Leaders' characteristics in Online Social Networks: a descriptive study of online leadership in the SunSmart campaign

Author: Jacqueline Beck
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

ABSTRACT,
Today, communication networks have become very popular and important, especially through the use of social media platforms like Twitter. These networks enable users to exert influence and shape other network actors' opinions due to the fast, easy and global communication. This exerted influence can be of special importance with regards to online health campaigns, like the SunSmart campaign. The SunSmart campaign is a health campaign which tries to raise skin cancer awareness and promotes its preventive measures. Our study makes use of three concepts from network theory, namely out-degree, betweenness centrality and PageRank, to appoint influential actors which are conceptualized as online opinion leaders. Thereby, three opinion leader groups are investigated based on a communication network, which is constructed from tweets containing the hashtag #SunSmart. These leader groups display different forms of leadership. First, active leaders, second, information controlling leaders and last, authoritative leaders. After having identified the actors employing this form of leadership we will characterize the identified leaders. Focus will be laid on six characteristics, namely: professional identity of entities, ascribed authority, audience size, sharing of knowledge, geographic location and central topics. In the end of this paper, we offer a typology of the function these leader groups play within the communication network. We label them respectively mobilizers, facilitators and administrators. This characterization offers a basis for understanding online opinion leadership in a health-related context.

Graduation Committee members:
1st Supervisor: Anna Priante
2nd Supervisor: Dr. Michel Ehrenhard

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Online Health Campaigns, Online Social Networks, Network Analysis, Leader identification, Leader characteristics, Twitter

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1. INTRODUCTION

Social media has been increasingly used to promote diverse health campaigns. Specifically, Twitter is constantly used to promote health campaigns, like the skin cancer awareness campaign SunSmart. Social media platforms provide an optimal basis to address such topics due to the fast and easy reachability of a huge, global audience. This fast and global communication platform enables a vast community to discuss any topic of relevance. Especially, with Twitter's function of searching for specific topics, via the search of a specific keyword (#SunSmart), users can actively engage in their interests and express their opinions. Due to these platform characteristics, users can publicly share their opinions and discuss diverse points of view, which leads to a certain level of influence within the network. Therefore, Twitter present an excellent opportunity to study opinion leadership dynamics. By investigating opinion leaders on Twitter, we gain a deeper understanding of online persuasion which helps us to become more reflective of our surroundings.

Previous research related to online opinion leaders was either concerned with the identification process itself (Cho et al., 2012; Li & Du, 2011) or identified leaders and their characteristics but without making use of network analysis (Boster et al., 2011). For example, the study conducted by Park and Kaye (2017) analyzes the characteristics of opinion leaders and leadership on Twitter by conducting an online survey of college students in the US. Their study categorizes Twitter opinion leaders into two types, the frequent tweet posters and the frequent retweeters. Moreover, much research related to health campaigns is either delegated to the structural aspects of the online campaign (Meitz et al. 2016), the influence of opinion leaders (Flodgren et al., 2011) or the identification of opinion leaders (Valente & Pumpuand, 2007) in an offline setting. The literature on health campaigns with regards to opinion leader in an online setting is rather limited (e.g. Yang & Tang, 2010a; Yang & Tang, 2010b).

Research is scant in terms of the overlap of leadership identification, via network analysis, and the leader characterization on social media platforms with regards to health campaigns. We believe that this could be due to the fact that most health-related research is conducted in fields such as psychology or sociology, whereas most leader identification research, which is based on network analysis, is conducted in fields such as computer science. These fields of expertise have different foci, where one is more delegated towards human behavior and the other is rather computational as well as computer-oriented. Our research tries to effectively combine these foci, thereby highlighting the necessity of crossover studies.

The article addresses the following research question:

What are fundamental characteristics of opinion leaders on Twitter in health campaigns, particularly with regards to the SunSmart campaign?

To answer this research question, we will first identify influential Twitter users by making use of three network theory concepts. Afterwards, we will continue to characterize these online opinion leaders by making use of six characteristics.

This study investigates leadership dynamics in a skin cancer related discussion. We gathered tweets over the course of approximately nine months, which contained the hashtag #SunSmart. The SunSmart campaign was originally founded in Australia and has spread globally. Its aim is to increase awareness of skin cancer and its preventive measures.

The present study deepens our knowledge of online opinion leaders and their characteristics in online health campaigns. Our results, will enable health campaign creators to optimize their campaign strategies, will support organizations in making use of online leadership and will highlight which individuals are a part of online campaigns promoting health issues. We thereby hope to broaden the understanding of online leaders' intentions who actively engage in such a discussion.

The paper is structured as follows. First, we will conceptualize opinion leaders, specifically in relation to network theory, which will be followed by the conceptualization of their characteristics. Afterwards we will shortly highlight the methodology, followed by the analysis, discussion and lastly, we will state limitations and give recommendations for future research.

2. CONCEPTUAL FRAMEWORK

2.1 Influence and opinion leaders in online communication networks

2.1.1 Opinion leaders

For the purpose of our study we first take a look at the general concept of opinion leaders, which will then be connected to the context of leaders in Online Social Networks, specifically Twitter.

The initial definition of opinion leaders was provided by Katz and Lazarsfeld (1955) as individuals who were likely to influence other persons in their direct environment. Katz and Lazarsfeld (1955) discovered that ''opinion leadership is not a trait which some people have and others do not,'' but rather, it is ''an integral part of the give-and take of everyday personal relationships'' (p. 33, Katz & Lazarsfeld, 1955). By making increasing use of social media platforms, like Twitter, opinion leaders are able to extend their network. Networking not only identifies the number of contacts in someone's community but also indicates the individual's position in the network (Katz, 1957). Opinion leaders not solely direct the attention of others to a specific issue, however, conjointly signal how others should respond or act. This influence occurs by giving recommendations and suggestions, by serving as a role model that others might imitate, and by persuading or convincing others (Weimann, 1994). Engaging in communication activities raises the potential to influence and extends the reach of the opinion leader (Weimann, 1994). For example, a tweet containing a hashtag (e.g. #SunSmart) will not only be displayed to your account's followers, but to everyone who searches for this hashtag. Gladwell states that opinion leaders play a crucial role in social communities (Gladwell, 2002). They occupy central positions in their networks and, as a result, are connected with many members of the community. This central role upholds opinion leaders' status, amplifies their reputation, and contributes to their ability to influence others (Mehra et al. 2006). For a long time, research has focused on the importance of identifying opinion leaders due to their contribution in dispersing information, sharing their opinions and shaping the general public opinion (Ruvio & Shoham, 2007). Specifically, Twitter has unique characteristics that are optimal for the timely and rapid distribution of information (Hansen et al. 2011; Huberman et al. 2009). The advancement of communication technologies has shifted the modes and therefore the preferences of the way individuals acquire and communicate information more towards the internet (Perrin, 2015). Since less research has been focused on online leaders' characteristics, which could be due to the fact that many researchers are focused on finding the perfect way to identify influential actors, the present study will investigate these and thereby aim to get a better understanding of online opinion leaders' characteristics.

2.1.2 Literature review

Since this study will make use of network theory to identify opinion leaders we will review past research to get a basic overview of relevant findings.

Much research regarding the identification of influential people is related to Social Network Analysis, where different concepts in network theory are used, to investigate who exerts influence within a network. The most common concepts thereby are the degree centrality (e.g., Iyengar et al., 2011; Kiss & Bichler, 2008; Van den Bulte & Joshi, 2007), the closeness centrality (e.g., Rayport, 1996; Hinz & Spann, 2008), and the eigenvector centrality (Hanneman & Riddle, 2005).

In general, social network analysis is focused on detecting relationship patterns among people and/or organizations (Berkowitz,1982; Wellman, 1988; Wasserman & Faust, 1994). Many researchers make use of indexes such as in-degree, out-degree, betweenness, closeness and PageRank in Social Network Analysis (Cho et al., 2012; Goldenberg et al., 2009; Kratzer & Lettl, 2009; Li et al., 2015).

Moreover, multiple researchers have developed new algorithms to approach the identification of online leaders (Han, Kim, & Cha, 2012; Yu, Wei, & Lin, 2010; Cruz, Vallejo, & Troyano, 2012). This research is less focused on characteristics, but instead its purpose is to optimize network analysis and to amplify knowledge related to the appointment of influential actors in Online Social Networks. This is most probably due to the fact that most of these researchers investigate online leadership from a computer science perspective and are therefore less interested in characteristics but more in algorithms and computations.

Much research has been delegated to the identification of leaders in Social Networks in fields such as politics (Khan et al., 2015) or marketing (Kim & Tran, 2013; Kiss & Bichler, 2008). Less attention was given to the identification of leaders in health-related campaigns, which could be related to the fact that health related topics are mostly assessed by psychology or medical researchers, who might not be concerned about leaders' characteristics, but instead in how they exert influence. Xu et al.'s (2014) research identifies leaders in a health-related conversation via Twitter hashtags by making use of content as well as network analysis, but their research is not focused on leaders' characteristics. Additional research on identifying online opinion leaders, has focused on analyzing opinion leaders' characteristics, such as persuasion, agreement/disagreement, dialog patterns (Biran et al., 2012), and the leaders' motivations to forward information (Ho & Dempsey, 2010). The research by Boster et al. (2011) examines leaders within a network in a health-related discussion, however they do not make use of network analysis measures, but instead use scales. The research by Cha et al. (2010) analyzes Twitter data by making use of indegree, retweets and mentions to examine the dynamics of user influence across topics and time. Thereby gaining the insight that "influence is not gained spontaneously or accidentally, but through concerted effort" (p.17, Cha et al., 2010).

To summarize, little research has combined the identification of online leaders, by making use of network analysis measures, followed by an investigation of their characteristics in a health-related context. However, we believe by making use of concepts from different fields of expertise we are able to contribute to all of these and highlight the importance on cross-overs within research.

Therefore, the following study aims to approach this overlap of diverse areas of expertise to deepen the current understanding of online leaders' behavior in online health campaigns.

2.2 Identifying online opinion leaders in online social networks

2.2.1 Network concepts explained

The present study will make use of three different network concept to identify three groups of opinion leaders: out-degree, betweenness centrality and PageRank. We will define each concept according to network theory and describe how it can be linked to the identification of opinion leaders.

First, we will make use of the weighted outdegree of each network actor. The weighted outdegree is the number of outgoing connections of a vertex (node) but pondered by the weight of each edge. In terms of Twitter this means how many times you send a tweet to someone else in the network. In literature, out-degree stands for the "choices made" by a node and sent to other nodes who belong to the same network (Wasserman & Faust 1994). In other words, a user decides to actively engage another user in a discussion by directing his tweet to this user. An online opinion leader is someone who engages actively in the network discussion and therefore addresses and informs other network actors (high weighted outdegree), which we label as a mobilizer. The term mobilizer displays the function of this leader group within the communication network, which means active leaders try to mobilize other actors to engage themselves in the relevant topic (see Appendix F).

Second, we will examine the betweenness centrality of each network actor. In graph theory, betweenness centrality is a measure of centrality based on shortest paths. Betweenness centrality measures the number of times an actor (node) lies on the shortest path between other actors (nodes), which means one can draw a conclusion of the strategic importance of a leader acting as a "bridge" within the network (Friedkin 1991). This measure helps us identify influential nodes, since without this specific node, which has a high betweenness centrality, the network might be less connected which could lead to a limited flow of information. In terms of the studied Twitter network this measure reflects a user connecting different subgroups with each other. For example, one subgroup (group A) could be talking about preventive measures of skin cancer whereas the other (group B) might share their personal experiences with skin cancer in general and user X connects this discussion by tweeting "@group A here are some personal experiences related to the screening for melanomas RT tweet group B". Since this user would enable the diffusion of information our study labels such an actor as influential. Therefore, this study argues that betweenness centrality is related to control over the flow of information. Actors with high betweenness centrality are influential, because they can decide to diffuse or withhold information between groups. If these nodes would not exist, the network would be disconnected or at least less connected. Therefore, this study claims that an online opinion leader is someone that is central in the network and connects different subgroups of the network with each other enabling the flow of information, which is why we label this group as facilitators. The term facilitator thereby depicts the leaders' function of supporting the flow of information within the communication network (see Appendix F).

Lastly, the study will make use of the PageRank algorithm. The algorithm assigns a score to each node based on its incoming ties (in-degree). These connections are also weighted depending on the relative score of its originating node. In other words, PageRank measures how many incoming connections one has and how valuable these are. In literature, PageRank is seen as a measure of importance (Page et al., 1999; Li et al., 2015). In the context of Twitter this means a user having a high PageRank is receiving many tweets which are somehow directed at him, as in the form of mentions (@username) or retweets (RT), from users who have a prestigious position, thereby boosting his own position. Therefore, we state that an online leader is someone who receives a lot of attention from prestigious network actors, which we label as an administrator. The term administrator, thereby presents the function this leader group occupies, meaning

this leader group takes on a managing function within the network.

To sum up, our study identifies three leader groups which are labeled mobilizers (active), facilitators (control) and administrators (authoritative) (see Appendix F).

2.3 Characterizing online leaders

To characterize the leaders, focus will be laid on six characteristics, which are professional identity, sharing of knowledge, ascribed authority, audience size, geographic location and central topics. To get a clear and quick overview the subsequent table (Table 1) displays all relevant information. We hereby try to investigate the following research question:

What are fundamental characteristics of opinion leaders on Twitter in health campaigns, particularly with regards to the SunSmart campaign?

2.3.1 Professional Identity

The first characteristic which is examined are the leaders' professional identities. "Professional identity is the concept which describes how we perceive ourselves within our occupational context" (p.2, Neary, 2018). Since Twitter accounts can be run by individuals as well as organizations we first have to distinguish between these categories, to than draw a conclusion on their professional identity. Thereby, we can get an understanding of how present skin cancer and its prevention is in everyday life and whether this discussion is mostly initiated by organization, because it is part of their strategic agenda, or by individuals, because they are interested in raising the general awareness of this disease. In terms of opinion leader identification Katz (1957) says that "influence is related to the personification of certain values" (p.10, Katz, 1957), which he labels as "who one is" (p.10, Katz, 1957). Other researchers make use of this concept to conceptualize (Choi, 2014) or identify (Valente & Pumpuang, 2007) opinion leaders. Our study relates this concept of "who one is" to the individuals professional identity. The professional identity will be deduced from the account's bio, which is a short self-description. Maybe some individual states in his account's bio that he is a journalist in a health-related magazine. This could lead to the conclusion that he is interested in sharing his knowledge and maybe extending his sources of information by actively participating in such a discussion.

Since, professional identity can only be related to individuals, we investigate the organizations field of expertise as a counterpart to professional identity. Thereby, we hope to get a better understanding of the organizations intentions and identify reasons why they actively engage in the skin cancer discussion. If, for example, a sunscreen company actively engages in the discussion we could assume that this is related to marketing. The company's effort in raising awareness of preventive measures could be tied to increasing their brand awareness and resulting sales. We will examine the accounts bio, to infer each organizations field of expertise.

To conclude this study investigates the opinion leaders professional identity/field of expertise to get a better understanding of their intentions to engage in the SunSmart campaign.

2.3.2 Sharing of knowledge

Furthermore, the present study will explore the sharing of knowledge of the appointed online leaders. Knowledge diffusion can be defined as the process of communicating research, information and/or knowledge to individuals, groups or organizations (Estabrooks, 2001; Rogers, 1995). In literature, opinion leaders assist the community to recognize a need for improvement as well as to communicate information (Young, 2003). Therefore, this study deduces that online leaders will support the dispersion of knowledge. Since tweets can only contain up to 140 characters, we estimate that most information or knowledge which is dispersed will be derived from external linking. External linking means a tweet contains a hyperlink which directs a user to another website. This website could for example display an article related to skin cancer or its prevention. Johnson et al. (2015) argue that by providing an URL in one's tweet the online influence of that person could be increased. Their research states that an URL could act as a "verifiable evidence for arguments made (…) provide a resource of value (…) [or] may directly address a question or concern of others" (p.17, Johnson et al., 2015). Therefore, we speculate that identified influentials will make use of hyperlinks to diffuse valuable information.

2.3.3 Ascribed authority

Next, the study will examine the ascribed authority of the leaders. In general, authority can be defined as the power to influence other people (Osorio-Kupferblum, 2015). Within this study we define this power as being ascribed by the network. In other words, we claim that the network accredits someone authority because they think this person has something important to say. Many times, literature states that opinion leaders gain their position from being peer-nominated (Young, 2003; Grimshaw et al., 2006; Grimshaw et al., 2012; Locock et al., 2001; Lomas et al., 1991; Majumdar et al., 2007; Siddiqi et al., 2005; Simpson & Doig, 2007; Waters et al., 2009; Rycroft-Malone et al., 2012). Therefore, this study assumes that the identified online leaders have gained a certain extent of authority. Since we conceptualize ascribed authority in terms of authority delegated by the community, this will be measured by investigating the total number of retweets received. We presume that the peers retweet the leaders' tweets because they want to spread or rebroadcast this message, which could signal that they perceive it as valuable or informative. Moreover, Choi (2014) found in his study that opinion leaders had a higher frequency of messages being retweeted than non-opinion leaders, which could be tied to the argument that opinion leaders have tweeted content, which had been seen as important or valuable by non-opinion leaders. Therefore, we theorize that the number of retweets received will display a certain level of ascribed authority.

2.3.4 Audience size

Moreover, we will investigate the leaders' audience size. Research argues that opinion leaders have wide interpersonal communication networks (Grimshaw et al., 2006; Grimshaw et al., 2012). Young (2003) highlights that this broad audience enables the effective diffusion of information within the network. Besides, Summers (1970) points out that opinion leaders are more socially active, which could imply a broad audience since socially active people commonly engage in a conversation with many people. In other words, research claims that leaders have a high number of followers to spread their knowledge and opinions. Due to these arguments we will investigate the average number of followers of the identified influential network actors. Thereby, we hope to get an understanding of the leader-follower relationship and the leaders' follower size.

2.3.5 Geographic location

Since the platform which is being analyzed is Twitter, which is available to everyone with access to the Internet, we will take a look at the geographic location of the identified leaders. Social media enables an easy, fast and most importantly global conversation, so we would infer that this is the fundament for a global audience and leader community. Popular social media platforms such as Facebook, Twitter, Pinterest, and LinkedIn

have a total userbase of more than one billion users worldwide, which is expected to increase (Wasserman, 2012). Given the reach and frequency of use, Twitter represents an interesting platform to deliver health promotion messages as well as to change health behavior. Additionally, according to Singhal and Rogers (2004) media professionals and health communication scholars as well as practitioners collaborate on a global basis to make use of the powerful influence of entertainment to promote specific health beliefs and behavior (Singhal & Rogers, 2004). Therefore, we would expect to find a quite geographically dispersed number of appointed leaders. By taking a look at the location of each identified online leader we hope to get an overview of the nationalities who are mostly engaged in raising skin cancer awareness. This enables us to draw some conclusions on the reasons countries have for engaging in this discussion. For example, if many leaders come from the United States this might be an indication for the country's rising interest in skin cancer prevention or an indication for the necessary education due to rising skin cancer incidents. In other words, the geographic location will present which countries are most involved in the ongoing discussion and might enable us to draw some conclusions why especially these countries have a raised interest.

2.3.6 Central topics

The last aspect which will be considered within our study is the content of the leaders' tweets. The content of the tweets will be analyzed by investigating the most frequent hashtags which are used by the appointed leaders. Thereby, we can get an insight into the topics which are addressed. This is of relevance to get a better understanding of the leaders' intentions in participating in the SunSmart discussion. It enables us to draw a conclusion with regards to the leaders' exerted influence. In other words, once we know which hashtags are mostly used within the three leader groups we might be able to reflect on their focus of interest. Researchers have analyzed hashtags to get a better understanding of the network and the information flow. For example, Small (2011) analyzes and classifies tweets and their contained hashtags to get a better understanding of hashtag usage in Canadian political developments. Moreover, Steinfeld and Lev-On (2014) investigated the discourse between citizens and local administrators on their official municipal Facebook pages by creating a co-occurrence network. Therefore, we estimate that by taking a look at the most frequently used tweets we will get a better understanding of the leaders' discussions.

Table 1 Leaders' characteristics

Characteristic	Relevant Research	Measure
Professional Identity	Neary (2018), Katz (1957)	Individual vs Organization, Occupational identity, Field of Expertise
Sharing of knowledge	Johnson et al. (2015), Estabrooks (2001), Rogers (1995), Young et al. (2003)	External linking, Source of information
Ascribed authority	Choi (2014), Young (2003), Grimshaw et al. (2006), Grimshaw et al. (2012), Locock et al. (2001), Waters et al. (2009), Rycroft-Malone et al. (2012)	Number of retweets received
Audience size	Cappelletti & Sastry (2012), Grimshaw et al. (2006), Grimshaw et al. (2012), Summers (1970)	Average number of followers
Geographic location	Quercia, Capra & Crowcroft (2012)	Location of tweets
Central topics	Small (2011), Steinfeld & Lev-On (2014)	Co-occurrence of leaders' hashtags

3. METHODOLOGY

3.1 Case study: SunSmart Campaign

Before continuing with the leaders' characteristics, we shortly want to highlight the purpose of the SunSmart campaign, its relation to Twitter and our study.

The SunSmart campaign was originally established in 1988 in Australia. Its purpose is to raise skin cancer awareness, educate the public about the disease and which actions should be taken in order to decrease the likelihood of skin cancer. Since the rise of social media many health campaigns have made use of these online platforms as a means of communication. The SunSmart campaign has been discussed on Twitter and has led to an ongoing online discussion. Twitter's feature of including a hashtag within one's message enables any user to classify their posts within a certain topic. Thereby, users can efficiently search content related to their interests. Within our study we have retrieved tweets over a timeframe of nine month which contained the hashtag #SunSmart to get an understanding of this online discussion.

3.1.1 Twitter in relation to network analysis

On Twitter users can post a short message, which can contain up to 140 characters. These short messages can have diverse functions. Starting off, we will first explain the different kinds of tweets.

In general, a tweet is a message posted to Twitter containing text, photos and/ or a video. Additionally, one can send a mention, which can either be regular or a retweet. If it is regular this means a user quotes the original author of a tweet by addressing this user. This is achieved if a tweet contains @username, which directly links the other user to this message. A retweet is characterized by the fact that a user posted a short message and another user wants to share this message with his audience, this is displayed by the shortcut 'RT'. Furthermore, a tweet can contain a hyperlink directing to another webpage, which could be something like an article or a video. Another tool on Twitter to spread one's message is the usage of a specific hashtag (#keyword). If a user is tweeting about a certain topic, like skin cancer, he can combine the symbol '#' with a relevant keyword, like #SunSmart. Once this hashtag is a part of the tweet, each Twitter user can view all tweets containing this hashtag, by either clicking on the hash-tagged word or by searching for a specific hashtag. Thereby, the Twitter users create a communication network which connects all relevant messages containing this specific hashtag and one can discover content and accounts based on one's interest.

In the next section we highlight our methodological approach, including how we translate tweets into a communication network.

3.2 Methodological Approach

This study makes use of secondary Twitter data which has been received by the supervisor of this study. The data grant which will be used was collected from Twitter and tweets have been posted in relation to the SunSmart project. Therefore, the data

consists of tweets which display the common hashtag #SunSmart. The data is from the period 30th of April 2014 until 01st of February 2015. For the purpose of this study only English tweets will be used.

The first step of analyzing the data will be delegated to conducting a Social Network Analysis. Starting off by inserting the data into the network analysis program Gephi 0.9.2. Thereby, the program will translate each tweet into an edge and each Twitter user into a node. Regular tweets are not directed at any other network user, which means they are translated into self-loops (A→A). However, these tweets still include valuable information for our analysis, which is why they are included in the data set. To avoid biased values for the betweenness centrality, PageRank and weighted outdegree these self-loops will be filtered out before running the algorithms in Gephi 0.9.2. Mentions, replies and retweets create relational ties (edges) between different network actors (A→B). Once the program constructed a network, we will calculate the weighted out-degree, betweenness centrality and the PageRank to identify the three groups of leaders.

Table 2 displays the relevant network characteristics to get a quick overview of the analyzed communication network.

Table 2 Network characteristics

Network characteristics (Directed)	Values
Number of nodes	5710
Number of edges	7060
Density	0
Mean weighted out-degree	2,402
Range weighted out-degree	0 – 8208
Mean Betweenness Centrality	72
Range Betweenness Centrality	0 –76063,66
Mean PageRank	0,0001748
Range PageRank	0,000613 – 0,01174

Once we have calculated all scores in Gephi 0.9.2. the data is exported to Microsoft Excel to enable further analysis. After having exported the data to Excel the mean and standard deviation of each network measure, namely outdegree, betweenness centrality and PageRank will be calculated. Each measure's mean and the corresponding standard deviation will be summed to calculate a cut-off value, which is used as a threshold to identify opinion leaders. A table for each network concept and its related mean, standard deviation and cut-off value can be found in the appendix (see Appendix A, tables 4-6). Charts displaying the investigated network concepts can be found in appendix B (figures 1 – 3).

All actors which are scoring above the cut-off values of all three measures will be considered as leaders within the network. This is due to the fact that this study assumes a leader actively engages in the network communication (weighted outdegree), connects different actors within the network enabling a better flow of information (high betweenness centrality) and receives a lot of attention from the network and is connected to other prestigious actors (high PageRank). We assure that the selected accounts are influential actors, since they score high on the relevant network measures, which have been used in prior research to identify leaders (Cho, Hwang, & Lee, 2012; Goldenberg, Han, Lehmann, & Hong, 2009; Kratzer & Lettl, 2009; Freeman, 1979; Chen et al., 2011). In this way, we identify a total of 186 leaders.

After having identified the top leaders of the SunSmart campaign network, we analyze the six proposed characteristics of these leaders. These are professional identity, sharing of knowledge, ascribed authority, audience size, geographic location and central topics.

The professional identity of the leader groups will be extracted for the account's bio, which is a short self-description. Thereby, we first consider whether the account is run by an individual or an organization, which is followed by the professional background, meaning the organization type or the occupational identity.

Sharing of knowledge is obtained by first determining the percentage of URLs included in the leader's overall tweets, which is complemented by investigating the type of information which is being shared by posting such links (e.g. educational).

Since the retweeting function on Twitter is commonly used to highlight a noteworthy tweet, we acquire the level of ascribed authority by taking a look at the number of retweets received.

The audience size of each leader is inferred by taking a look at the follower size during the relevant time frame. We have gathered a number of followers for each tweet, containing the #SunSmart, which was send. These are than used to calculate a mean follower number over the relevant time frame.

Next, the geographic location is extracted from Twitter's geo-tag function, meaning one can add a location to one's tweet. However, only about 2% of all tweets contain a geographic location (Van der Veen et al., 2015), which is why we are not able to determine each leader's location.

To derive the most used hashtags we create a co-occurrence network with the program Cortext Manager. First, each leader group's tweets are uploaded in the program, then the data is parsed, followed by the term extraction, to detect the most frequently used hashtags. Afterwards, the most central hashtags are used to construct a co-occurrence network for each leader group. The relevant graphs can be found in the appendices (see Appendix C, D & E, Figures 9, 16 & 23).

Lastly, we will draw a conclusion of the nature of online leaders within health-related Online Social Networks.

4. ANALYSIS

We will resume with appointing influential actors of the SunSmart network, which will be followed by an analysis of the six relevant leader characteristics.

4.1 Identified leaders as mobilizers based on high out-degree

Starting off, we first investigate the leader group scoring above the cutoff value, the sum of the mean and the standard deviation, with regards to out-degree. The identified online opinion leaders total to three Twitter accounts. Since out-degree represents the total amount of outgoing tweets, we conceptualize this as activity. Therefore, we argue that these three leaders are the leaders who engage most in the SunSmart discussion.

The relevant accounts consist out of one individual (33%) and two organizations (67%) (see Appendix C, figure 4). The individual's Twitter account lacks a lot of information and therefore is rather difficult to characterize. We are not able to detect any kind of occupational identity, neither are we able to state the accounts geographic location.

However, the accounts which are organizations have much more available information. One of the organizations concentrates on educating the public, whereas the other focuses on commercial activities (see Appendix C, figure 5). The educational organization is the official American SunSmart Twitter account.

Since their strategic agenda focuses on raising skin cancer awareness, we conclude that by sending out many tweets they aim to initiate a discussion or inform their audience. Thereby, they make use of Twitter as a way to reach a broad, global audience in a short timeframe. The commercial opinion leader is a company, who sells bracelets which light up once you have to renew your sunscreen to keep the optimal level of protection. Therefore, we deduce that by posting many tweets the company tries to raise brand awareness, to highlight the importance of their product and to make use of Twitter as a marketing tool.

With regards to external linking all accounts make use of many external links with a mean of 74,24% of all out-degree leaders' tweets containing hyperlinks and a standard deviation of 1,34%. This reflects the fact that all three accounts want to share external information and direct the audience to diverse sources of information. To get a better understanding of what these leaders want to share and why, we scanned through the hyperlinks and took a look at the websites one is directed to. All three accounts share more or less the same types of links. Most links direct to educational information sources like sunscreen protection and the difference between UVA and UVB. Moreover, all accounts share links which discuss policy updates. For example, one link directs to an article stating that the FDA (Federal Food Drug and Cosmetic Act) has tightened the regulations of tanning salon lamps. Besides, the three out-degree leaders share links displaying role models who have fought against skin cancer, to point out the severity of the disease. However, the difference between the organizations and the individual in sharing links is that both organizations share promotional links. The commercial organization mostly shares promotional links related to products, like a blogger evaluating a face soap with a sunshield. The official American SunSmart page however, posts many self-promotional links. They post a link to an article about their campaign and goals as well as a link directing to a donation page. Therefore, we can state that although all accounts share informative or educational links related to skin cancer and its preventive measures, the organizations try to extend the usage of external linking to fulfill their strategic goals.

Next, we investigate the accounts' ascribed authority which is measured in terms of retweets received. The commercial account received the most retweets, with a total of 18500. The educational organization as well as the individual account both received far less retweets, with 72 retweets for the official American SunSmart account and 106 retweets for the individual, which is why we can label the commercial account as an outlier. If we exclude this outlier the mean is 89 retweets with a standard deviation of 24 retweets (Appendix C, figure 6). Concluding, the commercial organization has by far the highest ascribed authority, whereas the other two accounts have gained less attention from their audience. However, at the same time both of these accounts have half the audience size of the commercial Twitter account, which can be a reason why they received less retweets.

The commercial organization has the largest audience with about 965 followers, followed by the individual, who has an audience size of approximately 495 followers and lastly the official American SunSmart profile has only 275 followers. On average the out-degree leaders have an audience of 578 followers with a standard deviation of 352 followers (see Appendix C, figure 7), which means that the follower size is quite spread. Thus, we infer that the commercial organization has already established itself and makes use of their account to support the business' growth.

With regards to the accounts' geographic location we are only able to detect the organizations location which is in the United States (see Appendix C, figure 8).

Lastly, we will investigate the most frequent hashtags used by this leader group (see Appendix C, figure 9). Most of the top hashtags are related to the disease itself. For example, the most prevailing hashtag is #melanoma, followed by hashtags like #skincancer, #sunsafe or #sunsafety. Other hashtags which are part of the co-occurrence network but are less related to skin cancer per se are #breastcancer or # patients. This reflects, that mobilizers mainly focus on the usage of hashtags which directly identify the disease or are at least to some extend related to cancer in general. Mobilizers seem to slightly address skin cancer prevention, with hashtags like #Sunsafe, however their main concern seems to be delegated to the disease itself. Hashtags which do not lead to any conclusions due to missing context are for example #dogs or #\x85.

To conclude, mobilizers, which have been classified based on out-degree are more likely to be organizations, who are based in the United States. They are equally likely to follow an educational or commercial purpose and have a rather small audience size but receive quite a lot of retweets compared to the other groups. External linking is an important aspect of mobilizers and tweets usually contain a hashtag which directly ties the tweet to the skin cancer discussion. Organizations tend to share promotional or even self-promotional links. Therefore, we conclude that mobilizers try to raise attention of their existence and make use of Twitter as a mean to grow.

4.2 Identified leaders as facilitators based on high betweenness centrality

The distinguished betweenness centrality leader group consists of 36 different Twitter accounts. Since high betweenness centrality means connecting different subgroups in a network and thereby acting as a bridge, we conceptualize betweenness centrality as having control over the flow of information. We will now explore the leaders' characteristics and aim to draw some conclusions on their intentions.

First, we investigate the composition of the group in terms of professional identity (see Appendix D, figure 10). 69% of all classified accounts are organizations and 31% are individuals. Within all 25 organizations we distinguish between three different types of organizations (see Appendix D, figure 11). First, the commercial organizations, who sell some kind of product or service, which could be a sunscreen company or an apparel company. These make up 48% of all leaders within the facilitator group. The next group are the organizations who delegate themselves to educate the public. These organizations are mostly cancer research groups, and some are official suborganizations of the SunSmart campaign, like the Live SunSmart Organization. These types of organizations amount to 48% of the total betweenness centrality leaders. Lastly, there is one account (4%) which is a political party. We derive that commercial organizations mainly take on a leading position to increase their brand awareness. The educational organizations intend to increase skin cancer awareness, educate society and decrease skin cancer rates by promoting preventive measures. Since the political party is from Australia it either intends to educate society to reduce skin cancer rates and the resulting governmental costs or it is part of their political agenda to raise skin cancer awareness and to promote its prevention.

Taking a look at the individuals who are labeled as online opinion leaders we distinguish between six distinctive groups (see Appendix D, figure 12). The biggest professional group labels themselves as ambassadors, these individuals amount to 29%. Ambassadors mostly stated in their bio that they are an official or proud ambassador of the SunSmart campaign or skin cancer in general. Moreover, ambassadors have not only identified themselves within this group, but most of them have an

additional occupational identity. Therefore, we infer that these individuals have a personal interest to educate society about skin cancer. Maybe, they were in contact with the disease somehow and their interest is triggered by altruistic reasons. Individuals who label themselves as working for the SunSmart project amount to 22%. These individuals most likely have professional reasons to contribute to the skin cancer discussion. Additionally, they are so engaged with the topic itself that they want to share their information throughout the network. The same reasoning can be taken for the next group, who amounts to 14% and works in skin cancer research. Besides, there are 14% who work in the media, meaning they are either journalists, blogger or moderate a radio show. Individuals working in media act as a broker to receive and distribute new information with regards to skin cancer. They most probably have a certain curiosity to receive as well as share information in general. Lastly, there are 7% who characterize themselves as teachers and 14% who have not stated anything related to their profession.

We can group the occupations related to skin cancer research, the employees working for the SunSmart project and the skin cancer ambassadors together, since all of these people should have an extensive knowledge related to skin cancer. Moreover, many individuals who stated that they work in media, either work for a broadcast or magazine which is focused on health in general, so we infer that they have, at least to some extent, knowledge related to skin cancer and its prevention. In addition, we claim that a person, who is a teacher, has some knowledge with regards to skin cancer, if for example he is a biology teacher. Aside from this aspect, we expect that a teacher has some curiosity to educate himself about a relevant topic. Therefore, we state that all occupational identities are to some extend related to skin cancer or gathering information, and a certain fundamental knowledge as well as curiosity is necessary for all professions.

With regards to external linking the mean is 69,03% with a standard deviation of 30,37%, meaning the usage of external links within one's tweets is more spread compared to the out-degree leader group. However, about two thirds (66,67%) of the accounts make use of at least the average amount of links included. Whereas, only 8,3% do not make use of any external links. Therefore, we conclude that the appointed leader group is likely to direct their audience to external websites. To get a better insight into the knowledge which is being shared via these links, we scan through the leaders' URLs and try to get a broad understanding of the relevant topics being addressed. The investigated links mostly concern educational posts, like articles related to how to best protect yourself from the sun and what should be kept in mind when being exposed to sunlight. Additionally, many commercial links are shared, like pages directing to the "best" sunscreen brands or websites of businesses offering to enter a competition. Lastly, the group also shares a few policy updates, like an article from Fox news which states the Sunscreen Innovation Act has been approved. This act is a law that the FDA speeds up their review and approval of sunscreens. Consequently, we state that by making use of external links leaders try to inform followers about skin cancer, its prevention and current developments or they try to market their brand to the audience.

Next, we consider the ascribed authority of this leader group. The mean equals to 529 tweets with a standard deviation of 3081 retweets. However, this is due to one account which has received 18500 retweets. Most of the leaders have received 13 retweets or lower. Therefore, we decided to treat this account as an outlier and recalculated the mean and standard deviation by excluding this leader. Therefore, the more accurate mean is 15 retweets with a standard deviation of approximately 27(see Appendix D, figure 13). About 17,14% of the group has received at least the mean number of retweets.

Investigating the audience size of these leaders we receive a mean of 1294 followers with a standard deviation of 1537 followers (see Appendix D, figure 14). About 33% of all classified leaders have an audience size which equals or is greater than the mean.

Furthermore, we examine the geographic location to get an understanding of the cultural composition and globality of the online leaders (see Appendix D, figure 15). The largest groups are located in Australia, with a total of 31%, and the United States, with 30%. This is related to the fact that Australia is the country of origin of the SunSmart campaign and the United States have an increased interest in skin cancer and its prevention, since they are in the top of the countries, which have the most skin cancer incidents worldwide (World Health Organization, 2017). The third most prevailing country is the United Kingdom which can also be related to their high skin cancer rate (World Health Organization, 2017). Since we are only focused on analyzing English tweets and all these three countries have English as an official language we can deduce that this is another reason why these countries compose 78% of the leaders' location. The minorities within this group are South Africa, with a representation of 8%, and Canada, with a total of 3%. Lastly, a total of 11% of the leaders have not specified any location.

Finally, we examine the co-occurrence network displaying highly used hashtags (Appendix D, figure 16). Facilitators main hashtag is #melanoma, followed by correlated hashtags like #skincaner or #sunsafe. However, facilitators make quite a lot of use of hashtags which are related to the prevention of skin cancer, like #sunsafety or #sunscreenbands. Therefore, we can state that this leader group extends its discussion to involve not only the disease but also its prevention.

To summarize a facilitator is most likely an organization, with either a commercial or educational purpose, located in Australia, the United States or the United Kingdom. Such a leader has a medium audience size and receives some retweets. Most of his tweets contain URLs directing to external websites. If the leader is an individual he is likely to work in a profession which is related to skin cancer and therefore has good knowledge of the relevant topic. In general, facilitators use hashtags which are tied to the disease and the prevention of the disease.

4.3 Identified leaders as administrators based on high PageRank

Lastly, we characterize the online opinion leaders which have been identified based on PageRank. Since PageRank not only considers the total amount of incoming tweets but additionally the authority of the account who send these tweets, we conceptualize a high PageRank score as being authoritative within the network. The relevant leader group consists of 147 total Twitter accounts. We continue by outlining the relevant characteristics of the identified influential network actors.

First, we investigate the professional identity aspect of all appointed leaders. We start by distinguishing between the accounts who are run by individuals, which make up 33%, and the ones' who represent an organization, which total to 67% (see Appendix E, figure 17).

We can classify six different types of organizations (see Appendix E, figure 18). The predominant group is employed within the educational field. These organizations are research organizations who are delegated to health, who are focused on cancer research in general or who target skin cancer in specific. Out of these organizations 9,38% identified themselves as being

a part of the SunSmart campaign. The next field of expertise within the leader group are commercial businesses with 27%. Commonly they consist of sunscreen brands, sun protection apparel companies or cosmetic brands which have an emphasis on sun protective products. We assume that their aim in engaging in skin cancer related discussions is to raise brand awareness. The following group of organizations consists of media. These are comprised of magazines, publishers or news services, like the Australian Medicine. Most of these media organization have a focus on health or specifically cancer. Leisure organizations, like big public pools or big cultural event organizers make up 7% of the organization. We suspect that these institutions engage in the skin cancer discussion since most of the addressed leisure activities expose the public to sunrays. The same reasoning is considered for the sport organizations, which total to 4%. They want to promote sportive activities by keeping safety in mind. Lastly, 3% of the organizations are political organizations. With two thirds located in the United States and one third in Australia. These want to increase skin cancer awareness to either improve society's health or to address a certain target group for the next election.

Taking a closer look at the individuals, one thing which stands out is that the occupational identities of these people are quite spread across different fields of expertise (see Appendix E, figure 19). We are able to differentiate between eight different professions, even though 18% of the identified leaders have not given any information related to their occupation. Most of the leaders work in media, which amounts to 42%. This is explained by the fact that journalists or hosts of a radio show frequently post articles and create a lot of content, which can attract many incoming opinions (tweets) from their audience. Therefore, they might be very prevailing in the leader group. The next largest group with a percentage of 9% are individuals working in health and individuals working in beauty-related professions. These two professional groups address different audiences. On the one hand, the followers who are concerned about their health and therefore interested in educating themselves to prevent the disease. On the other hand, the followers who educate themselves in terms of how sunlight can affect your skin by for example getting wrinkles. Besides, the beauty sector included many models, who act as a role model for their audience. The same reasoning holds for the leaders who work as athletes (7%). Since sports are often connected to being outside and therefore being exposed to the sunlight, these leaders have delegated themselves to point out the importance of sun protection when doing sports. Furthermore, about 7% of the leaders work in politics, most of them come from Australia, where sun exposure is a big concern. Therefore, they intend to show society that skin cancer is an important topic. The minorities include leaders working in education (4%), leaders working in retail (2%) and lastly leaders who are students (2%).

The mean with regards to the external linking is 66,84% and has a standard deviation of 40,62%, which means the usage is quite spread. However, 62,59% of the leaders share tweets which contain at least 66,84% URLs. To get a better understanding of which information is shared we further investigate the types of websites one is directed to. Many URLs direct the audience to educational articles, like why it is important to check your skin, especially moles, on a regular basis. Another type of links being shared is a mixture of educational and promotional links, like an article about Danielle Macaluso, who works for L'Oréal Paris. She was diagnosed with melanoma and started to act as an ambassador for sun screen usage. The article is highly connected to the brand itself and therefore tries to subliminal persuade customers to buy their brand. Moreover, the shared links contain many promotional activities like entering a competition or which sunscreen brands have been recommended. Additionally, also this leader group shares links related to policy updates like an article about the FDA's approval of a drug for the treatment of advanced melanoma.

Looking at the ascribed authority of the leaders we have a mean of 2,45 and a standard deviation of 7,43 (see Appendix E, figure 20). The ascribed authority therefore is less spread, which is also shown by the fact that about 19% of all leaders have received at least the mean number of retweets.

The mean audience size within this leader group is 39919 with a standard deviation of 208199 (see Appendix E, figure 21), which means the follower size is quite spread. Approximately 8,84% of the leaders have at least an audience which equals the mean.

This leader group is the largest group and the most geographically spread with a total of twelve different countries (see Appendix E, figure 22). However, 27% of all leaders have not specified any kind of location. The largest share of leaders comes from Australia (26%), which is justified by the fact that the SunSmart campaign originally started in Australia. 12% of all leaders are based in the United States and 11% are from the United Kingdom. Additionally, we have a share of 8% from Ireland, 5% from Canada, 3% from South Africa and 3% from New Zealand. The minorities, with a share of 1% are based in the Netherlands, Germany, Bermuda, South Korea and lastly Asia pacific. This shows us that about 69% of the countries are English-speaking countries. Moreover, this vast geographical spread reflects the functionality of Twitter of easily connecting people on a global basis.

After having considered the prior characteristics we explore the used hashtags within this leader group (see Appendix E, figure 23). Administrators make use of hashtags which are addressing the health campaign, like #sunsmart, are related to skin cancer, like #skincancer or #melanoma, and hashtags which are tied to the preventive measures of skin cancer, like #sunscreen or #dailyshade.

Consequently, we can characterize the administrators, which has been identified based on PageRank, as being most likely an organization engaged in education, media or commercial activities. If the leader is an individual, he is occupied in media, health or the beauty sector. A leader is from an English-speaking country, which could be Australia, the US or the UK. In general, a leader has quite a big audience size but only a few retweets. Leaders within this group use quite a lot of external links within their tweets, which are either educational or promotional links. Moreover, administrators use mainly three types of hashtags, the one's related to the SunSmart campaign, related to skin cancer and to its prevention.

5. DISCUSSION

Table 3 Characteristics of diverse leader groups

Characteristics	Mobilizers	Facilitators	Administrator
Network concept	Out-degree	Betweenness Centrality	PageRank
Individual vs Organization	Organization	Organization	Organization
Organization type	Commercial or Educational	Commercial or Educational	Commercial Educational or Media
Occupational identity	N/A	Cancer research	Media, Beauty or Health sector
Ascribed authority	89 retweets	15 retweets	2,45 retweets
Audience size	578 followers	1294 followers	39919 followers
Sharing of knowledge	74,24%	66,67%	62,59%
Geographic location	US	Australia, US, UK	Australia, US, UK
Central topics	Skin cancer	Skin cancer & skin cancer prevention	SunSmart campaign, Skin cancer, & skin cancer prevention

This study examined online opinion leaders and their characteristics in a health-related campaign on Twitter.

We used network analysis to identify three distinct leader groups. These were based on different forms of leadership. First, we appointed leaders who actively engaged in the online discussion and thereby took on the function of mobilizers within the communication network. Next, leaders who had the most control over the flow of information and thereby employed the function of facilitators with the network. Lastly, we diagnosed leaders in terms of their authority within the network, whose function within the network was to administrate (see Appendix F).

Afterwards, we characterized leaders based on six distinctive characteristics. Thereby, we addressed the professional identity, the sharing of knowledge, the ascribed authority, the audience size, the geographic location and ultimately the most central topics.

Many researchers made use of out-degree, betweenness centrality or PageRank to identify the most influential network actors (Cho et al., 2012; Goldenberg et al., 2009; Kratzer & Lettl, 2009; Li et al., 2015), but none of these created a typology like the one proposed within this study. With the development of a leader typology we aimed to close this gap and to clarify as well as structure online leaders' attributes. Therefore, the study contributed to the literature in that it extended on the existing knowledge of online leader identification and characterization by network analysis in relation to a health-related context.

The following discusses the implication of the findings across the three leader groups with regards to their characteristics.

As table 3 highlights all three leader groups have a tendency that leaders are an organization, whose purpose it is to either generate profit or educate the public. If the leader is an individual, the occupational identity varies quite a lot. Besides, the number of retweets received also changes a lot across the groups. The same holds for the audience size. The most interesting aspect thereby is that mobilizers get the most retweets, whereas the administrators obtain the least. The inverse holds for the audience size where administrators have an enormous audience, but mobilizers have only a rather limited number of followers. The use of external links is about the same across all groups, with a standard deviation of 6%, which means it is only slightly spread. The geographic location is quite persistent with regards to the majorities. However, we notice that the geographic dispersion increases from mobilizers over facilitators to administrators, but at the same time the number of identified leaders increases over these groups. With regards to the central topics, the number increases across groups. To some extend these topics overlap, meaning all three groups share central topics.

6. IMPLICATIONS AND LIMITATIONS

6.1 Theoretical Implications

Our research contributes to opinion leadership theory by offering a typology. Our typology can be applied in online communication networks. This proposed typology enables us to identify influential actors as well as to determine which functions these online leaders have within such a network. Thereby, we not only add to literature related to leadership dynamics, but, additionally, we connect leadership forms and leadership functions in networks (see Appendix F).

Research which is related to online leaders' characteristics is mostly focused on a few attributes, like the study from Ortega et al. (2012) who take a look at the trust which is present within a network, or the study by Boster et al. (2011), which investigates three characteristics of opinion leaders. Leader typologies within the online setting are rather scant, especially with regards to a health-related context. The study conducted by García et al. (2016) offers a typology of social media influencers. They distinguish between disseminator, engager and leader; however, they do not characterize them in detail and their research has not been conducted in a health-related context. Teichmann et al. (2015) present a typology of motivational drivers of content contribution which included an empirical study of three online communities. They only offer a typology of opinion leaders' key motivational drivers in a health context. Therefore, we believe with our proposed typology of mobilizers, facilitators and administrators we offer a new model.

By combining the network as well as leadership research both areas gain knowledge and emphasis will be put on the importance of this crossover, which will help future researchers.

6.2 Practical Implications

The conducted research helped gaining an insight into opinion leadership behavior in online communication networks.

In general, the gained understanding of online leadership can be valuable for corporations when developing strategies.

Even though we derived the typology from a health campaign it can be applied to different contexts within online communication networks. Thereby, we suggest taking on a more general perspective. For example, mobilizers will help engage others within any discussion irrespective of the topic. In the following we illustrate how our typology can be applied within a business context.

A company can apply our typology to identify leadership behavior within communication networks. If a company engages in any kind of communication network, it can use the leader typology to position themselves. Moreover, the typology can be used to analyze the other actors' functions within the communication network. Thereby, a corporation can decide on their own communication strategy, develop strategies on coping with competitors or make plans to form strategic alliances.

An additional field of expertise where our typology can be applied is market research. A company might want to analyze an online communication network related to their field of expertise. An example could be L'Oréal wanting to expand its business within the health-related cosmetics. They conduct market research to decide whether this investment would be profitable. One step of this market research could be supported by making use of our typology. Thereby, L'Oréal can effectively analyze online opinion leaders and get an overview of the climate within this business sector. If an organization, like L'Oréal, understands the characteristics as well as intentions of the different leader groups they will be able to either involve them within their strategic activities or they will be able to imitate such behavior. By making use of our typology as a guideline to approach the online leadership strategy development a corporation could save expenses.

Additionally, understanding online opinion leaders will be valuable for society in general. If society develops a better understanding of online influencers, society could critically reflect on how it is being influenced and become aware of which preferences were shaped by the persuasion of leaders. By directing the public's attention to online leaders' characteristics, they might become more aware of influential people within their own networks.

Having investigated leaders' characteristics, we better understand how to make use of network leaders. The mobilizers help in activating the public to engage in a specific discussion, which is not only helpful when raising health awareness but can also be important with regards to any relevant topic, like environmental development or politics. Facilitators help in dispersing information in a broad range, which supports health campaigns as well as any other field of interest. Administrators can especially be helpful in terms of being a role model. Due to their importance within the network they can influence the rest of the network by being an example.

In terms of health campaigns, the gained insights might help to setup a more efficient campaign and to better allocate resources. For example, the appointment of relevant leaders might be easier since the campaign creators can decide where to invest their resources. Maybe their focus is mostly to disperse information related to a health issue, which directs their attention and resources to facilitators.

Therefore, we believe our research has made contributions within different fields of expertise and highlights the relevance of research which addresses multiple topics at once.

6.3 Limitations and Future research

This study's aim was to get a better understanding of online leaders' characteristics; however, it has some limitations that can be addressed by future research which will be highlighted in the following.

The present study has only investigated leadership and its characteristics over a rather limited time frame. Some findings might alter if we would take on a more extended time frame, which is why we would suggest future studies to make use of a longitudinal approach.

Moreover, the study's emphasis was directed on a health-related context which means future research could test empirically whether the same holds for other fields of expertise. Thereby, they could point out similarities and differences between focus areas, which would lead to a more established typology. Since this research has only considered the SunSmart campaign, it could also be valuable to conduct a study which considers leadership across different online health campaigns, to achieve a higher generalizability. Other aspects which would enable us to draw more general conclusions would be by conducting a study across different social media platforms (e.g. Twitter and Facebook) or by leaving out a language constrain. Additionally, our study only scanned through the external links which had been included in the tweets, but one could further group these links. By for example stating how many educational versus how many commercial or self-promotional links have been used, we might have been able to get a better understanding of the leaders' intentions. Lastly, we would propose to investigate why similarities and differences between the different leader groups exist.

7. SHORT CONCLUSION

The central question of our study was: *What are fundamental characteristics of opinion leaders on Twitter in health campaigns, particularly with regards to the SunSmart campaign?* We have examined three leader groups; mobilizers, facilitators and administrators, which have been characterized by six attributes, namely: professional identity, sharing of knowledge, ascribed authority, audience size, geographic location and central topics. After which we offered a typology of online leaders in communication networks, which expands on existing literature and enables different parts of society to get an understanding of leadership in an online setting.

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10. APPENDIX A – NETWORK STATISTICS

The following three tables display relevant information for the identification of the three leader groups, which are mobilizers (weighted out-degree), facilitators (betweenness centrality), and administrator (PageRank).

Table 4 Weighted out-degree

Measure	Value
Range	0 - 8208
Cutoff value	111,095
Mean	2,40
SD	180,69

Table 5 Betweenness centrality

Measure	Value
Range	0-76063,66
Cutoff value	1505
Mean	72
SD	1432,14

Table 6 PageRank

Measure	Value
Range	0,000613 – 0,01174
Cutoff value	0,000605008
Mean	0,000174833
SD	0,000430175

11. APPENDIX B – SUNSMART NETWORK

The following figures display the investigated network. Each figure thereby shows one of the network analysis concepts which have been used to identify opinion leaders. To visualize which actors, have the highest scores we made use of varying size (small equals low, big equals high score) and employed a heat scale (blue-yellow-red equals low-medium-high) to highlight these nodes. The users (nodes) scoring highest are the biggest in size and red, whereas the users scoring lowest are small and blue.

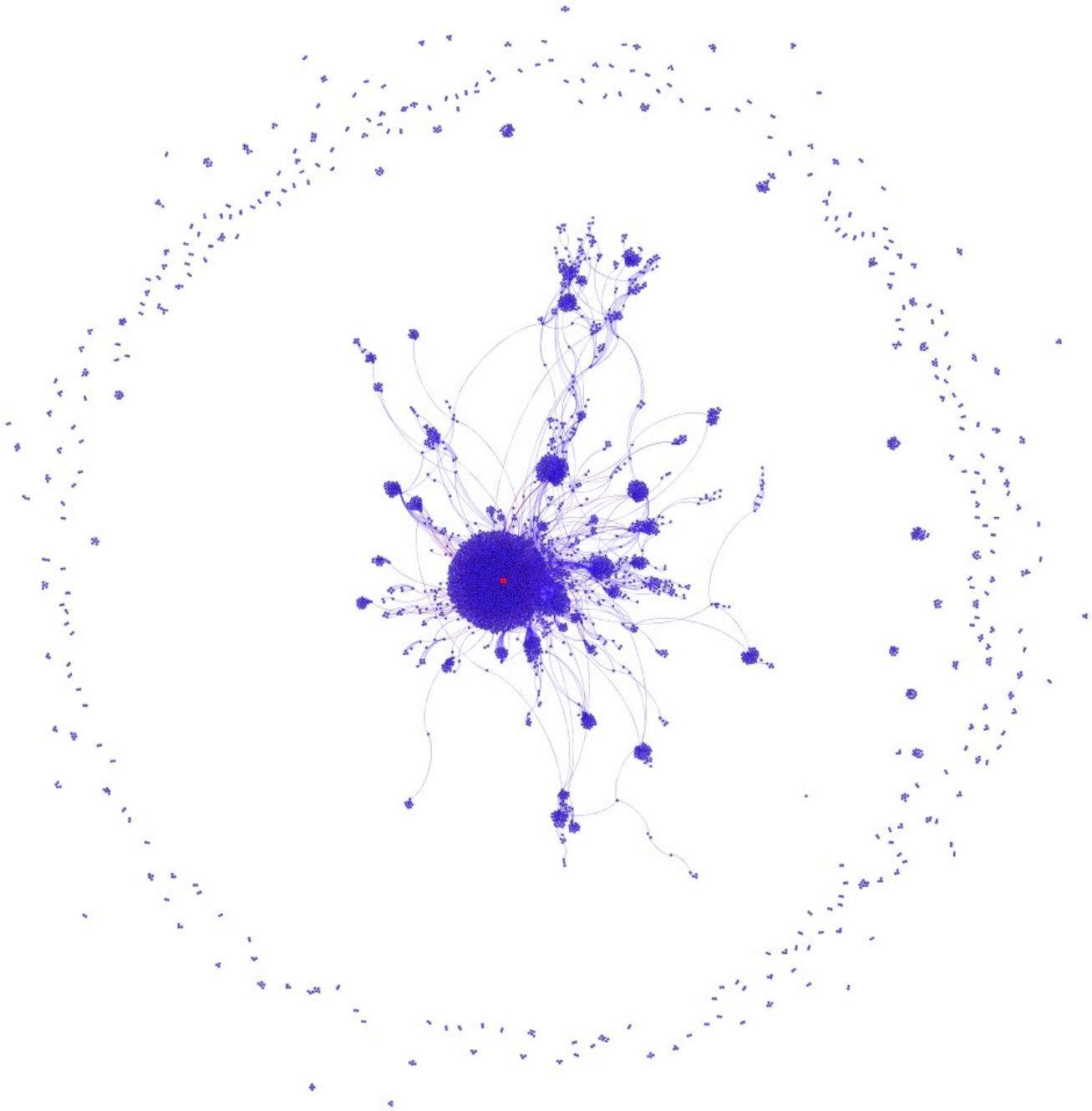


Figure 1 - Weighted out-degree

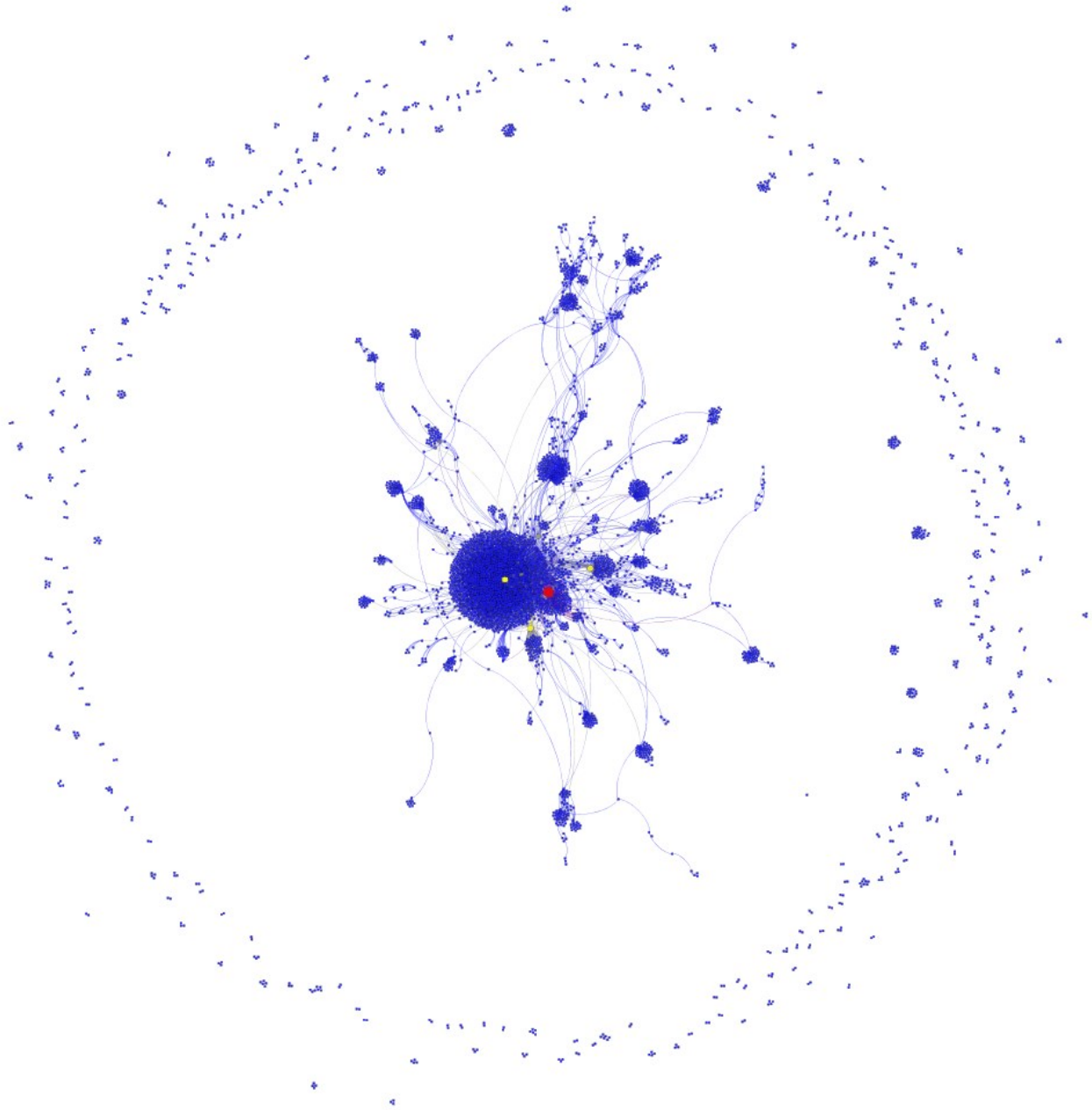


Figure 2 - Betweenness centrality

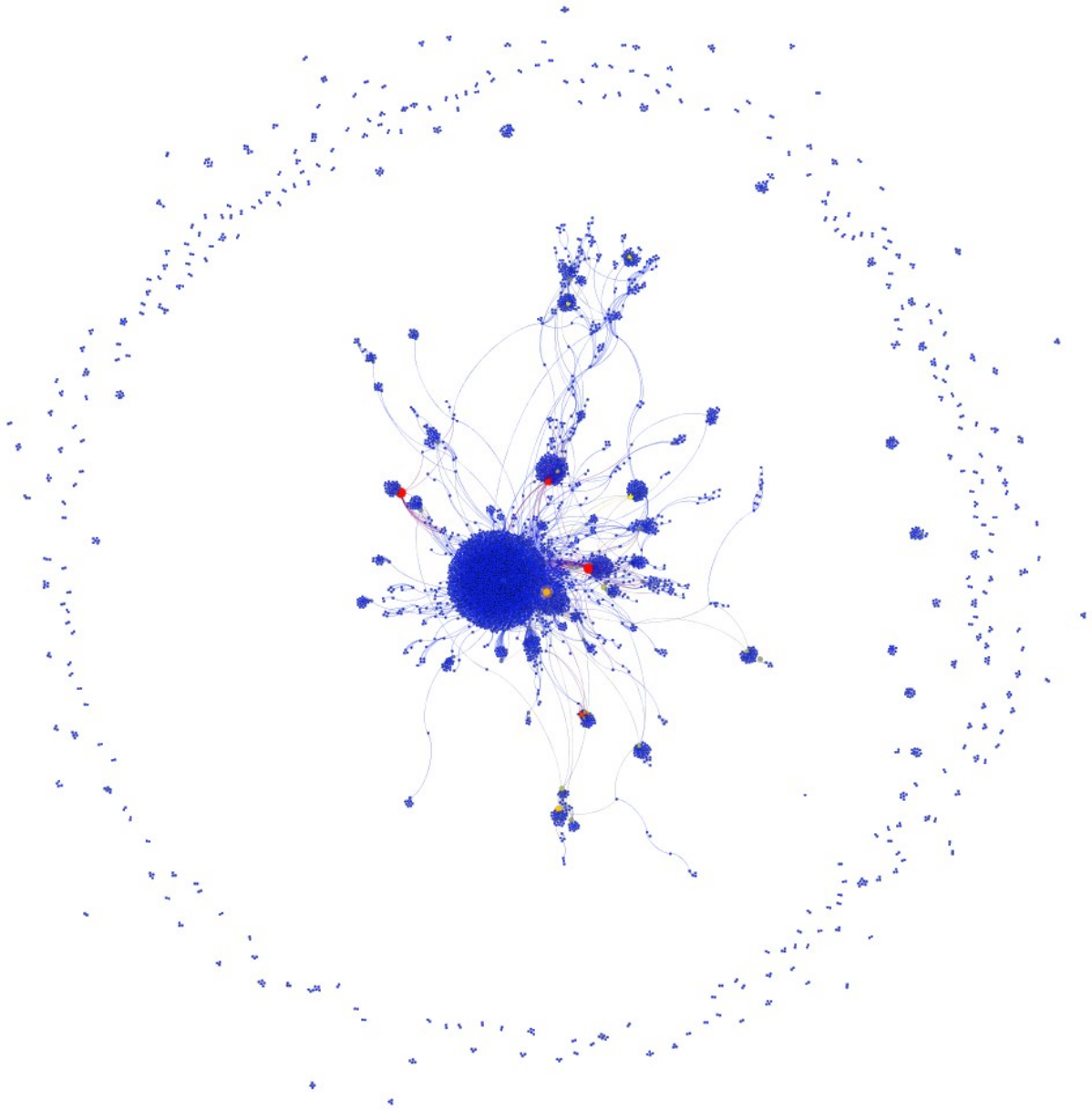


Figure 3 - PageRank

12. APPENDIX C – VISUAL REPRESENTATION OF MOBILIZERS' CHARACTERISTICS

The following graphs are visual representations of the analyzed characteristics. Any identification has been removed to assure confidentiality.

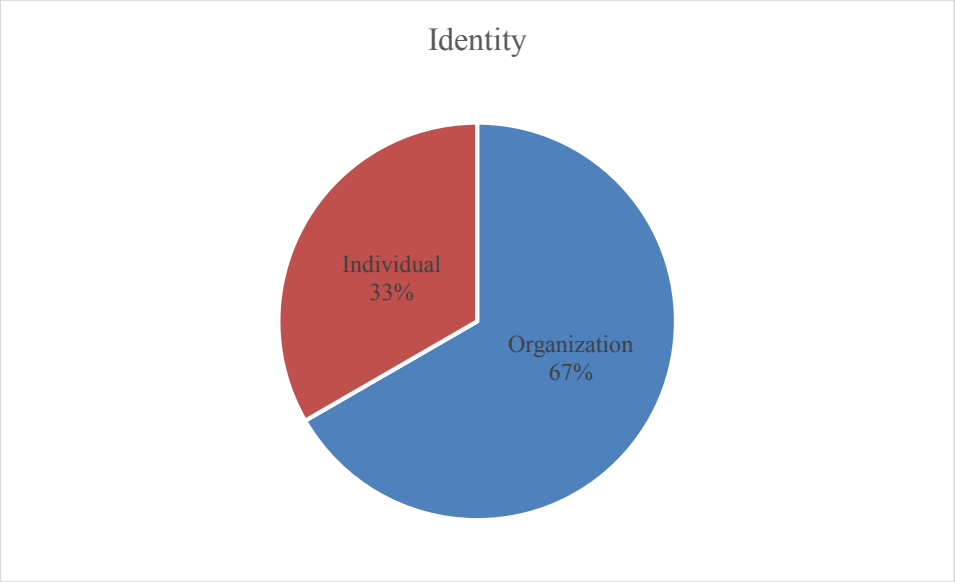


Figure 4 - Identity mobilizers

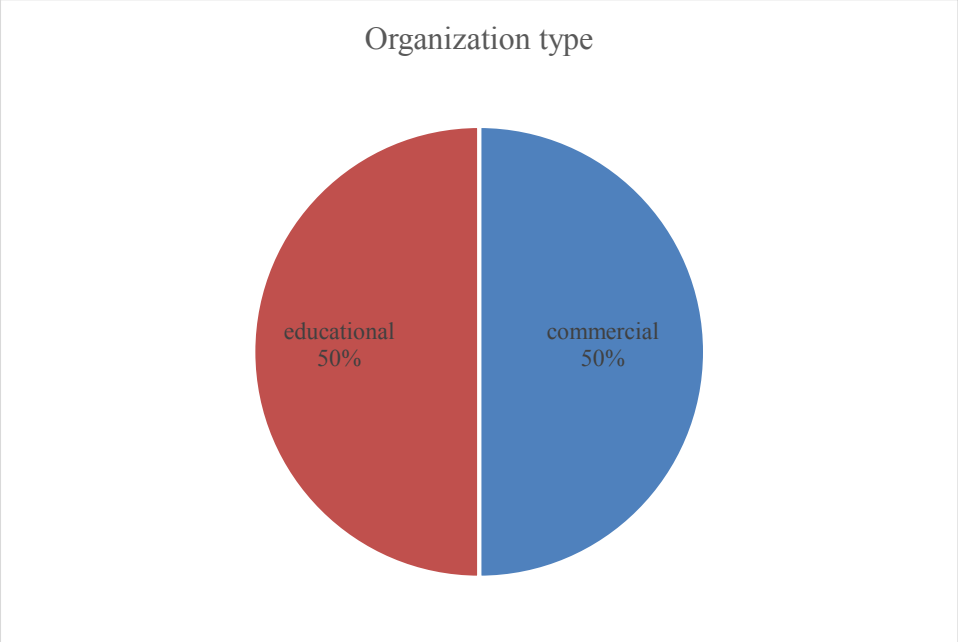


Figure 5 - Organization type mobilizers

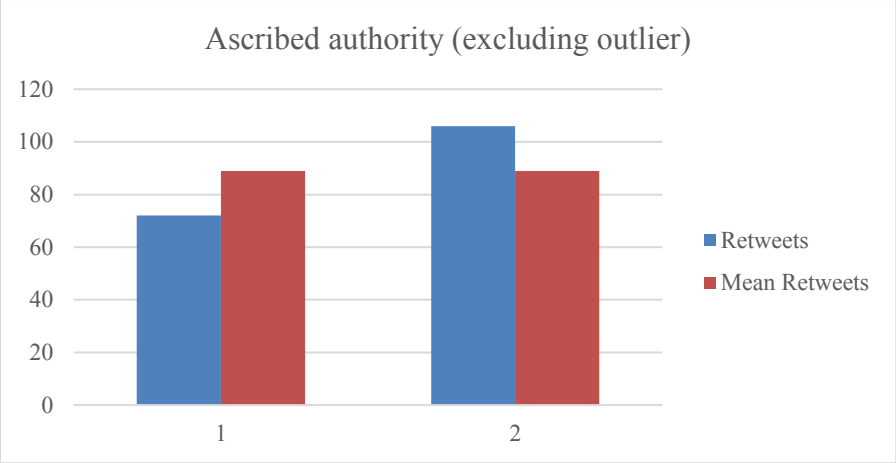


Figure 6 - Ascribed authority mobilizers

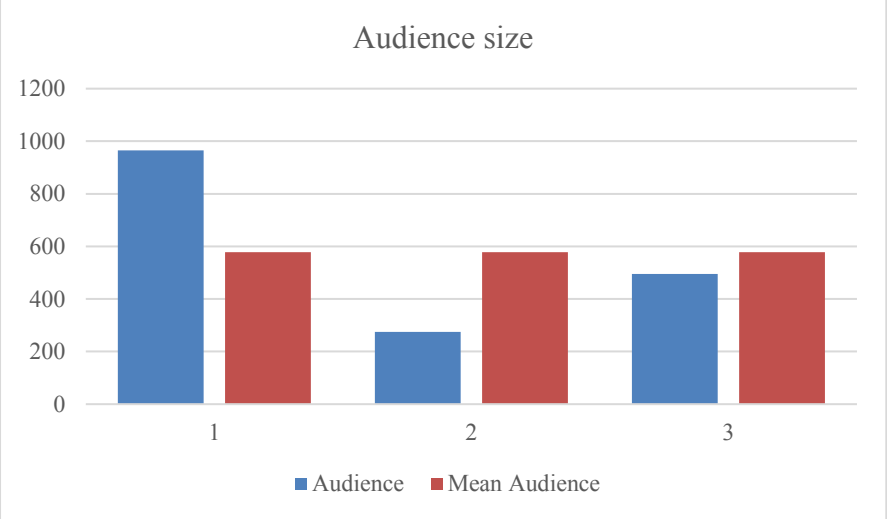


Figure 7 - Audience size mobilizers

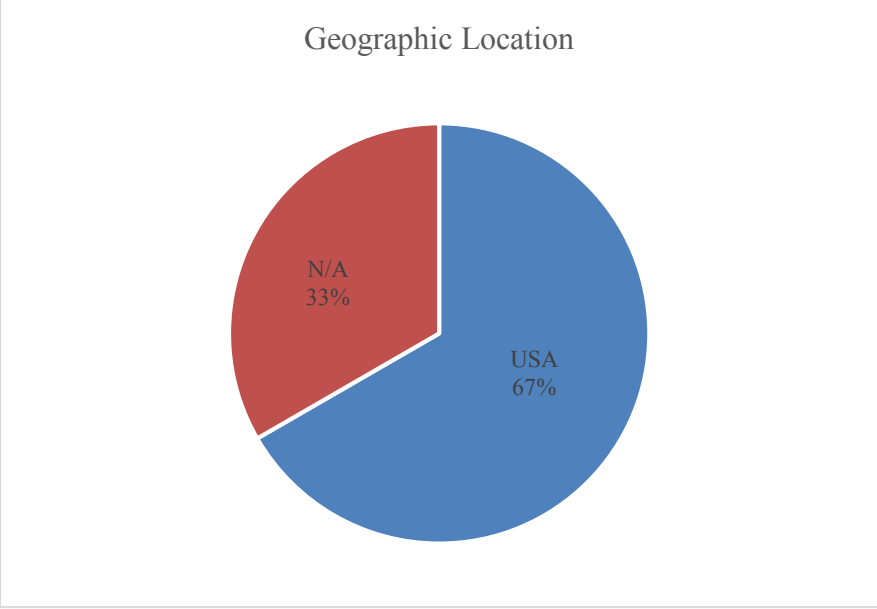


Figure 8 - Geographic location mobilizers

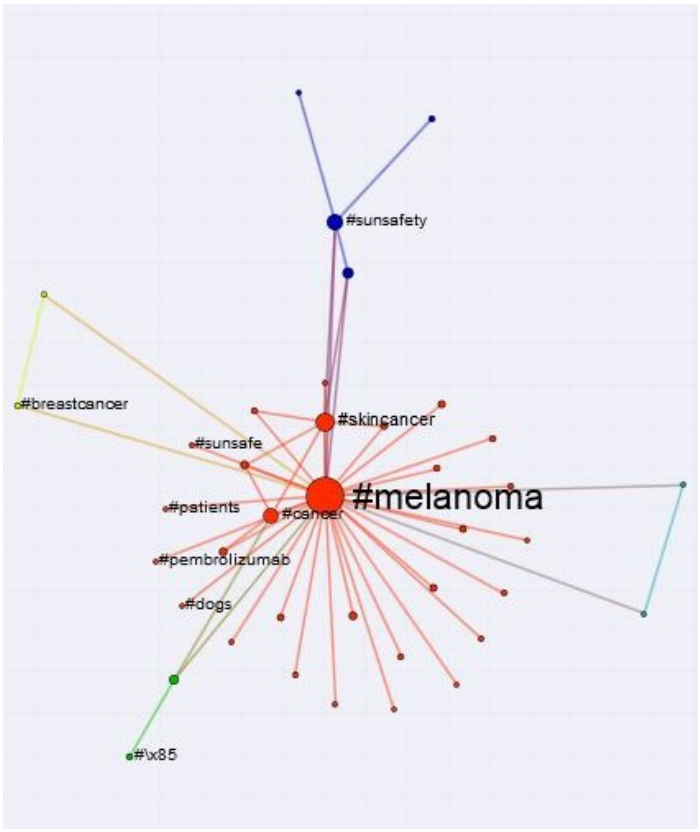


Figure 9 - Co-occurrence network mobilizers

13. APPENDIX D – VISUAL REPRESENTATION OF FACILITATORS' CHARACTERISTICS

The following graphs are visual representations of the analyzed characteristics. Any identification has been removed to assure confidentiality.

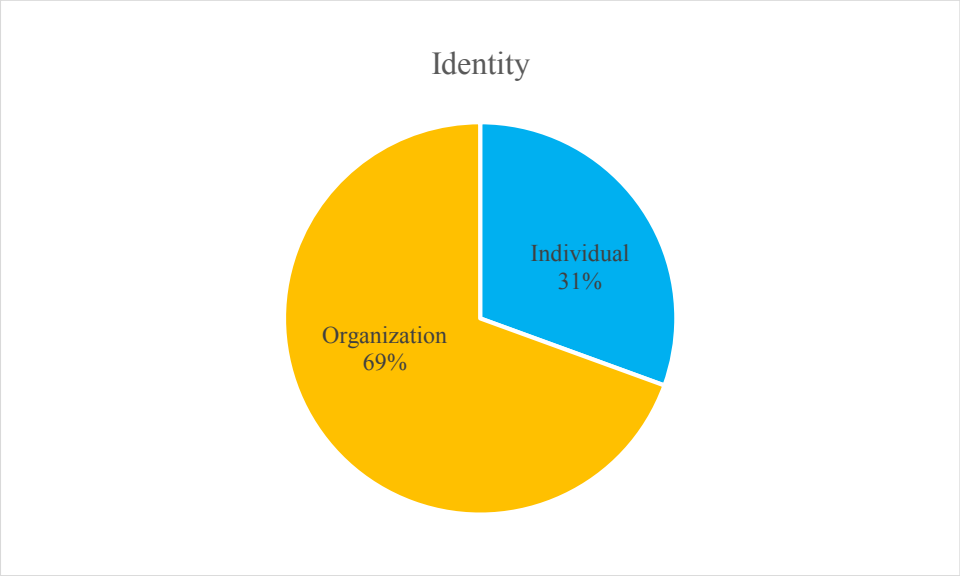


Figure 10 - Identity facilitators

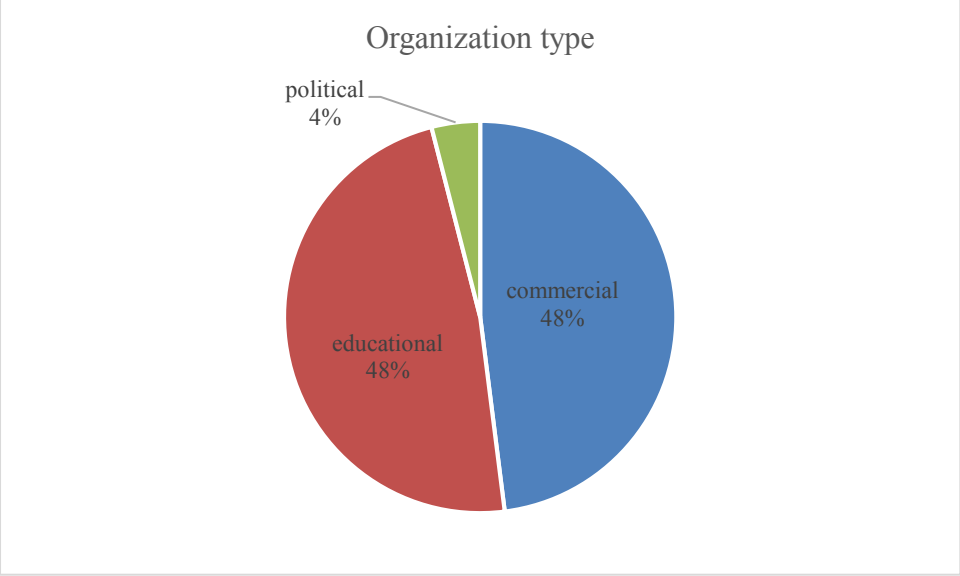


Figure 11 - Organization type facilitators

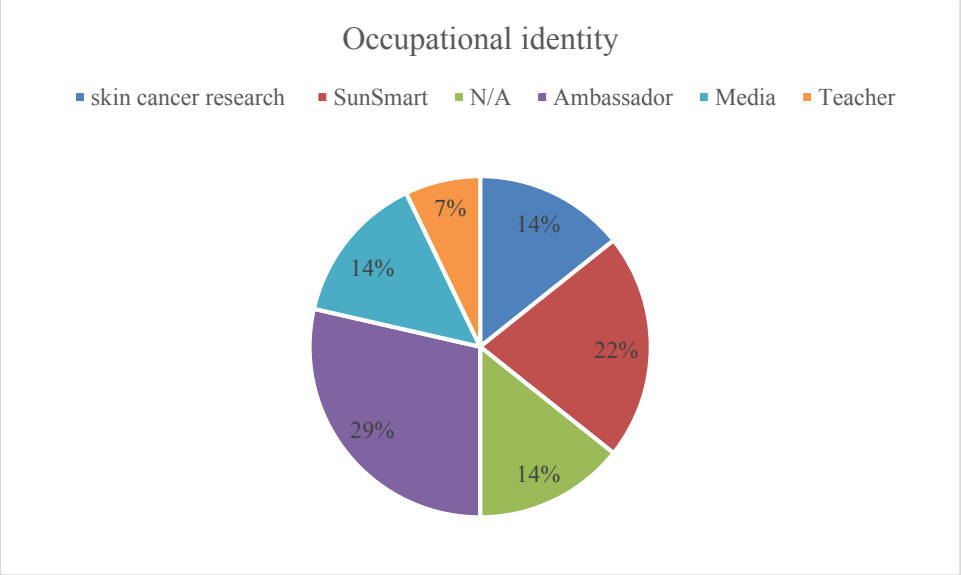


Figure 12 - Occupational identity facilitators

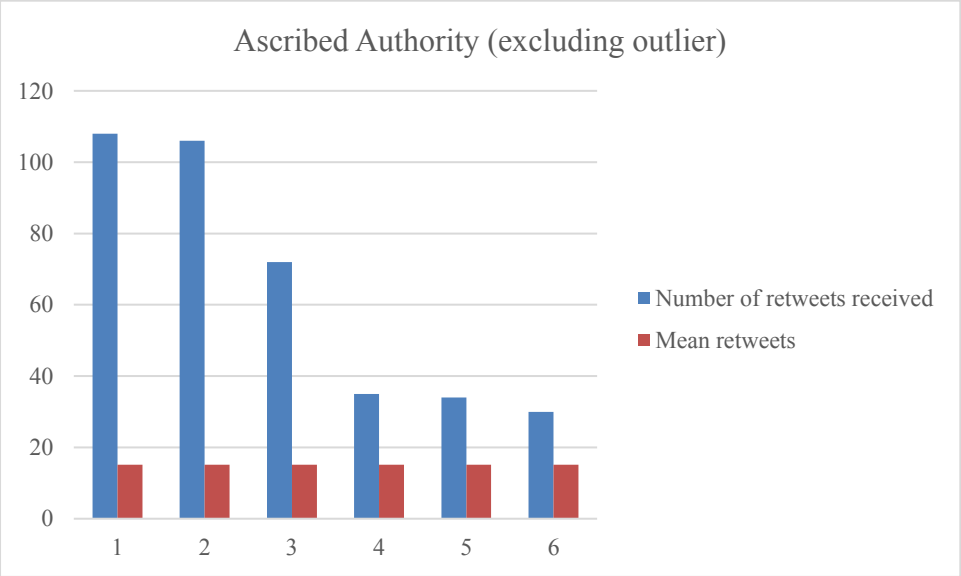


Figure 13 - Ascribed authority facilitators

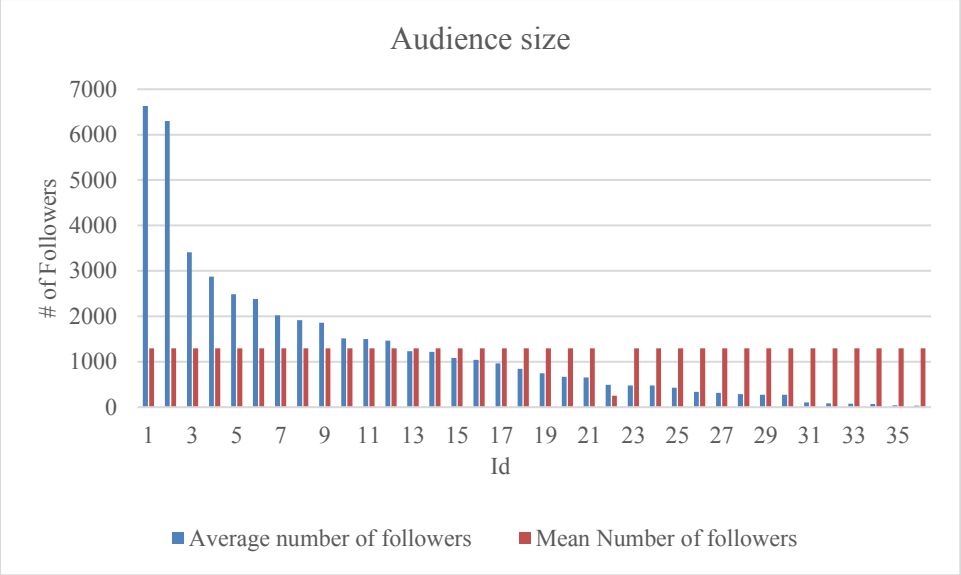


Figure 14 - Audience size facilitators

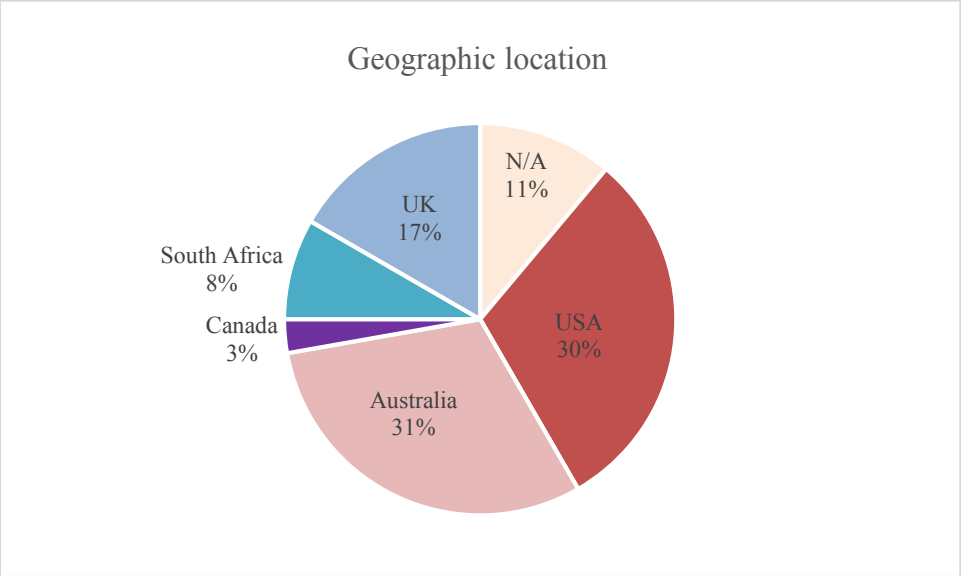


Figure 15 - Geographic location facilitators

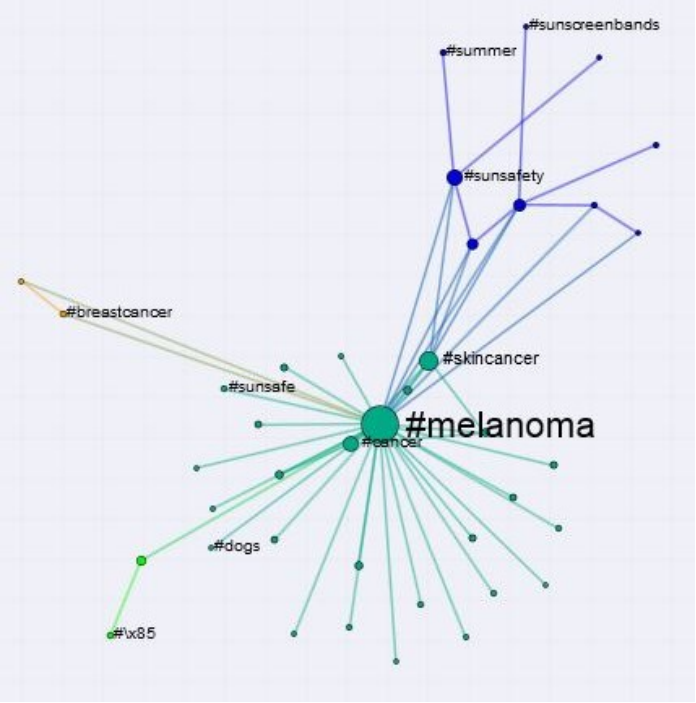


Figure 16 - Co-occurrence network facilitators

14. APPENDIX E – VISUAL REPRESENTATION OF ADMINISTRATORS' CHARACTERISTICS

The following graphs are visual representations of the analyzed characteristics. Any identification has been removed to assure confidentiality.

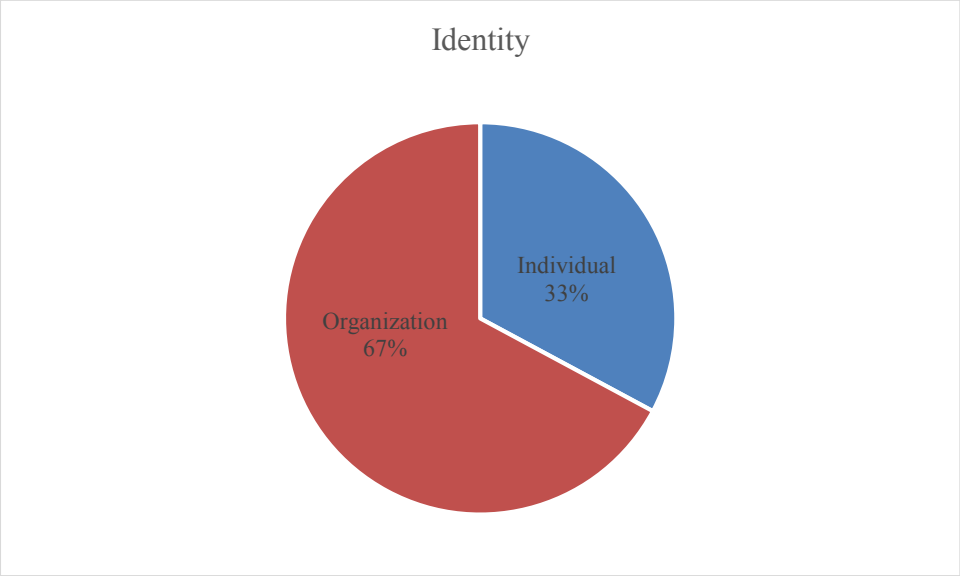


Figure 17 - Identity administrators

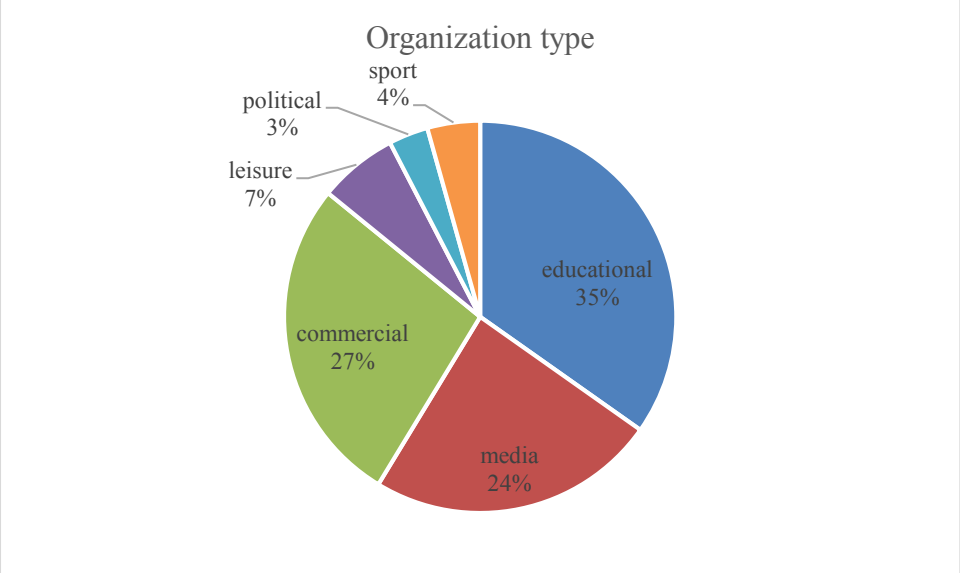


Figure 18 - Organization type administrators

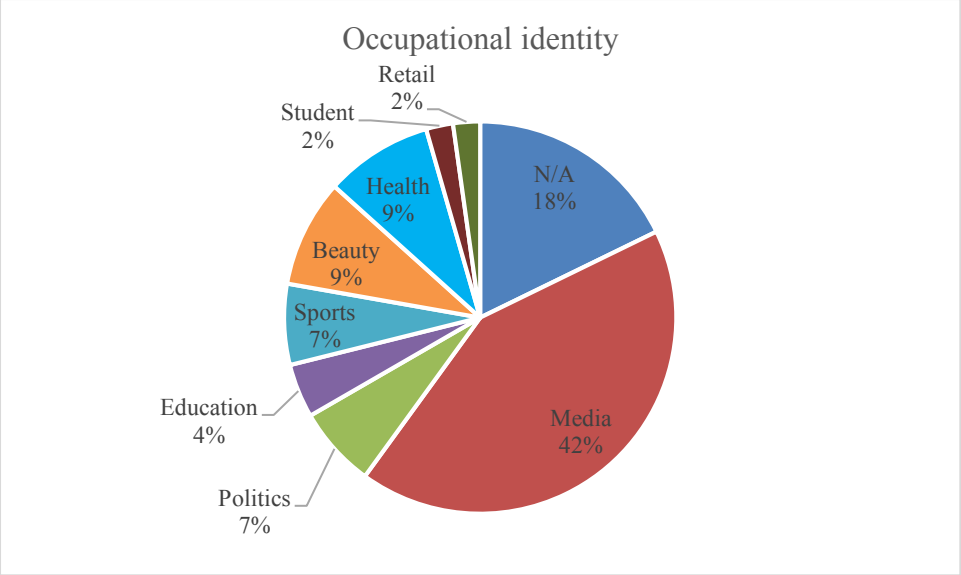


Figure 19 - Occupational identity administrators

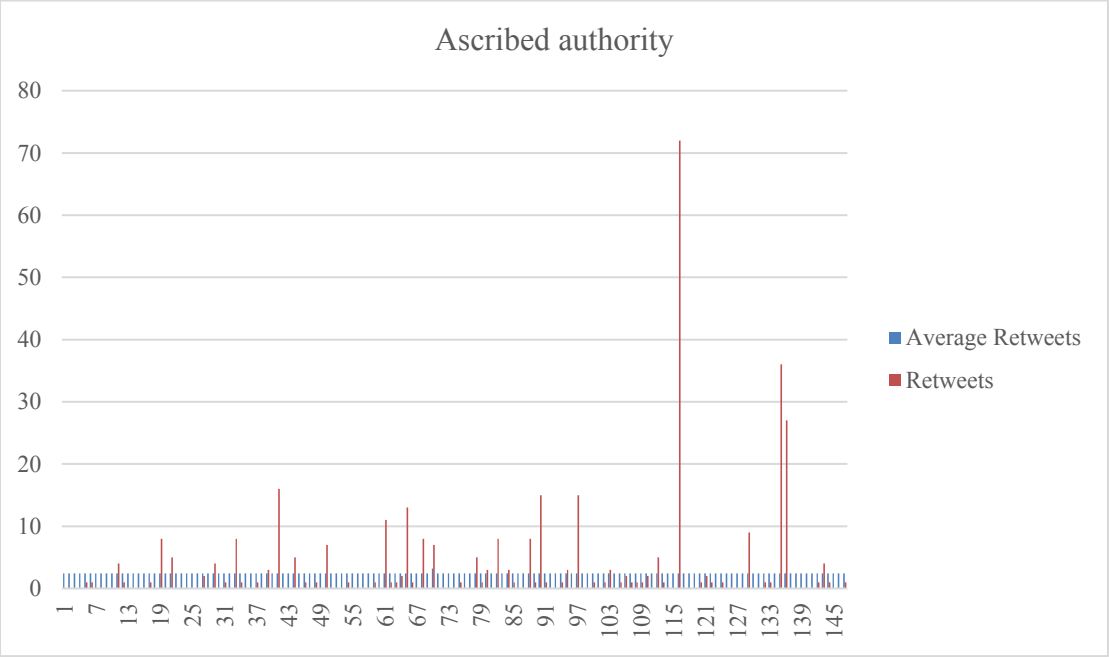


Figure 20 - Ascribed authority administrators

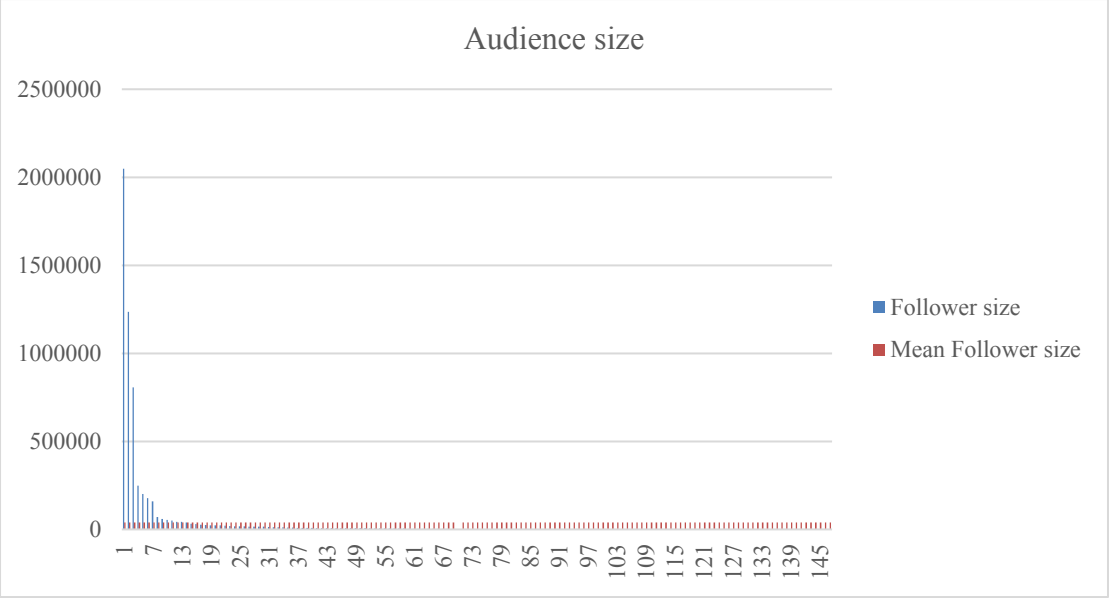


Figure 21 - Audience size administrators

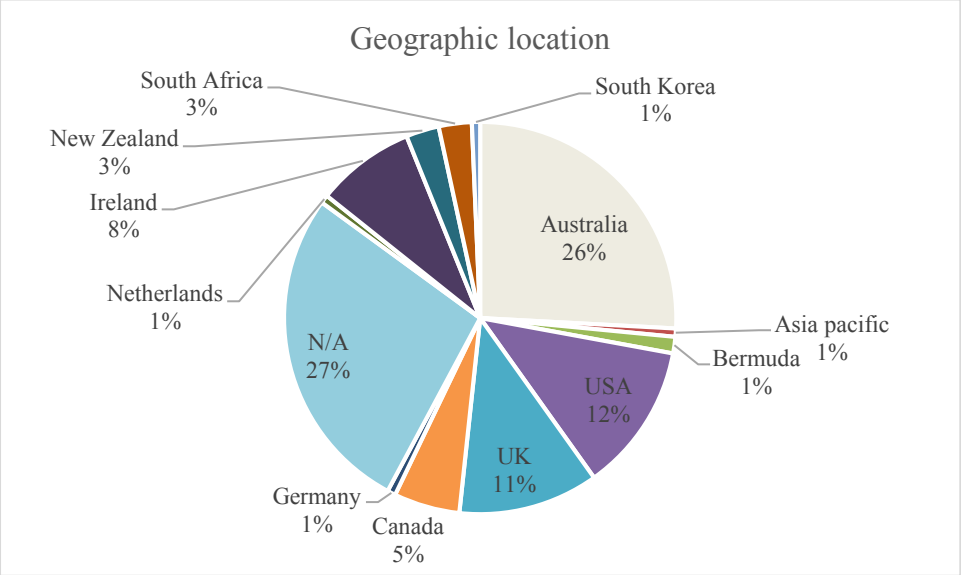


Figure 22 - Geographic location administrators

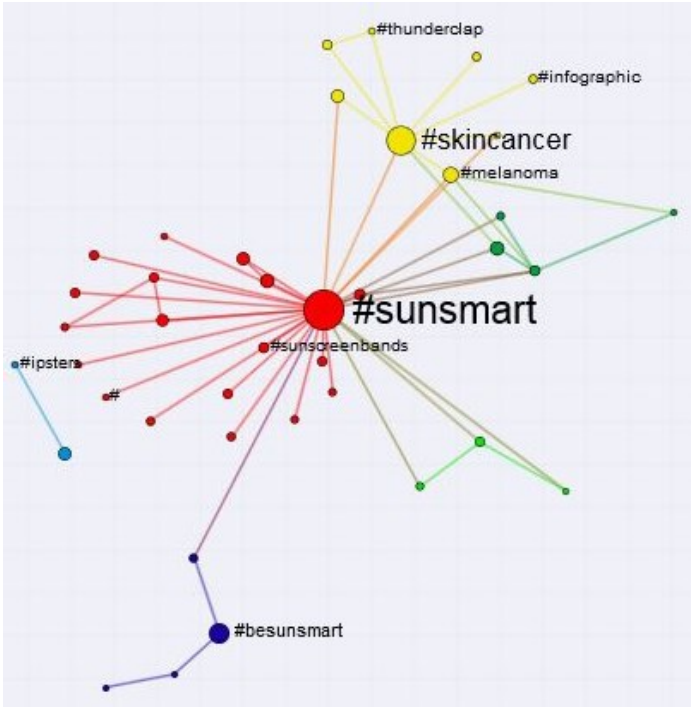
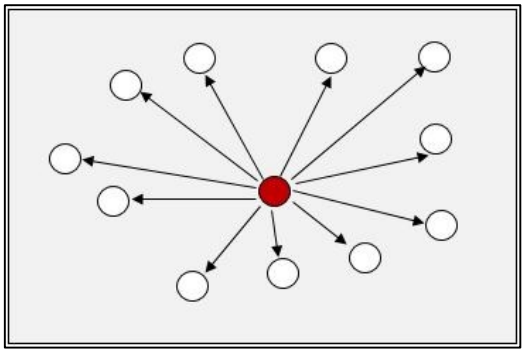


Figure 23 - Co-occurrence network administrators

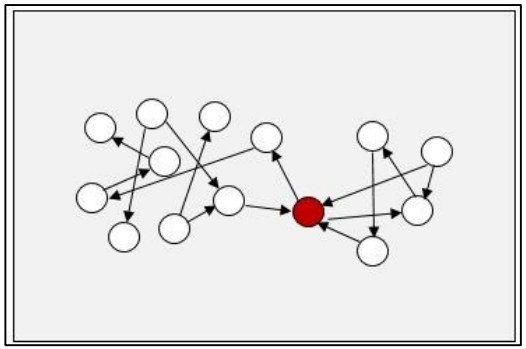
15. APPENDIX F - LEADERSHIP FORM AND LEADER FUNCTION

The following chart (visualization 1) presents the connection between the identification of active, information dispersing and authoritative leadership and the identification of their corresponding leader form as mobilizers, facilitators and administrators. The chart thereby only displays examples, which have been created to support the reader's understanding of our concept. No real data is displayed since the investigated network is much more complex than the examples displayed. Circles thereby represent different network actors (nodes), or in terms of Twitter different users. The circle which is colored red represents the investigated leader, whereas the white circles represent other Twitter users within the communication network. The arrows represent relational ties (edges) between the different users. Whereby, the black arrows represent the ties which created the network and the red arrows represent the effects the leader has by employing his function within the network. The top displays the leadership form each leader makes use of. Active leaders have a lot of outgoing edges, which is why all arrows originate from the leader and point towards other nodes. In terms of Twitter this can be translated into an influential user sending out many tweets to other network actors. The next picture on the top displays a bridging leader because the leader connects two subgroups with each other, thereby leading to a more connected, dense network. This could for example be translated to a leader, who is based in Ireland, but has send or received tweets from users in the United States as well as the United Kingdom. He thereby connects these two subgroups. The last top image visualizes an authoritative leader, since he has many incoming ties (in-degree) from actors who also have many incoming ties, thereby gaining prestige. This could be translated to an influential user receiving many tweets from other rather prestigious users. The lower level of the visualization represents the function these leaders take on within the communication network. The first displays the fact that mobilizers support an active discussion and thereby create more connections within the network. The second lower image represents the facilitating aspect of the second leader group. Facilitators enable the flow of information within the network, which is why the red arrows highlight the diffusion of information between the different subgroups, information can flow through the facilitator to any other part of the network. The final part represents the function administrators employ within the communication network. This leader group aims at managing the relations within the network. Meaning these leaders direct the focus of other actors on specific topics or users, which can create new ties within the network.

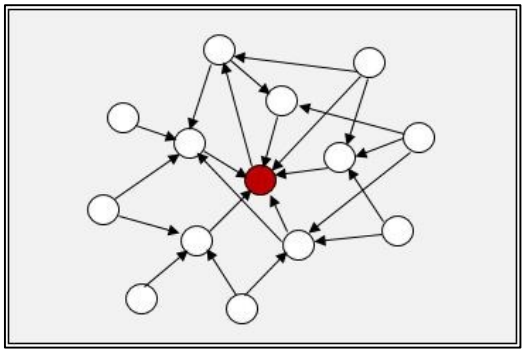
Active leaders



Information dispersing leaders

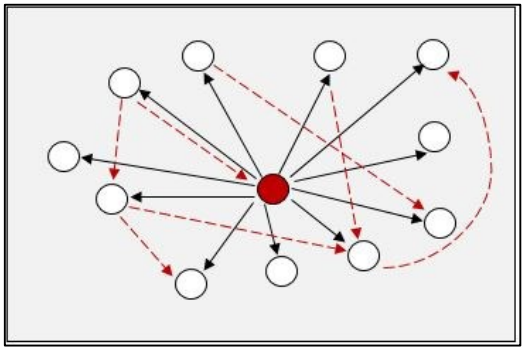


Authoritative leaders

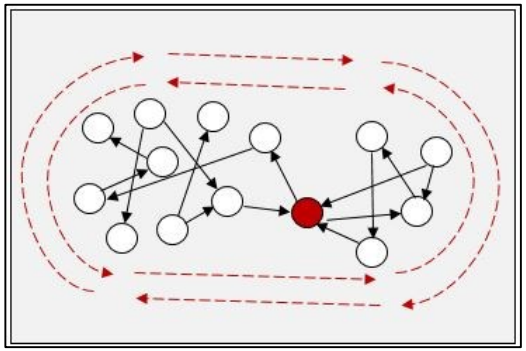


Leadership form

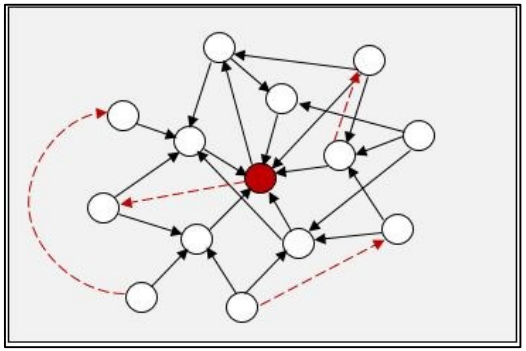
Mobilizers



Facilitators



Administrators



Leader function in the network

Visualization 1 - Leader form & function