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Understanding the Usage Characteristics of Twitter in the UK Universities: A Social Network Analysis (SNA) Approach

Ufuk BAKAN¹, Uğur BAKAN², Turgay HAN³

Abstract

The rate of use of social media platforms such as Facebook, Twitter, and LinkedIn has increased drastically over the last decade. Twitter is the eighth most popular website in the world, with an average of nearly eleven million hits a day. Twitter may be used for synchronous and asynchronous online conversations, asking and answering questions, and sharing opinions, ideas, and resources. Twitter also offers a platform for quick communication that could play a role as a catalyst for the learning process. This paper presents an investigation into the use of the Twitter social media platform by selected top universities in UK. Twitter data from that account in the 1-year period was captured. First was coded, the total number of tweets, like ranking, usable (non-spam) tweets, the number of retweeted, hashtags and tweets on the official Twitter accounts of selected universities. In this study, NodeXL program was visualized and analyzed by drawing the data from Twitter. As such data sets of no more than 2,500 tweets were gathered for each search topic. After 60 years of experience with computer-based text analysis approaches can be used to define rule-based classification, theme extraction, ontology/taxonomy modeling, topic categorization and document summarization. Statistics (degree and weighted degree, centrality statistics, network diameter, graph density, average path length) were then calculated for each node and for the network using the statistical module of NodeXL. The data were visualized using Fruchterman-Reingold and Harel-

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Koren Fast Multiscale algorithms as shown in the figures below. The implications of this finding are discussed.

Keywords: *Social Network Analysis; Twitter; UK, high education*

1. Introduction

Many information is produced for the first time or re-produced by new masses and non-institutionalized groups in the virtual platform with the assistance of various tools that are provided by social media. Social networks are carried to an effective level thanks to provision of information rapidly and easily, particularly with the introduction of internet to our life. The opportunity to share information, which is considered as the most valuable resource today, easily particularly with the development of internet allows social networks to extend rapidly and to become stronger economically. Social networks have become a field, on which media domain has the highest level of interaction and affect, with the development of digital technologies. Social networks, which constitutes the next step of internet can be considered as the most an important invention of 21st century, in the process of virtual socialization, and network theories that are developed to allow us to understand structure of such networks, their functions and theoretical framework of operating structures are endeavoured to be explained in connection with the characteristics of the social structure that constitutes social networks. These networks present opportunities to constitute new links and information clusters by forming a common area for interaction and cooperation between group members. Social networks are dynamic structures, and type and power of the relationship between components are determinant.

The social network analysis method used in social sciences is also used to examine the studies on a subject and to create a network of knowledge on the subject [15], [29]. In general, social network analysis refers to analysis of behaviours that occur in the face of individual and social variables by reviewing relations between individuals involved in the network on individual and social scale. Main area of interest of social network theory is to reveal how social structures facilitate and limit opportunities, behaviours and meanings. This type of analysis constitutes a conceptual structure by considering social dynamics within the framework of an integrated approach and by modelling mathematically network links and network members, which are owned individually and jointly by individuals, and characteristics and structures of the links established with these members [33].

Social network analysis is a quantitative method that is used in determination of the characteristics of social actors, and definition and visualization of the structures between actors [37]. In the early to mid-1990s, there has been an explosion of interest in networks and network-based approaches to modeling and analysis of complex systems [19]. Network theory uses graphic theory and statistical analysis techniques, which are listed among the branches of mathematics. Social network analysis methods generally operate by transforming graph models available in the social network to matrices. In addition to these methods, various other standard identifier statistical techniques are used to identify and assess social network data, such as univariate analysis, bivariate analysis or multivariate analysis etc. [10]. A graph is comprised of edges and links available between those edges. When we adapt graph theory to social network analysis, edges of a graph are considered as the actor and lines available between those edges are considered as the correlation between actors. Networks, which model the structure that lies beneath complex systems, are comprised on nodes and internode connections. The adjacency matrix for a graph with n vertices is an $n \times n$ symmetric matrix whose (i, j) th entry is 1 if vertices i and j vertices are connected, and 0 otherwise [40]. Information that may be obtained on nodes and internode connections is related with the concepts of distance, connectivity and centrality. Associative links between actors are considered as carriage of resources between actors or channels that enable circulation of the same.

Unlike statistics, the social network analysis deals with the links between the nodes and not the properties of the nodes. In addition, social network analysis has an important place in the formation of information network structure related to a certain discipline and in the examination of the change and development of the discipline over the years. There are specific conceptual classifications, in which these measurements are determined and applied. These measures are classified as power, degree (number of connections it connects to the network) and effect (connection values) of a node (actor) and betweenness and closeness [21: 25]. Centrality concept is known as the most critical variable of social network measurement methods. Degree centrality of a unit indicates the number of connections that such unit has. In cases where incidents are directed, the number of in-degrees and out-degrees are calculated separately [6]. Degree centrality is a calculation algorithm based on the number of ties to a particular node [36]. If any individual has a high level of centrality score, he/she may be determined as the most popular person, who has the highest number of connections with other actors in a group in the network, and on the contrary, individuals, who have a low score, may be determined as

individuals, who are left out of the group [26]. This calculation method, which is considered as the simplest and most critical value among centrality measurements, is considered as the measure that show the importance and activities of the actor most certainly. Closeness Centrality is the average value of the shortest distances to all other nodes in the network [34]. Closeness centrality location of a node is equal to the total distance from other nodes to relative node (graph). In the meantime, closeness is the total of the reverses of the shortest distances of any unit from other units in the network. Closeness centrality ensures subjective independency in the network, and it also reflect how fast a unit may connect to other units in the network at the point of early access and intelligence. Betweenness Centrality is an indicator of how many shortest paths between all members of the network pass through a particular node [8: 35]. The concept of betweenness centrality is concerned with how the relations between binary elements, which are not connected directly, are controlled by other actors or how they are directed. Betweenness centrality considers extreme information change in a network or control of the flow of funds as a critical indicator [17: 68]. Betweenness centrality allows one to quantify how highly connected an individual may be to others in the network, whether through direct or indirect interaction [28: 13]. Critical measures of betweenness link are density of nodes, closeness to a central location, intra-network flows and connection points, nodes that ensure controlling information, power to interfere in others relations, and connections that connect coordinatorship. Betweenness centrality is used to determine the most critical and strategic actors in a network. This measure may be interpreted as the characteristic of a node to connect the clusters available in a network.

2. Research into Social Networking Analysis on Education

Researchers have used social network analysis for different purposes in education. In 1930-1970s, studies that were conducted by sociologists on networks were mostly focused on built-in networks available in the business and industrial world [9]. In the study by Chang, Chang, Hsu and Chen [4], the idea leaders in the group were provided with the help of social network analysis. In a research that was conducted to determine research trends and subjects in medical education, 9379 research articles that were published between 1963-2005 are analysed by social network analysis. The study realistically contemplated the abstract knowledge network of medical education by identifying the network trends in medical education research topics through the use of SNA a [16]. Although there are many studies on the

technological aspect of social media, there are few studies to determine whether there is a relationship between social media and student participation in higher education. SNA research in online learning has grown large enough that synthesis and meta-analyses are available in literature [3], [13], [39]. One of the studies focused on this field, Junco and his colleagues examined college students' use of Twitter. The sample of this study consisted of 125 students. Seventy persons were the experimental group and fifty persons were the control group. Unlike the control group, Twitter was used as a communication tool in the academic and curriculum discussions between the experimental group. It was concluded that the experimental group had higher grade scores compared to the control group and a significant increase in participation [17].

In a study conducted by Yu et al. [38], potential benefits of social networks in education are defined. This study reveals the underlying mechanism that online social networking needs to go through to impact individuals' learning Outcome [38]. In one of the studies that were conducted on social network analysis in the field of education, data comprised of 5793 political documents dated to the period between 1973-2013 are analysed in China by social network analysis method [12]. Transformation to education policies and development are analysed according to the results. In another study, compared with the traditional university marketing channels in the Netherlands, a study was conducted to determine the role and importance of social media on the choice of education and university for future students [5]. Very little is known about the potential of network-based social media applications in higher education marketing strategy. Next, to this the study identifies and describes three market segments among future students based on their use of the social media [5]. In another study on social network analysis, Saq et al. investigated the potential of using social network analysis in monitoring online collaborative learning, finding gaps and pitfalls in the application, and the possibility of guiding an informed intervention [30]. In a study conducted by Tobias [35], factors that prevent adults from participating to life time education are analysed, and various solutions are suggested to get over such impediments.

3. Twitter as a Social Media Platform

Social networking sites are defined by users' ability to maintain a profile, connect with other users, and trace the networks of connected users within the system [1]. Web-based social networks present various

opportunities to users by the options of easy access and multi connections. Millions of people living and working in different continents and countries make production by meeting on a common platform in virtual environment without knowing each other at all. Blogs, discussion forums, music, video and file sharing websites, messaging boards, tagging and online news, micro blogs, social bookmarking, podcasts, digital books, virtual annuals and albums, wikis and e-mail groups are considered as the basic forms of social media. Social network websites are generally designed as tools that facilitate individuals to interact or share their opinions with each other within the framework of general purposes in the online environment [23]. Today, any complex system may be expressed as a network, i.e. from economy to biological cells, from politics to computer chips, and from transport systems to daily social relations [24]. It extends rapidly by being re-shaped in consideration of the conditions of the time. The rate of use of social media platforms such as Facebook, Twitter, and LinkedIn has increased drastically over the last decade. Among those social media platforms, Twitter is a free web service that primarily facilitates the exchange of short-form messages; a type of interactive format sometimes referred to as micro-blogging [14]. Launched in October, 2006, the growth in the popularity of the social network site Twitter is a short message service, or “micro-blogging” application, that allows users to broadcast real-time messages spanning a maximum of 140 characters. Twitter terminology users create messages known as “tweets”, which are posted on their profiles as well as to a live-streaming feed for the users’ followers. These tweets can be composed directly on the Twitter website, via a mobile device or application, or using a third party desktop application. The users who follow an account are called its *followers*. Followers receive every one of your messages in their timeline, a feed of all the accounts they have subscribed to. Becoming a follower on Twitter receives all of the messages (tweets) of the followed user [20].

4. Method

Social network analysis components are used when examining network formation. The method of gathering data for collecting, classifying, loading the matrices and obtaining the network visuals is of great importance. This paper presents an investigation into the use of the Twitter social media platform by selected top universities in the UK. We first gather information about selected universities official twitter accounts, total number of tweets, like ranking, usable (non-spam) tweets, number of retweeted (post another user’s post), Hashtags (The # symbol is used to

mark keywords or topics in a tweet) and tweets that forwarded information or media (photos and videos). Twitter data from that account in the 1-year period was captured. Details such as the tweets text, mentions, hashtags and URL's that may serve as a reference to support the user's argument. First was coded, the total number of tweets, like ranking, usable (non-spam) tweets, the number of retweeted, hashtags and tweets on the Twitter. Using Twitter's search function, the hashtags were entered and all results were found and the search was saved. The first stage was searched "#" the relevant keyword, such as 'The University of Cambridge', 'LSE', 'University of Glasgow', 'University of Manchester', 'University of Edinburgh', 'Imperial College', 'King's College', 'University of Oxford' on Twitter.

There are many network analysis and visualization software tools. In this study, NodeXL program was visualized and analyzed by drawing the data from Twitter. NodeXL has been widely used for collecting and analyzing social media networks in academia and in marketing [11], [32]. NodeXL is designed to enable Excel users to easily import, cleanup, analyze and visualize network data. NodeXL workbooks use edges, vertices, groups, and overall metrics to map relationships to produce graphs and charts so that a visual analysis of the data can be made [31]. As such data sets of no more than 2,500 tweets were gathered for each search topic. NodeXL extends the existing graphing features of the spreadsheet with the added chart type of "network", thus lowering the barrier for adoption of network analysis [31]. The most important feature of NodeXL is gathering online data from social networking sites such as Twitter, Facebook, Youtube, and others.

Descriptive calculations are made such as a number of nodes, connection (unidirectional, bidirectional, total). In addition, non-local centrism measures (degree, inter-intersection, proximity, and eigenvector) and local centrism measures (intensity, input grade, output rating) are calculated. The data were visualized using Fruchterman-Reingold and Harel-Koren Fast Multiscale algorithms as shown in the figures below. Each node in the networks shows a Twitter user. Twitter users (accounts) represent vertices, and the relationships among the Twitter users are edges. The Fruchterman-Reingold layout algorithm is the default algorithm of NodeXL that applies two criteria: connected vertices should be close, but two different vertices should not be too close [25]. Sentiment analysis has also been used for Twitter data. According to Liu [22] sentiment analysis or opinion mining is the computational study of opinions, sentiments and emotions expressed in text. With sentiment analysis, can be determined if the tweet was positive, negative or neutral.

5. Data Analysis

The aim of social network analysis is to examine the place of relations in social structure and the changes in time. Size of social relationship cluster refers to the number of persons contacted within social support network, and frequency and density of relationship. Sizes of established nodes are shaped by the character of units that establish the network and reason for establishment of the network. In consideration these graphs, one may guess weak and strong connections in a network, vital actors available in a network and actors, based on which the potential extension of the network may be made, In table 1, you may find information on the Twitter accounts of universities that are elected as the sample of this study. According to the data that indicate Twitter activity, the university that sends largest number of tweets is Glasgow University (n=17,2 k), and the university that sends the lowest number of tweets is Cambridge University. When we analyse distribution by number of followers, Oxford University is the university with largest number of followers (n=481 k), and The University of Manchester is the university with lowest number of followers (n=46,8 k).

Table 1. The Twitter Profiles of Eight Universities

| | Uni1 | Uni2 | Uni3 | Uni4 | Uni5 | Uni6 | Uni7 | Uni8 |
|-----------------|-------|--------|--------|--------|--------|--------|--------|--------|
| Tweets | 9595 | 15,3 k | 17,2 k | 13,7 k | 6762 | 12,3 k | 6779 | 14,2 k |
| Follow | 1087 | 1241 | 1,696 | 462 | 333 | 3233 | 1359 | 953 |
| Follower | 434 k | 75,6 k | 84,8 k | 46,8 k | 96,2 k | 86,3 k | 82,2 k | 481 k |
| Like | 2107 | 2055 | 16,2 k | 2037 | 768 | 7319 | 1126 | 7312 |

Uni1=CambridgeUni, Uni2=LSEnews, Uni3=UofGlasgow, Uni4=OfficialUoM, Uni5=edinburghuni, Uni6=imperialcollege, Uni7=kingscollegelon, Uni8=UniofOxford

Social networks extend by being shaped based on individual characteristics and group structures. Social network theories examine this development process and classify structures of social networks by determining mass principles. Various social network analysis statistics are used to determine the characteristics of actors, such as density, degree, centrality, distance, closeness, betweenness, clustering coefficient and structural spaces etc. Nodes (individuals, small groups or institutions) are components that move in the network and that affect the network. Links are structures that show the relations between nodes. Since individuals increase their statuses by these links, each new established link that shall be established must be considered as an opportunity [2]. In Table 2, you may

find various characteristics of universities on Twitter, such as nodes, links and degree etc. When we analyse the networks according to the social network analysis that is made, we may observe that King's College has the largest number of nodes ($n=1810$) and that The University of Manchester has the largest number of links ($n=5373$). Links between nodes become thicker as the number of links increase. Directional links available between these nodes indicate flow direction of the information obtained by data as a requirement of the social networking website. In graph theory, network density is found by dividing total potential links to the total number of links available in the network, and it is valued from 0 to 1 [7: 13]. When we assess densities available in the network, University of Oxford ranks in the first place (0,00274).

Table 2. Summary of Network Centrality Metrics of Eight Universities' Network Analysis

| Metrics | Uni1 | Uni2 | Uni3 | Uni4 | Uni5 | Uni6 | Uni7 | Uni8 |
|----------------------|---------|---------|---------|--------|---------|---------|---------|---------|
| Vertices | 855 | 1164 | 1698 | 1873 | 1810 | 1731 | 1877 | 1295 |
| Unique Edges | 830 | 2084 | 3014 | 3553 | 3475 | 2835 | 3508 | 2028 |
| Total Edges | 853 | 2600 | 4297 | 5373 | 4806 | 4502 | 5480 | 3281 |
| Single-Vertex | 49 | 19 | 14 | 18 | 30 | 44 | 26 | 14 |
| Density | 0,00105 | 0,00183 | 0,00118 | 0,0022 | 0,00227 | 0,00215 | 0,00230 | 0,00274 |
| Degree | 1,965 | 3,797 | 3,899 | 2,21 | 4,215 | 3,865 | 4,429 | 3,606 |
| In-Degree | 0,985 | 1,951 | 2,033 | 2,21 | 2,184 | 2,011 | 2,293 | 1,841 |
| Betweenness | 92,593 | 1565 | 2435 | 3000 | 2602 | 2298 | 3129 | 1877 |
| Closeness | 0,119 | 0,047 | 0,028 | 0,038 | 0,039 | 0,064 | 0,027 | 0,061 |
| Eigenvector | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 | 0,001 |

Uni1=CambridgeUni, Uni2=LSEnews, Uni3=UofGlasgow, Uni4=OfficialUoM, Uni5=edinburghuni, Uni6=imperialcollege, Uni7=kingscollegelon, Uni8=UniofOxford

When we analyse the structure of a network, centrality analysis is made in determination of relations between links. On the basis of these data, locations of twitters that constitute the rows of network participation are calculated according to these centrality measures. There are four types of centrality measures considered in this study: (1) Degree, (2) Closeness centrality, (3) Betweenness centrality, and (4) Eigenvector centrality. In Figure 1, you may find network view of this study, which may give an idea

on which of these nodes are closer to which centrality. In some of the links, it is a critical criteria to explain the strategic positions of nodes to have values that are close to centrality measures.

Degree centrality assesses actors quantitatively and independently. It aims to have an idea on the centrality of actors in the network by making a comparison according to the number of links that each actor has. Actors that have a high level of centrality in the network according to the measurement results of degree centrality are available in the centre of the network map. As the number of actors in a network increases, it becomes harder to give an answer to the question on the location of centrality. Since the increase in the number of links shall constitute a complex view, one may not find central node(s) by looking to the network map. When degree centrality results are analysed according to Table 2, King's College (4,429), Edinburgh University (4,215) and University of Glasgow (3,889) have the highest centrality. Nodes with the highest level of In-Degree indicate the person, tweet of whom is replied the most, tweet of whom is retweeted the most or who is mentioned the most in relative tweets.

Betweenness centrality may be analysed in directed and undirected networks, but adjacency matrix must be comprised of binary values. Main idea in determination of centrality based on betweenness is that the nodes available between two nodes are superior to others. When we analyse Table 2, we may observe that values are close to each other in the network established by selected universities. However, since the number of actors available in the network of Cambridge University is low, betweenness value is also low (92,593). Being localized between two nodes allows relative node to control various flows between nodes, such as information and source etc. Thus, by being localized between other nodes in the system, it allows nodes to be connected to each other. Nodes with high level of betweenness degree have a critical position in the network, and it ensures that other nodes available in the network are correlated.

Unlike other measures, closeness centrality deals with how much an actor is independent in the network. Indirect link numbers are also used in closeness centrality. In closeness centrality, unlike degree centrality, not only the number of direct links, but also the numbers of indirect links are considered. According to these analysis results, Cambridge University (0,119), Imperial College (0,064) and University of Oxford (0,061) have the highest values. A critical change is observed in impact listing by closeness centrality.

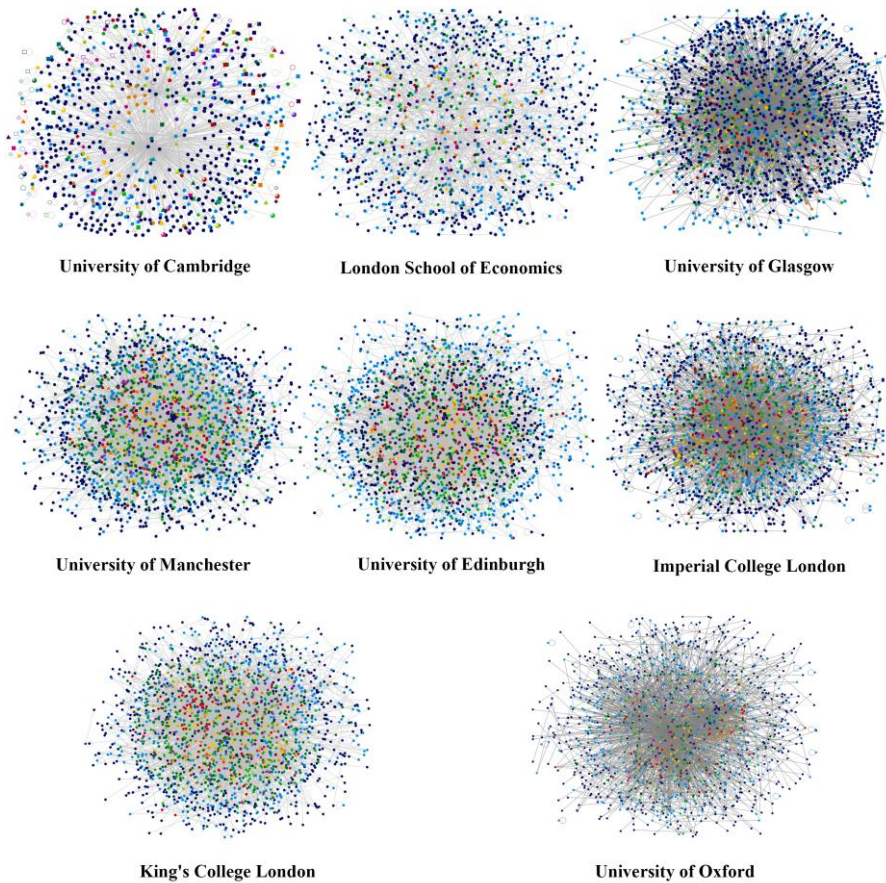


Figure 1. Network Visualization of Eight Universities' Network (Fruchterman-Reingold)

Sentiment analyses refer to methods that are used to eliminate positive, negative or subjective opinions from one or several texts in general. Today, all of the online data, particularly social media, may be subjected to sentiment analysis easily with the assistance of specific software. Scientific studies that are conducted in this field have gained a great momentum in connection with the increase of data in particular. There are two fundamental approaches in current scientific studies conducted in the field of sentiment analysis. These are sentiment analysis by mechanical learning and dictionary based sentiment analysis. In this study, Twitter is classified, based on a word-based approach, by considering whether it has any positive or negative interpretation or emotion. Words collected from the tweets

presented in Table 3 are analysed, and positive and negative words and their rates in total word group are determined. According to the results, tweets with the most positive content are available in the tweets of the University of Glasgow, University of Edinburgh and University of Manchester, and tweets with the most negative content are available in the tweets of the King's College, University of Oxford and LSE.

Table 3. Overview of Sentiment Analysis by Universities

| Words | Uni1 | Uni2 | Uni3 | Uni4 |
|--------------|--------------|--------------|--------------|--------------|
| | N (%) | N (%) | N (%) | N (%) |
| Positive | 437(0,25) | 637(3,13) | 1734(4,87) | 1319(3,7) |
| Negative | 31(0,02) | 210(1,03) | 244(0,69) | 290(0,81) |
| Total | 468(0,27) | 847(4,16) | 1978(5,55) | 1609(4,52) |

| Words | Uni5 | Uni6 | Uni7 | Uni8 |
|--------------|--------------|--------------|--------------|--------------|
| | N (%) | N (%) | N (%) | N (%) |
| Positive | 1605(4,43) | 1165(3,32) | 1134(3,23) | 602(3,25) |
| Negative | 229(0,63) | 355(1,01) | 475(1,35) | 239(1,29) |
| Total | 1834(5,06) | 1520(4,34) | 1609(4,58) | 841(4,54) |

Uni1=CambridgeUni, Uni2=LSEnews, Uni3=UofGlasgow, Uni4=OfficialUoM, Uni5=edinburghuni, Uni6=imperialcollege, Uni7=kingscollegelon, Uni8=UniofOxford

Results

Social network is a structure that shows the interaction, cooperation and communication between individuals or other majorities on a social context. Social network analysis, which also considers interactions between individuals, is developed to analyse social life that has a complex structure. It is critical for the development of the social structure that occurred in the network to determine the communication channels and actors, who hold the power in their hands, in social networks created by a community, as well as communication channels and actors that may prevent distribution of innovations. In this study, effectiveness of the eight most popular universities (The University of Cambridge, LSE, University of Glasgow, University of Manchester, University of Edinburgh, Imperial College, King's College, University of Oxford) in England is analyzed according to social network analysis method. Social network analysis (SNA) assumes that intergroup relations are important. Social network theory is based on the opinion that the social structures of relations between individuals, groups, organizations or institutions affect the behaviours or beliefs of such

individuals and groups. We initially examined official Twitter accounts of selected universities, and we compared their network activities based on the quantitative information therein. We observed that the University of Glasgow and University of Manchester are using their Twitter accounts more actively on the basis of various data that indicate activity on Twitter, such as Tweets, Followers and likes etc. According to the results of the social network analysis made to determine activities, it is determined that the University of Oxford, Imperial College and King's College are active. According to these results, we observed that it is more important to share an amount of information that exceed the amount of information shared on the network. At this point, one must determine the correlation between actors, who play a role in transfer of information. One of the most critical difficulties in analysis of a network is assessment of its status according to a similar different network or by comparing actors available in a network with others. In social networks, one must consider not only whether the links between nodes are available, but also the durability of the link available in particular. We understood the importance of the number of actors available in the network, as well as actors that allow new links to be established. It is argued that communication defects may be eliminated by connecting disconnected parts of a link connection [27]. It is considered that, the more the number of information provided by such link weights between nodes is, more realistic the strong and weak links obtained will be. As low network density emphasizes low amount of association in the network, it means that interpersonal communication is not centralized and is not controlled by several actors. The actor that interconnects the parties of the link, which shall be established by intermediating between disconnected parts required for realization of the network link gains competitive advantage. Thus, academicians and students, who follow the network, have the opportunity to reach to many participants, and thus, communication shall be not made among the members of a certain group.

Social networks are shaped according to the dynamics of societies, and present intended purposes and differences. Social realities, norms and network habits, to which users are related, must be analysed carefully in order to unlock network structures. In networks that are known at a global scale in particular, such as Twitter, one may not make any assessment according to norms and values. Instead of this analysis, one must assess contents provided in the network according to sentiment analysis. No correlation is established between the results of sentiment analysis (positive, negative) and level of usage of official Twitter accounts by universities. Likewise, no link is found between the activity in network and contents of texts. The limitation imposed by Twitter on the number of characters is

insufficient to allow people to express their emotions and thoughts, and this situation caused the words used to be differentiated. When we analyse the structure of social networks, we may observe that there is an interaction and a relationship based on mutual interests in general. Strategies used by parties that establish a mutual benefit (interest) network to obtain the best position are considered as links. When mutual interest is transformed into conflict of interest in certain circumstances, each of the parties must develop a new strategy in consideration of the attitude adopted by the other.

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