SENSEMAKING AND COMMUNICATION ROLES IN SOCIAL MEDIA CRISIS COMMUNICATION

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Abstract. Social media is becoming increasingly important during crisis situations. Affected people are now enabled to provide helpful on-site information, and emergency service organisations can use social media to inform people and communicate with them. This study addresses how different communication roles in social media affect sensemaking during crises situations. To this end, we conducted a study on Twitter during the Brussels attacks of 2016. We collected a sample of 3,223,197 tweets, which included a total of 1,535,943 participants. Our study reveals that, whereas information distribution dominates early crisis stages, attention-keeping gains in importance in subsequent stages. It is decisively depending on the characteristics and retweet behaviour of certain communication roles that information is being consulted by individuals in a situation of either lack of information or information overload.

Keywords: Sensemaking, Social Media, Twitter, Crisis Communication, Information Systems

1 Introduction

Crisis situations are characterised by ambiguity, confusion and feelings of disorientation. Thus, during disasters, people have a powerful occasion for sensemaking [1] to rationalise what is going on [2]. While sensemaking is the process of social construction by information seeking, sensegiving is a process by which attempts are made to influence the meaning construction and sensemaking of others towards a preferred interpretation of an occurrence [3]. People have a drive for sensemaking due to the motivation of simplification and the desire to construe the world in favourable ways [4]. From one of its first definitions, sensemaking is a process of social construction that occurs especially at that point, when discrepant cues interrupt individuals' ongoing activity in their real life. Thus, sensemaking involves the retrospective development of plausible meanings that rationalise what people are doing and making sense of a situation after it took place [2, 5]. To start

their sensemaking process, individuals need information to connect different cues and draw a picture of the crisis situation.

Social media services such as Facebook or Twitter are increasingly used to communicate during crisis situations by individuals, members of the affected public, professional media and organisations [6, 7]. The microblogging service Twitter especially emerged as a widely used social reporting tool to instantly spread information on social crises [8]. Recent research shows that Twitter is a resilient and rapid information diffusion tool under large-scale crises such as natural disasters [9–11], terror attacks [12, 13] or social movements [14, 15]. Due to its short texting service interface on cell phones, Twitter turned out to be extremely rapid in tweeting situational reports to the online community [16], thus allowing first responders to collectively cope with the crisis situation [17]. During large-scale crises, it has become the norm for the incident to be initially reported by a local eyewitness with a mobile communication device. The report is rapidly distributed through social media services, and mainstream media involvement follows [12, 18]. However, especially in social media communication during large-scale crises, there might either occur the problem of information dearth or the problem of information overload, depending on the particular crisis situation [19]. Therefore, besides a general need for information, people also try to select incoming information in social media. Both the provision of information as well as information selection can be undertaken by hashtags [20], but also through opinion leaders in a social network [21]. Twitter users not only consume the incoming information from their network, but also broadcast the consumed information into their own network [22]. By that, the most active users might direct the public sensemaking process in a social media crisis communication by information selection and providing. In this context, recent research mainly focused on communication patterns during crises [22].

Recent research primarily focused on face-to-face situations [4, 23], though less on sensemaking processes in social media environments. Social media is used as an information source in crisis situations, because it provides fast and easy access [24]. On the one hand, there is a need for information when it comes to natural disasters or terror attacks to start the sensemaking process; on the other hand, communication systems, such as social media applications, might be overloaded with information [19]. Thus, information tends to be chaotic and uncontrollable and it is difficult to maintain a vast overview. This can cause rumours or false information in dangerous situations and might hinder emergency services to manage the crisis efficiently.

An Information-Systems-Journal article [20] identified collective sensemaking through Twitter during the 2011 Egypt Revolution. It could be monitored as the emergence of few hashtags out of many, which mainly brought together crisis-related information. Conclusively, the authors revealed that – besides hashtags – one can investigate whether power users, who receive the highest number of retweets by others [25], direct the collective sensemaking process. If the existence of power users can be confirmed, one can further analyse them and their characteristics. In this paper, we build on the conclusions and suggestions of [20] and address the collective sensemaking and its dynamics through roles and characteristics in a case study. We therefore aim to answer two research questions:

1. Which roles can be identified within the collective sensemaking process in social media during a crisis situation and how do they develop over time?
2. Which characteristics do these roles adopt in the collective sensemaking process in social media?

The remainder of this paper proceeds as follows: in Section 2, we present the status quo of the literature regarding (1) crisis communication in social media, and (2) sensemaking in crisis situations. In Section 3, we introduce our research design, which includes the case description, the data collection and our data analysis in detail. We then present the results of our case study in Section 4, followed by a discussion of our research findings in Section 5. The paper ends with a conclusion in Section 6, including limitations and an outlook for further research.

2   Theoretical Background

Crises are characterised by high levels of threat, situational uncertainty and decision-making pressure under time constraints. Therefore, a critical need for immediate and accurate information occurs in crisis situations, which are usually provided by experts, emergency management professionals, governmental organisations or similar authority figures. Besides the face-to-face-context and traditional media, in the past few years, social media use has also become a consistent feature in crisis response [7, 19, 26]. In a crisis communication process, social media tools are being more and more used by each actor of society, like individuals or media, but also increasingly by formal crisis responders [6, 7, 27]. People use and rely on official sources and other believable eyewitness accounts from which to source their information [28]. In this context [29], six types of information resources under different crises types can be distinguished on Twitter: eyewitness, government, non-governmental organisation, business, traditional and/or internet media and outsiders. While tweets from governments mainly advice or warn the public, tweets from the media offer information about crisis development, whereas outsiders produce information, although they are not personally affected by the event. Depending on the role type, the social media usage in a crisis communication can differ: individuals especially tend to use social media during disasters and post-disasters to investigate what is going on, check with family and friends or mostly direct, relay, synthesize or redistribute (existing) information [9]. Nevertheless, organisations (e.g., emergency management agencies like the police) use social network to spread important information to the public by using microblogging channels for two-way interaction [30–32]. This behaviour was observed during the Queensland Floods in 2010/2011 [33, 34], in the information-sharing behaviour of the US police departments [35] and during the Boston Marathon bombings of 2013 [36]. EMA use their social media channels mainly to broadcast accurate and simple messages to keep populations informed [31], [37]. Furthermore, [37] mention that a government's communication behaviour on social media is dependent on who is tweeting: the PR-department (formal, one-way-communication) or an employee (informal two-way communication). Especially during social crises, companies need to spread reliable

information as early as possible to avoid rumours in social media crisis communication [17]. Overall, social media technologies mediate human communications in social crisis situations and present varying patterns of crisis communication [14]. In the social media context, e.g., in Twitter, users not only consume the incoming information from their own network, but also diffuse information to their own network. Furthermore, [21] showed through conducting an analysis of a 260 million Twitter dataset, that approximately 20,000 elite users (celebrities, media, organisations and bloggers) were responsible for 50 percent of the tweets. The authors suggest that people get their news directly through the elite users, who produce information, as well as through intermediaries (ordinary, non-elite users), which have a high follower count and distribute incoming information to their network [21]. Also, user characteristics, for example, the user's popularity, might be a driver for information diffusion [38], as well as URL and hashtag inclusion [39]. A social media crisis communication might involve users who seek information to start their sensemaking process, but also the ones who perform as sensegivers by information providing and sharing. Besides elite users and opinion leaders, in a case study about implementing an online platform for crisis communication, [40] suggest three different user types, which might play an important role for sensemaking in a social media communication: (1) inspectors, who define a certain event, (2) contributors, who provide media content and witness statements, and finally, (3) investigators, who verify media content by organising and sorting data and detecting missing information. In contrast, [41] distinguish the helper, reporter, retweeter and repeater as active user types on Twitter – each with their specific characteristic of producing, distributing and organising information.

Especially in crisis situations, people become highly suggestible and turn to others to find cues [42]. Collective sensemaking is manifested as the communication behaviours of active information seeking, offering and sharing among a like-minded group of people, which helps reduce the level of situational ambiguity and collectively defines an unfolding situation [20, 43]. Collective sensemaking can take place among emergent groups of actors, who interpret information together face-to-face [44], or remotely through social media [35, 45]. Through their ability to facilitate collective sensemaking, social media serves the purpose of filling in the possible information vacuum left by mainstream media [19] or other official channels. Crisis communication differs across media types like Facebook and Twitter [46–50], and therefore, the sensemaking process can also differ. But independent of the type of media and the leading roles, the direction of the sensemaking process is also dependent on the structure of a social network. During the 2011 Egypt Revolution, [20] detected the occurrence of collective sensemaking through collecting information and maintaining situational awareness via hashtags. In detail, the authors revealed that the Twitter space was structured around a few hashtags out of many, which can be related to the keynoting phenomenon [42]. Furthermore, during the 2011 Egypt Revolution, the hashtags' frequency changed over time and a content analysis showed that hashtags were used either as a symbol (to focus attention to a certain issue) or as a word in a sentence (to distribute information to a certain issue). Thus, [20] suggest that there are two characteristics of collective sensemaking through Twitter: (1)

maintaining a high level of awareness to a certain issue during an unstable situation (attention keeping), and (2) offering situational news and information about temporal events (information distributing). The authors conclude that, besides hashtags, one can investigate whether power users direct the collective sensemaking process and how these power users are characterised. In this context, power users could be defined as Twitter users, who receive the highest number of retweets [22], because retweet frequency can be seen as a measure of popularity for the message or its author [51].

3 Research design

In order to address our research questions, we conducted a case study and focused on the Brussels attacks in March 2016 as a type of a public crisis which generated a significant amount of attention and traffic on social media. We have chosen the microblogging platform Twitter as our data source, because recent research shows that Twitter as a social media application is frequently used for crisis communication in social crises or social change [14, 17, 20, 52]. Especially for the 2016 Brussels attacks, there is a direct link between Twitter and the crisis itself: in the first few hours after the bombings, the Crisis Center Belgium (@CrisiscenterBE) called on the people to communicate via social network sites, because mobile communication networks collapsed temporarily.

3.1 Case description

On the morning of 22nd of March 2016, three coordinated nail bombings occurred in Belgium: two at the Brussels Airport in Zaventem, and one at the Maalbeek metro station in Brussels. In the scope of the attacks, a total of 32 victims were killed. Furthermore, over 300 people were injured. Belgium raised the terror threat level to its highest, the public and air traffic of Brussels was suspended, and the population was told to stay where they were. As it was unclear who was responsible for the attacks and whether the suspects were still alive, the search and investigation went on. Thus, the population remained in uncertainty for nearly ten hours. Shortly after the attacks, the crisis communication began to spread over to social network applications.

3.2 Data collection and analysis

For our empirical analysis, we collected tweets regarding the Brussels attacks 2016 and examined the first 27 hours of the crisis, from March 22nd (8:00 am CET) to March 23rd (10:59:59 am CET), 2016. We collected the data through the Search API[1] of Twitter with a self-developed Java crawler, using the library Twitter4J[2]. We saved the collected data in a MySQL database, gathering all tweets that contained at least one of the following three keywords (including the hashtags): *brussels*,

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[1] https://dev.twitter.com/rest/public/search, last access: 08-22-2016
[2] http://twitter4j.org, last access: 08-22-2016

brusselsattacks and *bruxelles* and merged them into one dataset. The keywords were selected based on their frequent usage on the platform. After collecting the data, we decided to divide the data into seven time slots in order to handle the large amount of Twitter data. The slots are of different lengths (slot 1-5 cover three hours, slot 6-7 cover six hours) because of the tweet volume and the beginning dynamics of the communication, which decreases over the examined overall time period.

For identifying the roles of participants in the crisis communication, and thus, to answer our first research question, we used methods from social network analysis. For each time slot, we analysed the graph given by the retweet network. The nodes (vertices) of our network are Twitter accounts and the edges are retweets. The network is therefore a directed network and the edge weights are the number of retweets. To analyse and visualise the networks, we used the open source tool Gephi[3]. To produce the visualisations for each time slot, we ran the layout algorithm ForceAtlas 2. The size and colour of each node represent the number of retweets from a node. Subsequently, we filtered each time slot with the aid of the Gephi filter Giant Component to remove all nodes which are not connected to the main network. Furthermore, we highlight the nodes with the highest indegree with their account names. Indegree is the value of how much a node has been retweeted, whereas the outdegree describes the value of how much a node has retweeted itself.

As an elementary assumption, we suggest that the phenomenon of keynoting is not only applicable to the utilisation of hashtags, but also to the determination of roles during crisis situations – especially under consideration of power users of a social network. The retweet function is one of the core functions of information diffusion on Twitter. The retweet activity not only shows reciprocal relations between different users, but is also suitable for identifying particularly active or strong connected users [53]. The decisive key figure to determine power users by the means of a network analysis using Gephi is the indegree measure. Since the available data is represented in a directed graph, the indegree indicates a node's prestige by quantifying its frequency of being retweeted. The retweet frequency for certain tweet messages can be seen as a measure of popularity for the message or its author [51]. For the purpose of arranging a significant sample of power users, we identified the top 20 power users for each time slot based on their indegree value. We focused on the top 20 users, because these users have the most impact on sensemaking in our case.

We also calculated the overall follower count, overall original tweet count, and betweenness centrality value based on the directed graph. Betweenness centrality measures the degree to which a node is in a position of brokerage by summing up the fractions of shortest paths between other pairs of nodes that pass through it [54]. The resulting set of power users are subsequently categorised into roles by all involved authors independently. Similar to [29], we adopted information sources such as traditional/internet media or the government as roles. In contrast to [29], we extended the source of outsiders to the role of private person and various kind of public persons to gain more detailed insights. The categorisation leads us to seven different role types. To complete the analysis regarding the first research question, identified roles

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[3] https://gephi.org, last access: 08-22-2016

will be examined towards their development over time and how the presence of certain roles might shift during several crisis stages.

For the second research question, role characteristics are further examined. At that point, we combined findings from existing literature, in particular the definition of attention keepers and information distributors [20] with metrics of the Twitter network and the results of a detailed content analysis concerning all original tweets posted by the top 3 users of each role type sorted by indegree, hence the number of retweets received by those users. To obtain further insights on the characteristics, we conducted a qualitative content analysis [55], considering all original tweets (131) posted by the top 3 accounts of each role type (ranked by indegree). Indeed, 131 tweets represent less than 10 percent of the total number of tweets in the subdataset, but for two of the seven identified role types, there could be related only three user accounts each in the subdataset. Therefore, we decided to examine a smaller set of user accounts' original tweets, but with the same number of accounts per role (namely 3), instead of examining a larger set, but with a dissimilar number of related user accounts per role type. The 131 original tweets of the present selection by 21 user accounts (7 (roles) x 3 (top users)) were evaluated by all authors independently for the purpose of characterising the function each role adopts in the collective sensemaking process in a crisis situation. This includes the measure hashtag-use (symbolic/word) like [20] did, and furthermore, measures URL-use, which is a common measure to characterise tweet content [39], and the type of information (solicitousness, crisis information, opinion, other), which were partially adopted by [29] and further determined by the authors after exploring a random set of tweets out of the 2016 Brussels bombing dataset. We adopted relevant information types from [29], such as sympathy and emotional support, which we redefined as solicitousness. Furthermore, we applied caution and advice, as well as affected individuals, which we combined with infrastructure and utilities to general crisis information. Since we analysed the first 27 hours, and [29] argue that those are the most relevant information types in the early stages of a crisis, we excluded information types like donations and volunteering. Since neither information type addressed opinion sharing, we introduced another information type. Whether a hashtag is used as a symbol or as a word indicates the affiliation to either: 1) attention keeping or 2) information distribution. URL-use supports the designated characteristic of information distribution [39], whereas characterising the information type facilitates the understanding of role characteristics.

4   Findings

The results are split into two parts. The first part shows the results according to the first research question, including the results of the social network analysis and the analysis of the roles' development over time. The second part presents all relevant results to answer the second research question regarding the role characteristics. In total, we received a sample of 3,223,197 tweets, which includes a total number of 1,535,943 participants. In Table 1, the results for each time slot are summarised.

Table 1. Metrics of the directed network per each slot.

Day	Slot	Period (CET)	Edges	Nodes	Diameter	Giant Component (% of nodes)
22nd of March 2016	1	08:00-10:59:59	32620	33252	5	70.96%
	2	11:00-13:59:59	377116	265631	25	95.52%
	3	14:00-16:59:59	557533	386740	25	92.51%
	4	17:00-19:59:59	521538	383329	23	93.16%
	5	20:00-22:59:59	411192	318198	15	93.07%
23rd of March 2016	6	23:00-04:59:59	316421	234150	14	89.93%
	7	05:00-10:59:59	166365	134923	11	86.22%

First, we conducted a social network analysis to identify the top 20 power users ranked by indegree for each time slot. Figures 1-7 represent the social network analysis, which illustrate the top 20 power users for each time slot.
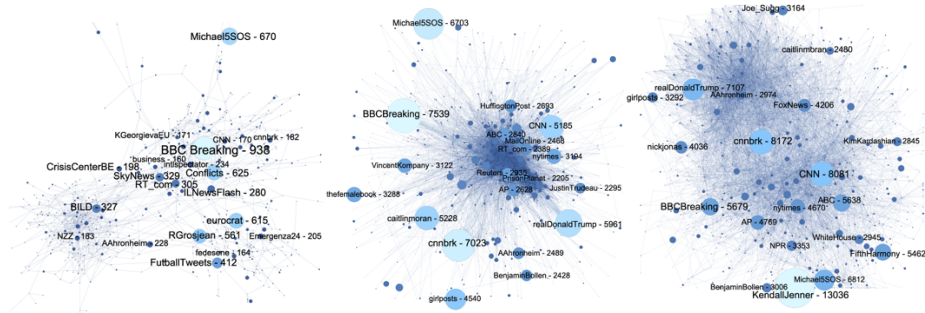

Figure 1. Social Network Analysis results: Time slots 1-3 (from left to right)
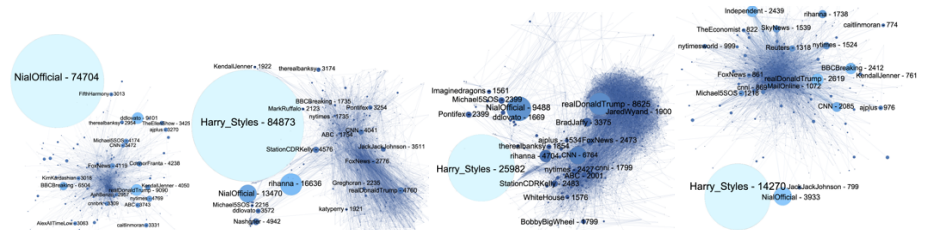

Figure 2. Social Network Analysis results: Time slots 4-7 (from left to right)

By analysing the accounts of the identified top 20 power users (ranked by indegree) of our dataset (table 2), we categorised them in seven distinct roles, derived from [29]: media organisations (e.g.: @CNN); 2) governmental organisations (e.g. @WhiteHouse); 3) private persons; 4) public persons (journalists); 5) public persons (celebrities) (e.g.: @Harry_Styles); 6) public persons (politicians) (e.g.: @RealDonaldTrump); 7) public persons (other) (e.g. @Pontifex).

Table 2. Top 20 users (ranked by overall indegree) categorised into roles

Rank	Role Type	Indegree	Betweenness Centrality (Rank)		Outdegree (Rank)		Follower Count
1	Public Person (celebrity)	125,125	0	(8)	1	(9)	28,6 m
2	Public Person (celebrity)	101,595	0	(8)	1	(9)	25,7 m
3	Public Person (politician)	38,162	0	(8)	4	(7)	9,48 m
4	Media Organisation	29,798	60433.41	(3)	36	(5)	25,57 m
5	Media Organisation	24,806	12677.3	(5)	23	(6)	23,6 m
6	Public Person (celebrity)	24,192	0	(8)	1	(9)	6,23 m
7	Public Person (celebrity)	23,079	0	(8)	1	(9)	62,3 m
8	Public Person (celebrity)	19,008	0	(8)	1	(9)	16,9 m
9	Media Organisation	18,686	41094.0	(4)	23	(6)	39,57 m
10	Media Organisation	18,347	166685.24	(2)	45	(3)	28,01 m
11	Media Organisation	15976	200576928	(1)	59	(1)	6.2 m
12	Media Organisation	14435	6173	(7)	50	(2)	9.4 m
13	Public Person (celebrity)	14342	0	(8)	1	(9)	36.9 m
14	Public Person (journalist)	11813	0	(8)	1	(9)	568 k
15	Public Person (celebrity)	8475	0	(8)	1	(9)	2.9 m
16	Private Person	7982	0	(8)	3	(8)	1.45 m
17	Public Person (other)	7832	0	(8)	1	(9)	6.19 m
18	Media Organisation	7396	6405.5	(6)	38	(4)	7.9 m
19	Public Person (celebrity)	6793	0	(8)	1	(9)	3.28 m
20	Public Person (celebrity)	5863	0	(8)	1	(9)	45.8 m

Second, we manually analysed the development of each role over time (Figure 3). For this step, we identified roles' total number of indegree for each time slot. The overall indegree of each role contains the number of indegree of every power user account, which could be assigned to the specific role.
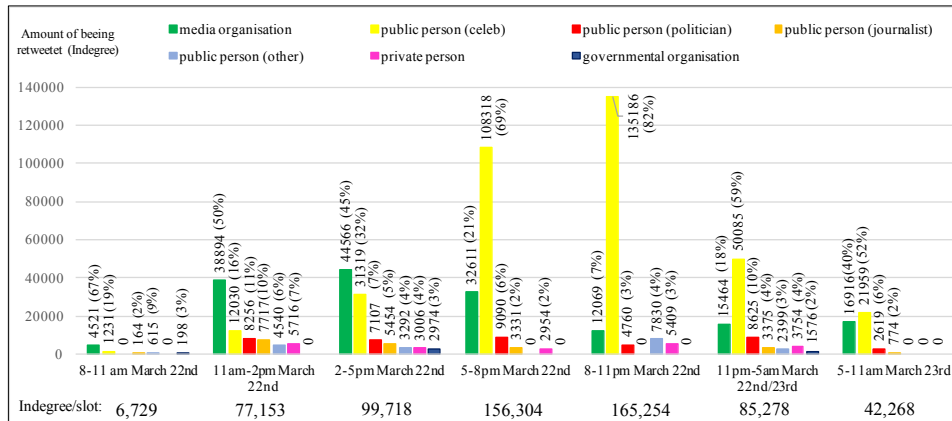

Figure 3. Roles' Development over time by indegree

In the dataset, we could identify two leading roles over time: 'media organisations' dominate over the first three time slots. Then, the role 'public persons' (celebrities) takes the lead until the end of the dataset. In the dataset, we could identify two peaks.

The first peak occurred on 22nd of March through the role media organisation, 2-5pm, the second on 22nd of March, 8-11pm, through the role public persons (celebrities).

As a second consecutive step of analysing upcoming roles in crisis situations, we defined role characteristics for participating roles during the Brussels attacks. Regarding hashtag-use, we found hashtags and keywords used as words within sentences far more often among all role types except governmental organisations (e.g. "All public transport in #Brussels shut down…"). The usage of hashtags as symbols was rather unusual concerning our sample (e.g., "I entrust to God's mercy all those who lost their lives. #Brussels"). The usage of URLs, which is designated to serve as an indicator for information content, turned out to be non-existent among public persons, whereas media organisations dominated the dissemination of URLs on Twitter. To accomplish the content analysis, the information type of each original tweet was matched to one or more of following categories: 1) crisis information, 2) solicitousness/condolences, 3) opinion, and 4) other (everything what does not fit into category 1-3. Media organisations were found to primarily post crisis information, as well as public persons (journalists) and governmental organisations. Solicitousness and condolences were expressed by public persons (celebrities), private persons and public persons (others). Two-thirds of Tweets stemming from public persons (politicians) contained opinions, the other third contained solicitousness, and the remaining contained content.

Due to a high value in indegree, a high amount of shared crisis information and the usage of hashtags as words, following roles, could be found to be information distributors: media organisations, public persons (journalists) and governmental organisations. To the characteristics of attention keeping, public persons (celebrities), public persons (politicians), private persons and public persons (other) could be matched. As a subordinate characteristic, we defined central users who show a high indegree value and a high betweenness centrality at the same time. From all involved roles, only media organisations suited these special characteristics (see Table 2).

5   Discussion

This study provides findings regarding important sensemaking actors and their different contributions to the sensemaking process, which supports the findings of [20], according to which power users play an integral role during collective sensemaking one way or another. Although retweeting behaviour has various motivations, retweeted messages seem to have a higher informational value than non-retweeted ones [39]. Adopting this theory to power users, their tweets could be perceived with a higher informational value and therefore be selected by individuals for the sensemaking process among a social community. Our findings are consistent with [21], suggesting that people get their news through elite users, who are generally the producer of information. In this context, we identified seven roles, which play a role in the sensemaking process about the Brussels bombings 2016 communication in Twitter. The identified roles are partially consistent with the information sources by [29] regarding media organisations and governmental organisations. In this study, we

extended the role of the outsider [29] – people that are not personally involved or affected by the event, to private persons and different kind of public persons like journalists, celebrities, politicians and others. While recent research mainly focused on sensemaking activities regarding information production and distribution [12, 22], our results support the findings of [20], according to which there are two characteristics of the collective sensemaking process. Even though celebrities seem to be important actors during the sensemaking process, their contribution to sensemaking differs from the attributes of media organisations. Media organisations, public persons (journalists) and governmental organisations could be primarily identified as information distributors. Public persons (celebrities or politicians or other), private persons, however, acted as attention keepers in the Brussel crisis communication, maintaining situational awareness by expressing their solicitousness or opinion. To relate these characteristics to the identified role types, we described them in a structural manner based on the Twitter network and the tweeted content. Besides the indegree value, media organisations can be characterised by a high betweenness centrality, a high outdegree, a high URL-use and a word-hashtag-use. In comparison, celebrities are characterised by no betweenness-centrality, a low outdegree, a high follower count, no URL-use and a word-hashtag-use. Contrary to [20], attention keepers in this study predominantly used word-hashtags rather than symbol-hashtags.

The follower count did not seem to predict the user's impact on sensemaking, since, for example, the user with the highest follower count was only on the seventh position in our top 10 ranking by indegree. Still, it is a determining factor for information diffusion, independent of the role type [38] and must be considered by examining online sensemaking. Additionally, a high overall betweenness centrality could be measured for the communication patterns of media organisations, while the betweenness centrality regarding tweets by public persons (celebrities) was nearly non-existent. Taking into account that the social network analysis was conducted for a retweet network, the betweenness centrality can be interpreted as a bridging function within the network that allows information to diffuse on the shortest routes. A non-existent score however emerges from not retweeting other user's content, while a high score identifies users, which are not only central to the social network, but also consumed and broadcasted other user's information. This is of high importance for the flow of crisis communication within a network and therefore for the sensemaking process [20, 43]. Those assumptions are reflected by the top 20 roles' outdegree. Whereas celebrities' indegree arose from one tweet alone, media organisations have an original tweet count varying between 23 and 45 tweets during the first 27 hours. In fact, media organisations posted on average at least one tweet per hour. The findings emphasise the influence of media organisations on public communication in social networks (as gatekeepers) and their role in the collective sensemaking process.

The observation of the role's development during the crisis moreover holds valuable information considering the sensemaking process. Similar to [29], our findings reveal that media organisations seem to be a dominant role during the early stage of a crisis, which can be defined as the event-breakout-phase [22], and is characterised by breaking news rather than local information avenues. Media

organisations' high number of retweets can be explained by the public's need for information, which constitutes the starting point for the individual sensemaking process [1]. People turn to social media, since it serves the purpose of filling in the possible information vacuum left by mainstream media and therefore facilitates collective sensemaking [19].

Our findings are consistent with [29] stating that media organisations show the highest fraction of tweets in crises situations that are instantaneous like the Brussels bombings. Simultaneously, large-scale crises on social media can elicit the problem of information dearth or information overload, depending on the particular crisis situation [19]. People need to find a way to select the incoming information in a social media crisis communication, which can be comprehended by focusing on power users (as roles). In both cases, power users can either provide relevant information to fill the information gap or help start people's sensemaking process by sharing relevant content and distance themselves from social media noise. Adopting the suggestion by [42], according to which the sensemaking process consists of the chaotic milling and organised keynoting interactions, our study provides evidence that not only hashtags can facilitate keynoting interactions [20], but also power users e.g. celebrities drawing attention to the crisis by declaring solicitousness, or media organisations distributing information about the development of crisis, or establishing or distributing symbols (e.g. pictures) related to the crisis. These actors might help people overcome the chaotic situation when a crisis breaks out by providing and selecting relevant information. Consistent with [42], during the breakout-phase, media organisations seem to hold the most dominant voices, which emerge to override the chaotic opinions of the crowd (milling) by starting organised keynoting interactions.

However, the dominant sensemaking role of media organisations can only be observed for the early stages of the course of events. After a few hours, their number of retweets decreases, while the number of retweets of celebrities heavily increases. Their role in collective sensemaking in crisis situations has not been respected in recent literature yet, though our study provides evidence that elite users like celebrities contribute strongly to the people's sensemaking process. Celebrities' influence seems to be even greater than information provided by media organisations, since their indegree are significantly higher. Regarding the development of the roles, we observed that in the early stages of a crisis event, people turn to social media to gather and share relevant information for their individual sensemaking process. Roles, which act as information distributors, are dominant sensegivers at this point, as they try to support and direct the sensemaking of others [3]. After the event-breakout-phase, celebrities take over as dominant roles, acting as attention keepers by sharing solicitousness and opinions to influence people's meaning construction [3].

6   Conclusion

In this study, we analysed the Twitter communication of the Brussels attacks (2016). Through conducting a social network analysis, we could identify seven roles which are relevant for the collective sensemaking process during a crisis. Although some

roles seemed to have a larger impact on sensemaking than others, every single categorised role contributed to the collective sensemaking process.

Given the complexity of human-involved collective sensemaking, focusing on retweets might not provide a holistic view. As the API is the only access point to large-scale Twitter data available to researchers outside of Twitter as a platform, there is no opportunity to independently verify the quality of the dataset. To mitigate this problem, [56] suggest creating more specific parameter sets with different users, bounding boxes, and keywords. We furthermore argue that a sample of 131 original tweets for content analysis is not large enough to generalise the different role characteristics we found. In the meantime, we analysed a bigger sample, but reached similar results. Nevertheless, for further research, we plan to expand the sample. We also note that our conclusions are case-specific and cannot be generalised without care and without examining a number of further crises, especially of different types.

Following the leading point of sensemaking through roles in crisis situations, the analysis of the case revealed significant aspects of social interaction in crisis communication. We contributed to the understanding of roles and their influence in social media during the sensemaking processes. Furthermore, this is one of the few studies that considers the dynamics of an event. In the underlying analysis, we detected a shift in the dominance of role characteristics regarding consecutive crisis stages. On a temporal layer, role characteristics alter from information distribution in early crisis stages to attention keeping in subsequent stages. The information being consulted by individuals decisively depends on the behaviour of major roles. In fact, information diffusion through retweets is a crucial means for collective sensemaking. If a situation generates a lack of information, (central) roles provide fast access to information, which can be immediately spread within a network or social cluster. In case of an information overload, the activity of roles in social media affects the selection of information to urge the sensemaking process. Through following the flow of information based on roles, the shaping of public opinion can be assessed more precisely.

Based on our findings, we recommend for further research to search for these role types in other Twitter networks automatically. Of course, these structural role descriptions have to be verified with other, larger datasets. Another approach that hasn't been addressed so far is the danger of upcoming rumours during crisis situation. [17] point out the importance of spreading trustworthy information as early as possible to avoid these. Since rumours are also part of the collective sensemaking process, one could examine the roles' impact on upcoming rumours in a social media crisis communication and the perceived trustworthiness by the public.

References

1. Maitlis, S., Sonenshein, S.: Sensemaking in crisis and change: Inspiration and insights from weick (1988). J. Manag. Stud. 47, 551–580 (2010).
2. Weick, K.E.: Sensemaking in Organisations. (1995).
3. Glola, D. a., Chittipeddi, K., Gioia, D.A., Chittipeddi, K.: Sensemaking and Sensegiving in Strategic Change Initiation. Strateg. Manag. J. 12, 433–448 (1991).
4. Chater, N., Loewenstein, G.: The under-appreciated drive for sense-making. J. Econ. Behav. Organ. 126, 137–154 (2016).
5. Weick, K.E., Sutcliffe, K.M., Obstfeld, D.: Organizing and the Process of Sensemaking. Organ. Sci.

16, 409–421 (2005).

6. Hughes, A.L., Palen, L.: The Evolving Role of the Public Information Officer: An Examination of Social Media in Emergency Management. J. Homel. Secur. Emerg. Manag. 9, (2012).

7. Palen, L., Anderson, K.M., Mark, G., Martin, J., Sicker, D., Palmer, M., Grunwald, D.: A vision for technology-mediated support for public participation & assistance in mass emergencies & disasters. Proc. 2010 ACMBCS Visions Comput. Sci. Conf. 1–12 (2010).

8. Jin, Y., Liu, B.F., Austin, L.L.: Examining the Role of Social Media in Effective Crisis Management: The Effects of Crisis Origin, Information Form, and Source on Publics' Crisis Responses. Communic. Res. 41, 74–94 (2011).

9. Vieweg, S., Hughes, A.L., Starbird, K., Palen, L.: Microblogging during two natural hazards events: what twitter may contribute to situational awareness. CHI 2010 Cris. Informatics April 10–15, 2010,. 1079–1088 (2010).

10. Kwon, H.Y., Kang, Y.O.: Risk analysis and visualization for detecting signs of flood disaster in Twitter. Spat. Inf. Res. 24, 127–139 (2016).

11. Jung, C., Tsou, M., Issa, E.: Developing a Real-time Situation Awareness Viewer for Monitoring Disaster Impacts Using Location-Based Social Media Messages in Twitter. Int. Conf. Locat. Soc. Media Data. 1–5 (2015).

12. Oh, O., Agrawal, M., Rao, H.R.: Information control and terrorism: Tracking the Mumbai terrorist attack through twitter. Inf. Syst. Front. 13, 33–43 (2011).

13. Potts, L., Mapes, K.: HCI in Business, Government, and Organizations: Information Systems. 9752, 72–81 (2016).

14. Starbird, K., Palen, L.: (How) will the revolution be retweeted?: information diffusion and the 2011 Egyptian uprising. Proc. acm 2012 Conf. CSCW. 7–16 (2012).

15. LeFebvre, R.K., Armstrong, C.: Grievance-based social movement mobilization in the #Ferguson Twitter storm. New Media Soc. 1–21 (2016).

16. Lerman, K., Ghosh, R., Surachawala, T.: Social Contagion : An Empirical Study of Information Spread on Digg and Twitter Follower Graphs. Proc. Fourth Int. AAAI Conf. Weblogs Soc. Media. 90–97 (2010).

17. Oh, O., Agrawal, M., Rao, H.R.: Community Intelligence and Social Media Services: A Rumor Theoretic Analysis of Tweets During Social Crises. MIS Q. 37, 407–426 (2013).

18. Oh, O., Kwon, K.H., Rao, H.R.: An Exploration of Social Media in Extreme Events: Rumor Theory and Twitter during the Haiti Earthquake 2010. In: ICIS. p. 231 (2010).

19. Shklovski, I., Palen, L., Sutton, J.: Finding community through information and communication technology in disaster response. Proc. 2008 ACM Conf. Comput. Support. Coop. Work. ACM. 127–136 (2008).

20. Oh, O., Eom, C., Rao, H.R.: Research Note —Role of Social Media in Social Change: An Analysis of Collective Sense Making During the 2011 Egypt Revolution. Inf. Syst. Res. 210–223 (2015).

21. Wu, S., Hofman, J.M., Mason, W. a., Watts, D.J.: Who says what to whom on twitter. Proc. 20th Int. Conf. World Wide Web. 705–714 (2011).

22. Kwon, H.K., Oh, O., Agrawal, M., Rao, R.H.: Audience Gatekeeping in the Twitter Service: An Investigation of Tweets about the 2009 Gaza Conflict. AIS Trans. Human-Computer Interact. 4, 212–229 (2012).

23. Bordia, P., Difonzo, N.: Problem Solving in Social Interactions on the Internet: Rumor As Social Cognition. Soc. Psychol. Q. 67, 33–49 (2004).

24. Austin, L., Liu, B.F., Jin, Y.: How Audiences Seek Out Crisis Information: Exploring the Social-Mediated Crisis Communication Model How Audiences Seek Out Crisis Information: Exploring the Social- Mediated Crisis Communication Model. J. Appl. Commun. Res. 40, 188–207 (2012).

25. Oh, O., Tashmasbi, N., Rao, R.H., Vreede, G.-J.: A Sociotechnical Vie of Information Diffusion and Social Changes: From Reprint to Retweet. ICIS 2012 Proc. 1–11 (2012).

26. Heverin, T., Zach, L.: Use of microblogging for collective sense-making during violent crises: A study of three campus shootings. J. Am. Soc. Inf. Sci. Technol. 63, 34–47 (2012).

27. Mirbabaie, M., Ehnis, C., Stieglitz, S., Bunker, D.: Communication roles in public events – A case study on Twitter communication. In: Information Systems and Global Assemblages. (Re)Configuring Actors, Artefacts, Organizations. pp. 207–218 (2014).

28. Starbird, K., Palen, L., Hughes, A.L., Vieweg, S.: Chatter on the red: what hazards threat reveals about the social life of microblogged information. CSCW '10 Proc. 2010 ACM Conf. Comput. Support. Coop. Work. 241–250 (2010).

29. Olteanu, A., Vieweg, S., Castillo, C.: What to Expect When the Unexpected Happens: Social Media Communications Across Crises. Proc. 18th ACM Conf. Comput. Support. Coop. Work Soc. Comput. -

CSCW '15. 994–1009 (2015).

30. Ehnis, C., Mirbabaie, M., Bunker, D., Stieglitz, S.: The role of social media network participants in extreme events. In: 25th Australian Conference of Information Systems (2014).

31. Sutton, J.N., Johnson, B., Greczek, M., Spiro, E.S., Fitzhugh, S.M., Butts, C.T.: Connected Communications : Network Structures of Official Communications in a Technological Disaster. Proc. 9th Int. ISCRAM Conf. 1–10 (2012).

32. Krüger, N., Stieglitz, S., Potthoff, T.: Brand Communication In Twitter - A Case Study On Adidas. In: PACIS 2012 Proceedings (2012).

33. Bruns, A., Burgess, J.E., Crawford, K., Shaw, F.: #qldfloods and@QPSMedia: Crisis Communication on Twitter in the 2011 South East Queensland Floods, http://eprints.qut.edu.au/48241/, (2012).

34. Ehnis, C., Bunker, D.: Social Media in Disaster Response: Queensland Police Service - Public Engagement During the 2011 Floods. Proc. 23rd Australas. Conf. Inf. Syst. 1–10 (2012).

35. Heverin, T., Zach, L.: Twitter for city police department information sharing. Proc. Am. Soc. Inf. Sci. Technol. 47, 1–7 (2010).

36. Ehnis, C., Bunker, D.: The impact of disaster typology on social media use by emergency service agencies: The case of the Boston marathon bombing. In: 24th Australasian Conference on Information Systems (2013).

37. Bergstrand, F., Landgren, J., Green, V.: Authorities don ' t tweet , employees do ! In: MobileHCI (2013).

38. Macskassy, S. a, Michelson, M.: Why Do People Retweet ? Anti-Homophily Wins the Day ! Proc. Fifth Int. Conf. Weblogs Soc. Media - ICWSM '11. 209–216 (2011).

39. Suh, B., Hong, L., Pirolli, P., Chi, E.H.: Want to be retweeted? Large scale analytics on factors impacting retweet in twitter network. In: Proceedings - SocialCom 2010: 2nd IEEE International Conference on Social Computing, PASSAT 2010: 2nd IEEE International Conference on Privacy, Security, Risk and Trust. pp. 177–184 (2010).

40. Blum, J., Kefalidou, G., Houghton, R., Flintham, M., Arunachalam, U., Goulden, M.: Majority report: Citizen empowerment through collaborative sensemaking. ISCRAM 2014 Conf. Proc. - 11th Int. Conf. Inf. Syst. Cris. Response Manag. 767–771 (2014).

41. Reuter, C., Heger, O., Pipek, V.: Combining Real and Virtual Volunteers through Social Media. Iscram 2013. 780–790 (2013).

42. Turner, R.H., Killian, L.M.: Collective Behavior. Prentice Hall College Div; 3 Sub edition (1987).

43. Dailey, D., Starbird, K.: "It's Raining Dispersants." Proc. 18th ACM - CSCW'15 Companion. 155–158 (2015).

44. Kendra, J., Wachtendorf, T.: The Waterbourne Evacuation of Lower Manhatten on September 11: A case of Distributed Sensemaking. (2006).

45. Vieweg, S., Palen, L., Liu, S.B., Hughes, A.L., Sutton, J.: Collective Intelligence in Disaster : Examination of the Phenomenon in the Aftermath of the 2007 Virginia Tech Shooting. Iscram. 44–54 (2008).

46. Hughes, A.L., St. Denis, L. a. a., Palen, L., Anderson, K.M.: Online public communications by police & fire services during the 2012 Hurricane Sandy. Proc. 32nd Annu. ACM Conf. Hum. factors Comput. Syst. - CHI '14. 1505–1514 (2014).

47. Kaufhold, M.A., Reuter, C.: The Self-Organization of Digital Volunteers across Social Media: The Case of the 2013 European Floods in Germany. J. Homel. Secur. Emerg. Manag. 13, 137–166 (2016).

48. Birkbak, A.: Crystallizations in the Blizzard : Contrasting Informal Emergency Collaboration In Facebook Groups. Proc. Nord. Conf. Human-Computer Interact. 428–437 (2012).

49. Bruns, A., Stieglitz, S.: Quantitative Approaches to Comparing Communication Patterns on Twitter. J. Technol. Hum. Serv. 30, 160–185 (2012).

50. Bruns, A., Stieglitz, S.: Twitter Data: What Do They Represent? it - Inf. Technol. 56, 240–245 (2014).

51. Kwak, H., Lee, C., Park, H., Moon, S.: What is Twitter , a Social Network or a News Media? Int. World Wide Web Conf. Comm. 1–10 (2010).

52. Stieglitz, S., Bruns, A., Krüger, N.: Enterprise-Related Crisis Communication on Twitter. Proc. der 12. Int. Tagung Wirtschaftsinformatik (WI 2015). 917–932 (2015).

53. Ahn, H., Park, J.-H.: The structural effects of the sharing function on Twitter networks: Focusing on the retweet function. J. Inf. Sci. 41, 354–365 (2015).

54. Brandes, U.: On variants of shortest-path betweenness centrality and their generic computation. Soc. Networks. 30, 136–145 (2008).

55. Mayring, P.: Qualitative Inhaltsanalyse. Grundlagen und Techniken. (2008).

56. Morstatter, F., Pfeffer, J., Liu, H., Carley, K.: Is the sample good enough? Comparing data from Twitter's streaming API with Twitter's firehose. Proc. ICWSM. 400–408 (2013).