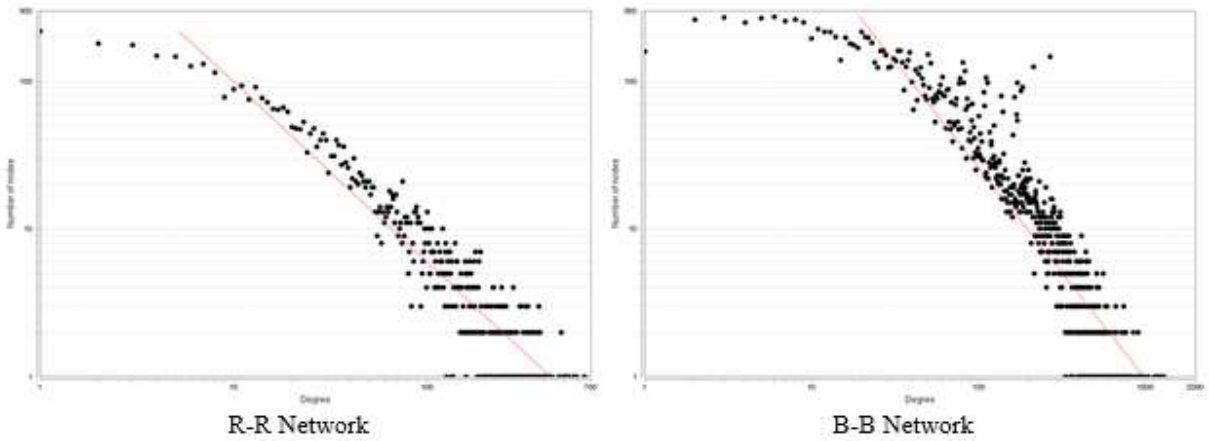

Figure 2. Degree distribution charts of R-R and B-B networks

3.2.3. Small-world Analysis

Besides being scale-free, most real-world networks are known to be small-world, which means that they show a higher clustering than random networks and they have a very short average path length independent of their size [2]. In order to check the existence of small-world characteristics in the R-R and B-B networks, we artificially generated 10 different Erdös-Rényi [20] random graphs for each network with the same number of nodes and edges as each one. The steps to generate a corresponding Erdös-Rényi random graph for a network with N nodes and M edges are as follows. First, the graph with N nodes without any edges is created. Then, an edge is created between a pair of nodes (that are not already connected by an edge) picked at random, until the graph has M edges in total. As a result of this process, a random graph with N nodes and M edges is obtained. After generating the random graphs, we compared the mean values of the topological analysis results of these corresponding random graphs to the results of our original networks. Table 2 shows the comparisons.

Table 2. Clustering coefficient and characteristic path length comparison

	Clustering coefficient		Characteristic path length	
Network	R-R	B-B	R-R	B-B
Original	0.450	0.734	2.872	2.923
Random	0.012	0.006	2.553	2.578

For both networks, corresponding random graphs had much lower clustering coefficient values as expected. Moreover, characteristic path lengths of the corresponding random graphs were very close considering the size of the graphs. These findings were consistent with the general expectation as it is a

well-known fact that random networks do not exhibit the high clustering of real-world networks but short characteristic path length is a common behavior of both real-world and random networks. As a result, we showed that the R-R and B-B networks presented small-world characteristics.

Additionally, the degree distributions of the random graphs were far from Power Law; they were Poisson actually as expected as a result of random edge addition between nodes. When compared to the random graphs in terms of these three characteristic properties, we finally inferred that the R-R and B-B networks under study were far from randomness. This is not surprising because readers do not borrow books from libraries at random. Instead, they decide to borrow books depending on their study needs and reading tastes.

3.2.4. Centrality Analysis

In this stage of the network analysis, we obtained degree, closeness, and betweenness centralities of the nodes in the B-B network only because reader names were not available in the book lending Excel file, most central Reader IDs would not make sense to find. Thus, we limited our centrality analysis to the B-B network as we could match Book IDs with book titles. Degree, closeness, and betweenness centralities are the most commonly used ones that usually give useful insights about the relative importance of nodes in the network [17]. Degree Centrality of a node is simply the number of neighbors of that node. A node with high number of neighbors or connections can be considered important. Closeness Centrality determines how close a node is to all other nodes in a network by measuring the sum of the shortest paths between that node and all others. According to this definition, a node with a high closeness centrality value is important and valuable because it can reach the whole network more quickly than the others. Betweenness Centrality calculates the relative importance of a node by measuring the amount of shortest path traffic that flows through that node to other nodes in the network. A node with a high betweenness centrality value is considered important because its position in the network gives it a relatively higher power to control the information flow in the network. To sum up, the higher the centrality value, the more central a node is. Top 20 book titles are ranked by their degree, closeness, and betweenness centralities in Tables 3, 4, and 5 respectively.

Whereas different centrality measures calculate the importance of nodes from different perspectives, we usually see that their results support each other. The same thing also proves to be true in our analysis. We see that 13 books appear in all centrality tables. These books are emphasized in the tables with boldface font. We also see that classicals from both Turkish and world literature have appeared in the reading list of many readers consistently.

Table 3. Top 20 books by their degree centralities

Rank	Book Title	Degree
1	**Kürk Mantolu Madonna, Sabahattin Ali**	1,294
2	**Şiir tahlilleri 2, Mehmet Kaplan**	1,260
3	**Sevme sanatı, Erich Fromm, çev. Özden Saatçi-Karadana**	1,257
4	**Tutunamayanlar, Oğuz Atay**	1,202
5	**Hayvan çiftliği: bir peri masalı, George Orwell, çev. Celal Üster**	1,164
6	**Simyacı, Paulo Coelho, çev. Özdemir İnce**	1,136
7	**Bin dokuz yüz seksen dört, George Orwell, çev. Celal Üster**	1,048
8	Türk mitolojisi, Bahaeddin Ögel	977
9	**Aşk, Elif Şafak, çev. K. Yiğit Us**	975
10	**Türk mitolojisinin anahatları, Yaşar Çoruhlu**	969
11	20. Yüzyıl siyasi tarihi: 1914 - 1995, Fahir Armaoğlu	963
12	**Benim adım kırmızı, Orhan Pamuk**	944
13	Keşfedilmemiş benlik, C. G. Jung, çev. Barış İlhan, Canan Ener Sılay	917
14	**Dede Korkut Kitabı, Muharrem Ergin**	914
15	Batı edebiyatında edebi akımlar, İsmail Çetişli	906
16	**Şah ve Sultan, İskender Pala**	895
17	Yeni Türk Edebiyatı: 1839-2000 : El Kitabı, Ed. Ramazan Korkmaz	882
18	Beyaz gemi, Cengiz Aytmatov, çev.Refik Özdek	848
19	Şiir tahlilleri 1, Mehmet Kaplan	848
20	**Bozkurtlar : Birinci Kitap Bozkurtların ölümü**	831

Table 4. Top 20 books by their closeness centralities

Rank	Book Title	Closeness
1	**Kürk Mantolu Madonna, Sabahattin Ali**	0.47470
2	**Sevme sanatı, Erich Fromm, çev. Özden Saatçi-Karadana**	0.47017
3	**Simyacı, Paulo Coelho, çev. Özdemir İnce**	0.46994
4	**Hayvan çiftliği: bir peri masalı, George Orwell, çev. Celal Üster**	0.46744
5	**Tutunamayanlar, Oğuz Atay**	0.46741
6	**Aşk, Elif Şafak, çev. K. Yiğit Us**	0.46643
7	**Bin dokuz yüz seksen dört, George Orwell, çev. Celal Üster**	0.46505
8	**Şiir tahlilleri 2, Mehmet Kaplan**	0.46295
9	**Şah ve Sultan, İskender Pala**	0.45858
10	Beyaz gemi, Cengiz Aytmatov, çev.Refik Özdek	0.45803
11	**Benim adım kırmızı, Orhan Pamuk**	0.45725
12	**Bozkurtlar : Birinci Kitap Bozkurtların ölümü**	0.45672
13	**Dede Korkut Kitabı, Muharrem Ergin**	0.45651
14	Batı edebiyatında edebi akımlar, İsmail Çetişli	0.45629
15	**Türk mitolojisinin anahatları, Yaşar Çoruhlu**	0.45627
16	Anayurt oteli, Yusuf Atılgan	0.45536
17	Şeker Portakalı, J. Mauro de Vasconcelos, çev. Aydın Emeç	0.45472
18	Ruh adam, Hüseyin Nihal Atsız	0.45448
19	Keşfedilmemiş benlik, C. G. Jung, çev. Barış İlhan, Canan Ener Sılay	0.45442
20	İçimizdeki Şeytan, Sabahattin Ali	0.45418

Table 5. Top 20 books by their betweenness centralities

Rank	Book Title	Betweenness
1	**Simyacı, Paulo Coelho, çev. Özdemir İnce**	0.00905
2	**Tutunamayanlar, Oğuz Atay**	0.00877
3	**Kürk Mantolu Madonna, Sabahattin Ali**	0.00853
4	**Aşk, Elif Şafak, çev. K. Yiğit Us**	0.00799
5	**Dede Korkut Kitabı, Muharrem Ergin**	0.00681
6	**Şiir tahlilleri 2, Mehmet Kaplan**	0.00674
7	**Sevme sanatı, Erich Fromm, çev. Özden Saatçi-Karadana**	0.00643
8	**Hayvan çiftliği: bir peri masalı, George Orwell, çev. Celal Üster**	0.00640
9	Aşkın gözyaşları I, Tebrizli Şems, Sinan Yağmur	0.00615
10	Soğuk kahve, Ahmet Batman	0.00544
11	Şeker Portakalı, J. Mauro de Vasconcelos, çev. Aydın Emeç	0.00541
12	Türk mitolojisi, Bahaeddin Ögel	0.00519
13	**Bin dokuz yüz seksen dört, George Orwell, çev. Celal Üster**	0.00517
14	**Türk mitolojisinin anahatları, Yaşar Çoruhlu**	0.00450
15	20. Yüzyıl siyasi tarihi: 1914 - 1995, Fahir Armaoğlu	0.00430
16	**Şah ve Sultan, İskender Pala**	0.00405
17	**Bozkurtlar : Birinci Kitap Bozkurtların ölümü**	0.00400
18	Uçurtma Avcısı, Khaled Hosseini, çev. Püren Özgören	0.00396
19	**Benim adım kırmızı, Orhan Pamuk**	0.00382
20	Dönüşüm, Franz Kafka, çev. Ahmet Cemal	0.00374

3.2.5. Community Analysis

In this final stage of the complex network analysis, we simply identified the dense groups of nodes called communities (or clusters) in the R-R and B-B networks using the Louvain algorithm, which employs a technique called Modularity Optimization [21]. We applied this operation with its only parameter resolution set to its default value of 1.0. Identified communities can be seen with distinct colors of nodes in the network visualizations in Figure 1. There are 13 and 22 communities in R-R and B-B networks, respectively. Clusters of readers may be interpreted as groups of readers with similar study needs or reading tastes as readers were linked together if they have borrowed at least one same book. Likewise, clusters of books may be interpreted as groups of books with similar and/or related genre as books were linked together if they have been borrowed by at least one same reader. For the

same reason in centrality analysis, we limited our community analysis to the B-B network. Properties of the identified communities in the B-B network are given in Table 6.

Table 6. Communities in the B-B network

Community Id	Size	Apparent Genres
1	4,618	Mixed, predominantly Turkish and world literature, poetry
2	1,991	Ottoman and Turkish history
3	1,955	Management, law, education
4	1,047	Management, law, education
5	982	Mixed, history, education, Turkish and world literature
6	772	Highly mixed, no apparent genre
7	733	Turkish literature, poetry
8	589	Science, medicine, Turkish and world literature
9	512	Turkish and world literature, mythology
10	500	Poetry
11	410	Technology, predominantly Turkish and world literature
12	356	Ottoman and Turkish history
13	330	Social sciences, philosophy, psychology, education
14	325	Ottoman and Turkish literature, poetry
15	290	Social sciences, history
16	284	Ottoman literature, history, mythology
17	237	Mixed, predominantly Turkish and world literature, poetry
18	228	Social sciences, management
19	218	Mixed, predominantly Turkish and world literature
20	129	Science, mathematics
21	128	Ottoman history
22	97	Ottoman literature, history

Because the identified communities were mostly dominated by books of Turkish and world literature, it was very difficult to assign specific genres to them. Despite this, some of the communities had books from apparently specific genres like science and maths, social sciences and history, and so on.

4. Conclusion and Future Directions

In this study, we analyzed the book-borrowing network constructed from the database of the libraries of Ardahan University by using complex network analysis techniques. After the construction of the bipartite reader-book relationship network (R-B), we constructed reader-reader (R-R) and book-book (B-B) networks via one-mode projection technique. Once the R-R and B-B networks were available, we explored and analyzed them both visually and topologically.

When we investigated the degree distributions of the networks both visually and analytically, we observed Power Law distribution in both of them, as observed in many real-world networks regardless of their origins and sizes. It could be said that R-R and B-B networks were scale-free networks.

We also examined the existence of small-world property in the networks by comparing some topological features of them with those of the corresponding random graphs that we artificially generated. Consequently, we showed that the R-R and B-B networks were small-world networks.

In a further analysis, we identified the most central (or important) books in the B-B network by calculating degree, closeness, and betweenness centralities of the nodes. According to centrality rankings, 13 books appear in all top 20 lists. These books are highly popular works from both Turkish and world literature, which were in the reading list of many readers.

For the analysis of communities embedded in the networks, we used the Louvain algorithm and identified the community of readers and community of books visually. Besides, we analyzed the genres of books inside the communities of the B-B network.

Among the studies presented in the introduction, the one by Han et al. was the closest study to ours in terms of the study objectives and the applied methodology [14]. Dividing the book borrowing data into school years, they constructed and analyzed five different R-R and B-B networks. They showed that the degree distributions of their networks followed the exponential distribution rather than the Power Law distribution, and that the small-world phenomenon was also observed in the networks. From this point of view, our findings are similar to theirs. Their work, on the other hand, did not present a detailed centrality and community analysis.

Analysis of book lending processes of libraries from several different perspectives like business intelligence, data mining, and complex network analysis has the potential to provide significant insights to improve these processes for service quality and reader satisfaction. For example, number of printed books per title or per genre could be optimized depending on the reader expectations and reading tastes. In addition, library services could be extended to recommend books to readers using the identified reader communities with similar reading tastes or some other advanced recommendation techniques as many online e-commerce systems do.

In this research, only the Reader IDs and Book IDs were available for constructing the reader-book relationship bipartite network. It would be possible to create several different projected networks if there were more data about the readers like their faculties/schools, departments/programmes, degrees, etc., and about the books like their categories, sub-categories, genres, etc. Analyzing these networks, it would be possible to bring to light several important patterns and relationships regarding the reading behaviors of the readers.

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Author's Contributions

All authors contributed equally to the study.

Statement of Conflicts of Interest

There is no conflict of interest among the authors.

Statement of Research and Publication Ethics

The authors declare that this study complies with Research and Publication Ethics.

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