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Clustering Social Media Services and Messengers by Functionality

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ABSTRACT

The objective of this research is to analyze which functions make up web-based as well as mobile social media services and messengers. Services are clustered by their functionality. A total of 640 individual functions were identified, while investigating altogether 44 selected services in their web and mobile versions. Applying content analysis, functions were assigned to the services. The services were ranked by the number of implemented functions, and the functions were ranked by their occurrence in the services. Cluster analysis was applied to classify the services according to their functionality. Facebook and VKontakte were found to be the ones with the most functions; the most frequently implemented functions are support, profile, and account-related. Cluster analysis revealed six classes for mobile and seven classes for web applications. There is a noteworthy difference regarding the functionality scope between web and mobile applications of the same services. An example for this is Mendeley with 38 functions in the mobile and 91 functions in the web version. This is the first empirical attempt at clustering social media services based on their functionality.

Keywords: social media, instant messengers, cluster analysis, functionality, content analysis, function

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1. INTRODUCTION

In recent years, social media has unquestionably become an integral part of social interaction and information sharing in everyday life (Wenniger, Cheung, & Krasnova, 2019). The term *social media* describes "a group of Internet-based applications which are built on the ideological and technological foundations of Web 2.0 and enable the creation and exchange of user-generated content" (Kaplan & Haenlein, 2010, p. 61). In line with this definition, Obar and Wildman (2015, p. 3) mention two further important characteristics which apply to all social media services, namely the creation of "user-specific profiles for a site or app designed and maintained by a social media service" and the facilitation of "the development of social networks online by connecting a profile with those of other individuals and/or groups."

Relevant literature provides different approaches to classify social media services (Aichner & Jacob, 2015; Bruhn, Schäfer, Schwarz, & Lauber, 2011; Kaplan & Haenlein, 2010; Kietzmann, Hermkens, McCarthy, & Silvestre, 2011; Linde & Stock, 2011; Schmidt, 2018). Linde and Stock (2011) mention four subclasses of social media, namely *social networks*, *sharing services*, *social bookmarking services*, and *knowledge bases*. While social networks focus on users and their connections to others, as well as on professional self-presentation (Sander, Teh, & Sloka, 2017), sharing services revolve around content. These platforms focus on uploading, sharing, commenting, and liking, mainly of photos and videos (Schmidt, 2018). Social bookmarking services enable users to manage their bookmarks detached from local storage and collect them in one single service (Peters, 2009). Knowledge bases can be further subdivided into wikis and blogs. A wiki, similar to an encyclopedia, collects entries for terms and allows them to be edited constantly. Since different authors work together to build up a wiki, they are considered collaborative social media services (Linde & Stock, 2011). On the other hand, blogs consist of entries which are sorted backwards in chronological order. This category also includes microblogs. The most prominent example of this class is Twitter, where, with a limitation of 280 characters, short *tweets* can be shared (Linde & Stock, 2011).

Finally, there are also instant messaging services which enable "near-synchronous computer-based one-on-one communication" (Nardi, Whittaker, & Bradner, 2000, p. 80). In addition to the transmission of text messages, there are also offers that provide video calling functions (Schmidt, 2018). These services exist outside the scope of the previously mentioned definition of social media as they cannot be sorted into the four categories. Instant messengers, like social media services, provide platforms for people to connect and share content. However, they differ in the fact that content shared via instant messengers is "intended to be private, or at least directed towards a specific group" (IPG Media Lab, 2014, p. 6), whereas social media services implement a "many-to-many broadcast mechanism" (IPG Media Lab, 2014, p. 6), which makes content essentially public.

To our knowledge, there is no generally accepted classification of social media services and messengers in the relevant literature. This circumstance stems from the fact that categorization in previous research happens intuitively without an empirical basis and that all mentioned approaches differ with respect to their granularity. Hence, the aim of the present study is to empirically classify social media services and messengers.

The Information Service Evaluation (ISE) Model by Schumann and Stock (2014) serves as the basis for the research model presented in this paper. The ISE model offers a holistic approach to evaluating a wide variety of information services. It consists of five dimensions comprising the service quality, the user, the acceptance of an information system, the information environment, and time. As the ISE Model "offers a wide choice of aspects that can be evaluated [...] it is also possible to apply only some of the characteristics shown in the model" (Schumann & Stock, 2014, p. 15). In the present study the first dimension of the model is applied, evaluating the information service quality by focusing on the aspect of the objective information service's quality: "'Objective' in this context means that the measurement results are not based […] on user's perceptions" (Schumann & Stock, 2014, p. 11). Furthermore, Schumann and Stock (2014) name different aspects which can be considered in order to evaluate the objective quality of an information system. Besides the system's usability, effectiveness, and efficiency, the objective quality of an information system includes "the range of functions it offers" (Stock & Stock, 2013, p. 482). Therefore, the functionality scope was chosen as a measurement unit to compare the selected social media services and messengers.

The functionality of an information system is defined as "the extent of its functions for information production and information searching (measured independently from the factual application by the users)" (Schumann & Stock, 2014, p. 11). A function, in turn, is considered to be an objective or characteristic of a system, a "part of an application that provides facilities for users to carry out their tasks" (International Organization for Standardization, 2017, para. 3.1677). Clustering the services based on these fundamental building blocks ensures that only those applications which show similarities with respect to their functionality will form one class. This way, a classification model for social media services and messengers

is created, based on empirical evidence. Analysis of functions will not only reveal which services consist of the highest number of functions, but also which functions are most frequently implemented in different services.

1.1. Previous Research

Taking a look at the research landscape, various approaches can be found to investigate social media services. While some articles focus on the user's motivation for using social media or on the functions the services comprise, others try to establish a classification of social media. In terms of usage motivations, a branch of research has directed attention towards linking social media with the uses and gratifications theory. Originally, uses and gratifications theory research has been described as an approach seeking to depict "(1) the social and psychological origins of (2) needs, which generate (3) expectations of (4) the mass media or other sources, which lead to (5) differential patterns of media exposure (or engagement in other activities), resulting in (6) need gratifications and (7) other consequences" (Katz, Blumler, & Gurevitch, 1973, pp. 5-6). In line with this, Whiting and Williams (2013) present "social interaction," "information seeking," "pass time," "entertainment," "relaxation," "communicatory utility," "expression of opinions," "convenience utility," "information sharing," and "surveillance and watching of others" as key themes in the context of applying uses and gratifications theory onto social media. Information seeking, information sharing, or social interaction are directly reflected in the previously mentioned instances, like social networks, sharing services, and knowledge bases. This assumption is proven by a recent study on social live streaming services in which a direct relation between in-service content categories, such as chatting or sharing information, and motivations like social interaction or self-presentation, was identified (Zimmer & Scheibe, 2019). As the gratifications aspect itself is treated as a means to differentiate between types of media (McQuail, 1984), the gratifications named in general theory can be directly applied to the conception of social media services. Consequently, entertainment can be used to label services which provide easily and, thus, efficiently consumable entertainment with a possible impact on the consumer's mood (Shao, 2009). Similarly, another application can be found in Goffman's (1959) "information game" in which an individual assumes control of the information disclosed about him or herself in order to shape the perception of others. This kind of self-presentation is considered as one of the main reasons for using Facebook (Nadkarni & Hofmann, 2012). The mentioned examples showcase the viability of the idea of using uses and gratifications theory terminology to label social media services.

Apart from focusing on the user, past research has accentuated the main features of specific platforms like hashtags on Twitter as well as likes on Facebook (Weller, 2015). Additionally, Weninger, Zhu, and Han (2013) concentrated on Reddit and its core functions, investigating subreddits, posts, comments, and votes as well as the karma function. Similarly, Zimmer et al. (2018) evaluated the functionality of Reddit. Cases like these raise the problem that many functions have been ignored by researchers, for example the support functions of various services. However, the present study takes all functions into account, which creates the opportunity to explore the vast field of the functionalities of different social media services and messengers. In this way, important functions which have not yet gotten the necessary scientific attention are moved into the spotlight.

Moreover, functionality-based research has crossed the boundaries of the classification topic, as demonstrated by Kietzmann et al. (2011, p. 243) who define "seven functional building blocks of social media," containing identity, exchange, conversations, groups, reputation, relationships, and presence. These blocks are intended to help companies to classify and evaluate social media services such as Facebook. Kietzmann et al. (2011) use their seven blocks to explain what effects social media have on a company and make recommendations on how to deal with them.

Stock and Stock (2013, pp. 486 ff.) give a comprehensive list of functions of information retrieval systems. In contrast to our study, they concentrate on information systems for professional users, for instance, DIALOG, STN International, or Questel. In this list, there are six groups of functions, namely selection of databases, looking for search arguments, search options, display and output, push services, and, finally, informetric analysis. For every group of functions they have identified dozens of single functions on a very low granularity level. For the information suppliers, such a list works as a checklist of the completeness of their retrieval functionality; for evaluators of information services, it is a list of quality criteria for professional search engines (Stock, 2000).

As mentioned above, there is no generally accepted classification model for social media services and messengers. Some attempts have been made to categorize social media services, all of which yield different results. While some approaches classify them into four subclasses (Linde & Stock, 2011), there are other sources that differentiate between six (Kaplan & Haenlein, 2010; Schmidt, 2018) or ten subtypes (Bruhn et al., 2011). Aichner and Jacob (2015) even subdivide so precisely that they identify 13 classes of social media services. These different results originate in an intuitive categorization of the services without empirical basis. The phenomenon of

various numbers of classes could also be connected to the fact that the subjective views of different people may result in different groupings – the classification is influenced by human bias (Shah & Oppenheimer, 2011).

Hence, the present study aims at developing an empirically based classification model for social media services and messengers. In order to achieve this, content analysis is applied to analyze which individual functions make up the investigated services that are clustered according to their functionality. The study explores a new area of empirical research on functions and their distribution among social media services and messengers and, thus, provides theoretical added value for information science and system science.

1.2. Research Questions

Following this empirical approach, altogether 640 functions of the selected social media services and messengers were identified. Based on these functions, the applications are classified according to similarities in their functionality scope. This way, it is possible to establish rankings of the investigated services as well as of the functions they consist of. This approach entails the definition of three research questions (RQs) which need to be answered:

- (RQ1) Which investigated services implement the highest number of functions?
- (RQ2) Which functions are the most frequently occurring ones in mobile and web-based applications of social media services and messengers?
- (RQ3) To what extent is it possible to empirically classify social media and instant messaging services according to their functionality?

1.3. Research Model

The research model of the present study is based on the first dimension of the ISE Model by Schumann and Stock (2014). They emphasize that "[t]he quality of an information service depends not only on the perception of its quality by the users, but also upon objective (user-independent) measures" (p. 7). According to the ISE Model, one possible aspect for evaluating the objective quality of an information system is to analyze the variety of functions it offers (Schumann & Stock, 2014). Therefore, in the present study a research model is introduced that measures objective information service quality by analyzing the functionality scope of the selected services. Based on the identified functions, a hierarchical cluster analysis is performed, yielding an empirical classification model of social media services and messengers.

The research model depicted in Fig. 1 shows the interplay of the elements which make it possible to answer the RQs mentioned in Section 1.2. Investigating the functionalities of social media services requires taking into account that many services appear in two different forms – as a web service that can be directly accessed in a web browser or as a downloadable mobile application. On that note, as distinguished from web applications, mobile applications are mostly used in completely different situations as on the go, focusing on functions which provide a better user experience in the given situation (Benyon, 2019). Thus, the investigation of their similarities should be divided into these environments. As an information system's functionality consists of its individual functions, these need to be drawn from the same pool of functions f_1 to f_n. This makes it possible to empirically compare the same types of services based on their functionality rather than creating intuitive classes as it is done in previous research. In order to accomplish this, it is noted whether functions exist or do not exist in a service's web or mobile version.

Since there is no basic assumption on which social media services show similarities, an empirical approach is taken based on the methods used in empirical information science to create concepts with words and tags. On the basis of observation, similarity calculations can be employed which are combined with cluster-analytical consolidation of the similarity relations (Stock & Stock, 2013, pp. 777 ff.). However, the present study does not cluster by words or tags. Instead, it compares the identified functions f1 to fn of the investigated services. Consequently, applications which exhibit certain similarities create their own classes, each of which represents the functionality of a service.

Based on these elements, a research model was created which follows the procedure of extracting functions from social

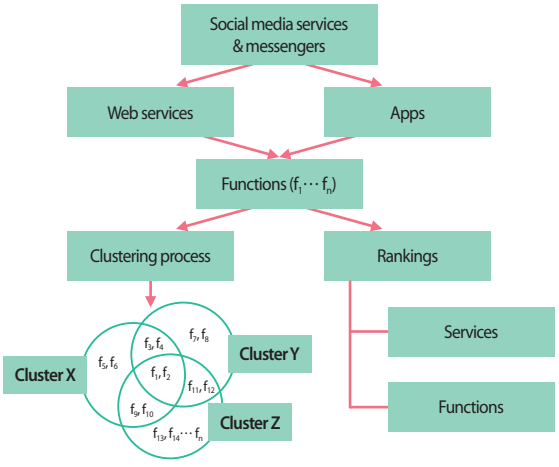

Fig. 1. Research model.

media services and messengers, determining their existence over all investigated services, and clustering the services by the appearance of these functions. Additionally, rankings of the services are established based on their individual functions. The used approach makes it not only possible to determine which information systems have the highest number of implemented functions, but also which ones are particularly often represented in different social media services and messengers. Furthermore, it appears logical that more important functions are present in many services. This way, indirect conclusions about their importance can be drawn.

2. METHODS

2.1. Data Collection

The data set was collected between April 16 and May 22, 2019. The individual functions of social media services and messengers were collected from mobile and web applications by means of the analysis of functions. Only the most recent version of each application was taken into account, with no further updates within the set timeframe. The web applications were all investigated from a desktop web browser, while the mobile applications were examined with smartphones using Android OS as their operating system. As the market share of Android devices in 2018 was 88.1% (Statista Research Department, 2018), the research team decided to focus only on Android smartphone applications, excluding other operating systems with possibly different specifications, such as iOS. Furthermore, desktop applications showed less traffic compared to mobile applications (Enge, 2019) and were therefore excluded from the research sample. Web browser applications, on the other hand, are taken into consideration as the majority of the chosen mobile apps have an appropriate counterpart.

In total, 44 different social media services and messengers were examined, 25 of which were mobile applications and 19 were web applications (see Table 1). Finally, altogether 640 functions were identified while analyzing these information systems. Due to the high effort to describe all functions, the research team had to limit the number of investigated services. For that, it was decided to include those services with the highest number of monthly active users. In order to identify these, several statistics about social media use in 2019 were considered (Influencer MarketingHub, 2020; Kemp, 2019; Sharma, 2018; Spencer, 2019).

On account of the authors' language skills, mainly English-language services were investigated, which are complemented by one service in German (Jodel) (Nowak, Jüttner, & Baran, 2018). The services in Chinese language (such as WEIXN/WeChat, QQ, QZone, Sina Weibo, Douban, and Baidu Tieba) were systematically excluded. Although TikTok is Chinese, it was taken into consideration, as there is a special English-based version of the service for non-Chinese countries (Shutsko, 2020). To increase the number of cases for cluster analysis, some further services were added. VKontakte in its English-language version was appended to the list as a counterpart of Facebook (Baran & Stock, 2015). ResearchGate and Mendeley were included as professional-oriented services. Furthermore, the list was extended by some very popular systems beyond the world of social networking services, e.g., the knowledge base Wikipedia and the social live streaming service Twitch. Finally, YouNow and Periscope were included as information systems analogous to Twitch (Zimmer & Scheibe, 2019).

The research consisted of four stages. In the first stage, all services were evenly distributed among the seven coders. All coders then systematically wrote down all features they found in their assigned service, paired with a matching description.

Following this, all identified functions were inductively assembled into a single unified code book. One of the main problems in determining whether functions were duplicate entries or not was due to the fact that many provided functions mean the same but are named differently from service to service. Furthermore, it was deemed to be insensible to create an over-particular list, as this could lead to inflation in functions without any greater impact. Such an instance is represented by the case of notification settings, where there exist individual ones for even the smallest features. Depending on the type of functions in question, they can be summarized in an upper class function, since their contribution to the general functionality of a system is too minuscule. Consequently, each function had to be reviewed by each coder and if similar or identical ones with different names were found, these were either merged into a class based on their granularity or were removed. This process resulted in the final codebook, eventually comprising 640 identified functions from all investigated services.

Following the standard procedure of content analysis (Krippendorff, 2018), each service was coded independently by two coders, using the codebook as a reference point. Here, a binary approach was taken to mark whether or not a given function was present in the respective service. Since a single coder's judgement is not entirely reliable, it is common practice to rely on a basic measure to check unanimity among the coders.

The inter-rater reliability score used in the present study was Krippendorff's alpha (Krippendorff, 2011). If a resulting alpha value between two coders of the same service is below 0.8, the coding is considered to be unreliable, as either the coders or the codebook constitute a problem (Raupp & Vogelsang, 2009).

Table 1. List of investigated social media services and messengers and the initial Krippendorff's alpha values for each coded service

No.	Mobile applications	α	No.	Web applications	α
1	Discord	0.884	1	Discord	0.978
2	Facebook	0.865	2	Facebook	0.882
3	Facebook Messenger	0.817	3	Flickr	0.931
4	Flickr	0.984	4	Instagram	0.993
5	Instagram	0.969	5	LinkedIn	0.911
6	Jodel	0.937	6	Mendeley	0.905
7	Line	0.857	7	Pinterest	0.866
8	LinkedIn	0.888	8	Reddit	0.853
9	Mendeley	0.809	9	ResearchGate	0.861
10	Periscope	0.941	10	Skype	0.892
11	Pinterest	0.994	11	Telegram	0.943
12	Reddit	0.846	12	Tumblr	0.968
13	Skype	0.915	13	Twitch	0.883
14	Snapchat	0.891	14	Twitter	0.856
15	Telegram	0.951	15	VKontakte	0.973
16	TikTok	0.809	16	WhatsApp	0.972
17	Tumblr	0.901	17	Wikipedia	0.858
18	Twitch	0.939	18	YouNow	0.841
19	Twitter	0.818	19	YouTube	0.938
20	Viber	0.912			
21	VKontakte	0.908			
22	WhatsApp	0.819			
23	Wikipedia	0.844			
24	YouNow	0.939			
25	YouTube	0.855			

Function	Discord App	Discord Web	Facebook App	FB Web	Facebook Msgr	Flickr App	Flickr Web
About: license information	1	1	0	0	0	0	0
About: service information	1	0	1	1	0	0	1
About: used OpenSource libraries	1	1	1	0	0	0	0
Accessbility: voice input	0	0	0	0	0	0	0
Accessibility: change font size	1	1	0	0	0	0	0
Accessibility: Change text direction	0	0	0	0	0	0	0
Accessibility: Content: Post: Picture: edit alternative text for your photo	0	0	0	0	0	0	0
Accessibility: media auto play	1	1	1	1	0	0	0
Accessibility: Profile: Add sections in different languages	0	0	0	0	0	0	0
Accessibility: Region locked content	0	0	0	0	0	0	0
Accessibility: Speech to text	1	0	0	0	0	0	0
Accessibility: text to speech	0	1	0	0	0	0	0
Accessibility: translate post	0	0	1	1	0	0	0
Accessibility: zoom contents	0	0	0	0	0	1	1
Account: 2nd e-mail for advertisements	0	0	0	1	0	0	0
Account: authorized Apps management	0	1	1	1	0	0	1
Account: Automatic Device Login	1	1	1	1	1	1	0
Account: Calender: Integrate external	0	0	0	0	0	0	0
Account: Calender: Integrate internal	0	0	1	1	0	0	0
Account: change contact information	1	1	1	1	0	0	1
Account: change username	1	1	1	1	1	0	1
Account: claim identity	0	0	0	0	0	0	0

Fig. 2. Excerpt of the coding table.

In the present research, the results of the coding step were sufficient as the initial Krippendorff's alpha values were found to be in an acceptable range (see Table 1). The few remaining inconsistencies in the coding results were clarified in a personal conversation between the two coders. They agreed on whether the respective function exists in the social media service or not. After this step, the coding of all functions was identical and accordingly the new alpha value was 1. A small excerpt of the final coding table can be found in Fig. 2.

2.2. Data Analysis

After the coding process, the number of functions for each social media service and the occurrence of the individual functions in the services were calculated. For this purpose, the data set was divided into mobile and web applications. Based on the calculated data, two different rankings of the investigated social media services and their functionalities were compiled. The first one gives an indication of which function is available in how many services. The number of occurrences of the respective function in the various services was summed up. The functions were then assigned to the corresponding ranks based on the descending order of their occurrences in the different social media services. Similar to the described procedure, the second ranking gives information about which services provide the widest range of functions from a number's perspective.

Furthermore, a cluster analysis using IBM SPSS Statistics 25 (SPSS) was performed. The approach used is a hierarchical cluster analysis which is particularly suitable for small sample sizes (Verma, 2013). The cluster method applied is Ward's method (Ward, 1963), frequently used in cluster analysis as it achieves the greatest possible cohesion within clusters and the maximum separation between clusters (Giudici & Figini, 2009; Murtagh & Legendre, 2014). The Squared Euclidean distance was chosen as the distance measure in line with the recommendations for SPSS (Murtagh & Legendre, 2014). 641 variables were included in the clustering process – one variable that stores the names of the investigated services and 640 ordinally scaled variables, named after the identified functions, storing whether the function is available in a service or not. Due to the relatively small sample size, the resulting dendrograms were especially useful for the analysis and interpretation of the results, which is in line with Řezanková (2009).

One of the biggest challenges of clustering ordinal data is the assumption of equal intervals (Řezanková, 2009). There is no certain way to represent the difference between functions through numbers alone – at least not if the functions are not assigned with a distance value beforehand. Nevertheless, the data in this paper still meets the requirement for a hierarchical cluster analysis since it is represented by a binary matrix (Řezanková, 2009).

Another challenge when performing a cluster analysis is to ensure that the resulting clusters are not just randomly assigned, but indeed possess an internal validity. This is the reason why

the data set had to be pre-tested before running it through the final clustering process (Bacher, Pöge, & Wenzig, 2010). For that, the multidimensional scaling (MDS) was applied as this method is also based on the analysis of the dissimilarity matrix (Borg, Groenen, & Mair, 2018; Timm, 2002). To generate the MDS solution, the distance matrix calculated earlier for the cluster analysis was passed to the PROXSCAL module of the SPSS. In line with Borg et al. (2018), the initial configuration of the SPSS was adjusted to Torgerson's metric model with 1,000 iterations and 0.0000001 stress value. The resulting distribution of data points resembled clusters produced with Ward's method (compare Fig. 3 with Fig. 5, and Fig. 4 with Fig. 6) confirming that the clusters were not formed randomly.

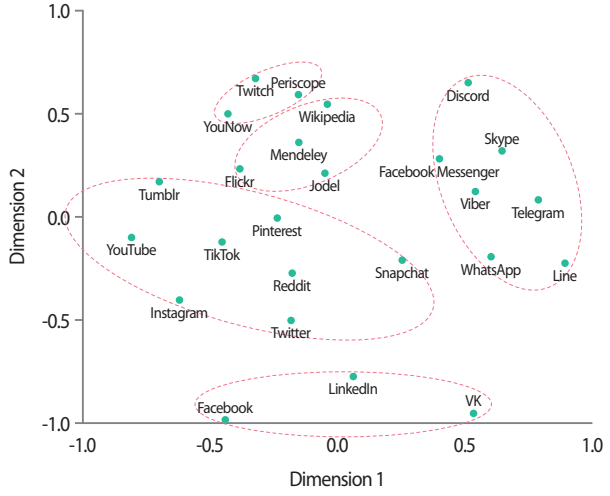

Fig. 3. Results of the multidimensional scaling for the mobile applications of social media services and messengers.

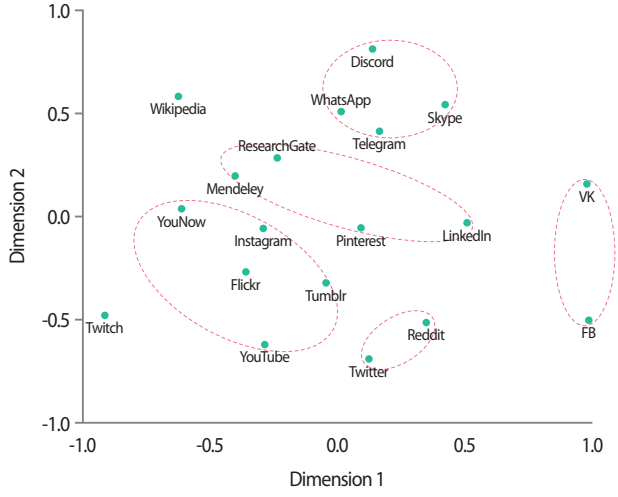

Fig. 4. Results of the multidimensional scaling for the web applications of social media services and messengers.

3. RESULTS

3.1. Ranking of the Services with Respect to Their Functions (RQ 1)

The findings reveal that VKontakte is the mobile application with the most functions (see Table 2), comprising a total of 228 functions. These already make up 35.6% of all functions investigated in this paper. Similar to this, Facebook stands atop the ranking of the web applications, comprising 261 functions (see Table 2), which account for 40.8% of the total. Moreover, the results show that the range of investigated functions can strongly vary in both mobile and web applications in context of the same service. This can be exemplified by direct comparison between the mobile application of Mendeley, having 38 functions, and its corresponding web version comprising a total of 91 functions.

Table 2. Ranking of mobile and web applications of social media and instant messaging services by number of functions

Service	Mobile applications		Web applications	
	Rank	Number of functions	Rank	Number of functions
VKontakte	1	228	2	233
Facebook	2	213	1	261
Line	3	181	-	-
LinkedIn	4	165	6	154
Telegram	5	162	15	92
Twitter	6	153	4	173
Discord	7	150	7	151
Instagram	8	148	18	86
YouTube	9	147	8	147
WhatsApp	10	146	19	79
Skype	11	144	9	138
Reddit	12	136	5	164
Tumblr	13	129	10	124
Viber	14	128	-	-
Snapchat	15	120	-	-
TikTok	16	118	-	-
Pinterest	17	106	11	122
Facebook Messenger	18	101	-	-
Twitch	19	87	3	188
YouNow	20	78	17	87
Flickr	21	72	12	114
Periscope	22	68	-	-
Jodel	23	61	-	-
Wikipedia	24	40	14	94
Mendeley	25	38	16	91
ResearchGate	-	-	13	103

Mendeley's mobile version lacks, among others, large numbers of functions belonging to the account, communication, content, and profile categories. Furthermore, functions serving notification and privacy purposes are missing entirely. Another example for the discrepancy of functions between mobile and web versions is Wikipedia. Here, the mobile version only offers 40 functions, while the web version provides 94 ones. The differences mostly concern the notification settings as well as the content posting aspect of the service – the latter being basically non-existent in the mobile application but ubiquitously present in the web counterpart. In general, it can be stated that the investigated web services have a higher number of individual functions with an average of 139.9 functions, as compared to an average of 124.7 functions for the corresponding mobile versions.

3.2. Ranking of the Most Implemented Functions (RQ 2)

A distinct set of the most present functions in contemporary relevant social media services was discovered. Many functions share the top spots in a ranking as they occur similarly often in different social media services and messengers. Here, a clear distinction can be made between the coverage rates for web and mobile applications. The top five functions in web applications reach a coverage of at least 94.7% (see Table 3). In contrast, the percentage of services that include the five most frequently occurring functions regarding mobile applications reaches a value of 84.0% (see Table 4). Also, the top 14 ranked functions are covered by at least 84.2% of all investigated web applications, while rank 12 of the functions occurring in mobile applications only has a ratio of 76.0%. The most frequently occurring function for both mobile and web applications is "Support: help page/FAQ/terms and conditions" which unites all support pages, granting access to information on the application usage and its restrictions to a user. By nature, this was found in nearly all applications analyzed – except for Facebook Messenger. Generally, many support functions appear rather frequently, as they are part of the majority of all services investigated. Moreover, account-related functions, such as the ability to change one's username or password recovery functions, are also present in the top of the ranking for the occurrence of functions in the investigated services.

Table 3. Ranking of functions present in mobile applications of social media and instant messaging services[a)]

Rank	Function	Function description	Number of applications[b)]	Percentage of applications[c)]
1	Support: help page/FAQ/terms and conditions	The ability for user to find pages with helpful information on functions of the service in question and/or pages with answers to frequently asked questions and/or pages with terms and conditions of the respective service	24	96.0%
1	Support: report	The ability to report any kind of problems. Users can be reported as well as inappropriate content or policy infringements	24	96.0%
3	Account: Automatic Device Login	The ability to automatically log into the service when using a specific device	23	92.0%
4	Block: users	The ability to block other users. This means that the blocked users can no longer access blocking user's profile or interact in any other way with him or her	22	88.0%
5	Account: Login/Logout: platform account	The ability to use an in-service account to log into the service as well as to log out	21	84.0%
5	Account: Sign Up: sign up password	The ability to sign up to a service by providing a password for login purposes. This means that the registration demands the act of setting an in-service password and no login can be done automatically through the device	21	84.0%
5	Profile: Upload: avatar/profile picture	The ability to upload an avatar/a profile picture	21	84.0%
8	About: service information	There is an about section, explaining version number of the services, etc.	20	80.0%
8	Profile: change display name	The ability to change display name (not username)	20	80.0%
10	Account: change username	The ability to change the username	19	76.0%
10	Communication: Chat: emojis	The ability to send emojis in chat	19	76.0%
10	Upload: Photo/Video: from local storage	The ability to upload a photo or video from a local storage (smartphone or PC)	19	76.0%

[a)]Number of listed functions: 12; [b)]Total number of mobile applications with the given function (maximum number of mobile applications: 25); [c)]Percentage of mobile applications with the given function.

Table 4. Ranking of functions present in web applications of social media and instant messaging services[a)]

Rank	Function	Function description	Number of applications[b)]	Percentage of applications[c)]
1	Support: help page/FAQ/terms and conditions	The ability for user to find pages with helpful information on functions of the service in question and/or pages with answers to frequently asked questions and/or pages with terms and conditions of the respective service	19	100.0%
2	Profile: change display name	The ability to change display name (not username)	18	94.7%
2	Profile: Upload: avatar/profile picture	The ability to upload an avatar/a profile picture	18	94.7%
2	Support: help page: search	The ability to search through the help page of a service	18	94.7%
2	Support: report	The ability to report any kind of problems. Users can be reported as well as inappropriate content or policy infringements	18	94.7%
6	Account: Login/Logout: platform account	The ability to use an in-service account to log into the service as well as to log out	17	89.5%
6	Account: set/change password	The ability to set and/or change the password	17	89.5%
6	Block: users	The ability to block other users. This means that the blocked users can no longer access blocking user's profile or interact in any other way with him or her	17	89.5%
9	Account: change contact information	The ability to change contact information, such as email-address or phone number	16	84.2%
9	Account: Password lost function	The ability to retrieve the lost password or set a new password, if the user forgot the password	16	84.2%
9	Account: Sign Up: email	The ability to register an account using an e-mail address. This can come hand in hand with an e-mail verification process	16	84.2%
9	Account: Sign Up: sign up password	The ability to sign up to a service by providing a password for login purposes. This means that the registration demands the act of setting an in-service password and no login can be done automatically through the device	16	84.2%
9	Communication: mention with @addressing	The ability to address another user in the chat by mentioning. This action of mentioning is performed by typing a "@" symbol followed by the username	16	84.2%
9	Support: contact us	The ability to use contact form to write a complaint to or to demand help from support team of the service	16	84.2%

[a)]Number of listed functions: 14; [b)]Total number of web applications with the given function (maximum number of web applications: 19); [c)]Percentage of web applications with the given function.

3.3. Classification of Social Media and Instant Messaging Services according to Functions (RQ 3)

The generated clusters are named after the unique characteristics of the services within them and their most prominent functionalities. Moreover, the chosen names are either drawn from the uses and gratifications theory, from general functionality definitions present in the social media research landscape, or directly derive from the investigated functions.

Beginning with the cluster analysis for the mobile applications (see Fig. 5), six clusters were found. On the highest layer the services are divided into *Social Media Services* and *Messengers*. The cluster of Social Media Services contains all services that are typically associated with the definition of the term. Messengers, on the other hand, are true to the original group of instant messengers. They comprise Discord, Facebook Messenger, Line, Skype, Telegram, Viber, and WhatsApp.

The cluster of Social Media Services is then divided into services with *limited functionalities* and those not matching that category. In the limited functionality class, there are only services that have less than 100 functions to offer. The complementary class is formed of all services offering more than 100 functions and, thus, also a larger functionality scope. Besides this, the limited functionality class involves the classes of *single purpose services* and *live streaming services*. Single purpose services have such a limited range of functionalities that they are mostly focused on one general main feature, ideally not offering anything else on the sidelines. Such a main feature can be seen in Jodel's case, where users can only share short text messages with other users in their immediate surroundings and nothing beyond. Apart from Jodel, this category contains Flickr, Mendeley, and Wikipedia. Similarly, the class of live streaming services solely consists of applications with a distinct focus on live streaming activities, comprising Periscope, Twitch, and YouNow.

The class containing services that do not hold limited functionalities is divided into the clusters of *sharing services* and *socialization services*. The first one is characterized by services with an explicit focus on sharing content by uploading it publicly or semi-publicly, while the second cluster follows the general goal of pursuing the gratification of socialization. In this context, such socialization-focused applications include Facebook, LinkedIn, and VKontakte. The superclass of sharing services is further subdivided into *self-presentation services* and *information and entertainment services*. In this case, self-presentation services are defined in accordance with the finding that all services in this cluster pursue the idea of granting control over which information users want to reveal about themselves – enabling a full-on self-representation strategy. These services include Instagram, Snapchat, and TikTok.

On the other hand, the *information and entertainment services* cluster consists of sharing services with less accentuation of the act of self-presentation and more of the ideas of consuming information or entertainment contents. Following the uses and gratifications theory, this class is labeled this way, as information sharing and entertainment are the main goals users pursue when using the services the class consists of. Uniting these terms builds a class of services that pursues either of those characteristics or both at the same time. The services contained herein are Pinterest, Reddit, Tumblr, Twitter, and YouTube.

Even though the functionality scopes of web and mobile applications are different with respect to their numbers of functions, the clusters formed by the investigated web applications (see Fig. 6) take quite a similar shape compared to the ones built by mobile services. Uniquely, the top layer shows a distinction between general *social services* and *contacting services*. In this context, *social services* are defined as social media services with an emphasis on the act of socializing instead of actually contacting other users.

The contacting services class contains applications with a clearly visible main aspect of directly contacting other users. This is furthered by the fact that these contacting services are divided into the previously defined *messengers* and *socialization services*. In this case, the messengers comprise Discord, Telegram, Skype, and WhatsApp, while the socialization services contain Facebook and VKontakte.

The superclass of social services is built on the foundation of *sharing services* and a single service class represented by Twitch. Unlike before, the sharing services contain two subclasses consisting of *information services* and their complement. Information services are considered to be services with a general purpose of acquiring and sharing information in all shapes, based on the fact that they only contain Reddit and Twitter. The complement is further divided into Wikipedia as its own class, representing the category of knowledge bases, and the remaining sharing services. On the other hand, these services are discerned by *entertainment services* and *professional self-presentation services*. The class of entertainment services in this case contains services to which are attributed a clear focus on user entertainment as defined previously. The web applications sorted into this category are Flickr, Instagram, Tumblr, YouNow, and YouTube.

The professional self-presentation services are primarily all services with a focus on self-presentation in a business context. This can be exemplified by the class members LinkedIn, Mendeley, and ResearchGate, whose primary focus is on creating

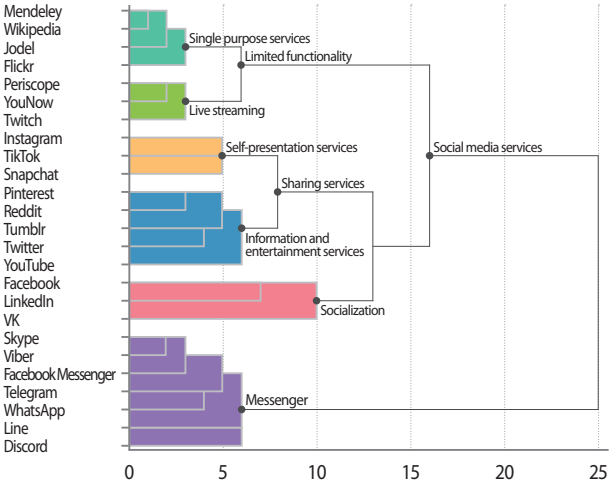

Fig. 5. Dendrogram representing cluster analysis results regarding the mobile applications of social media services and messengers.

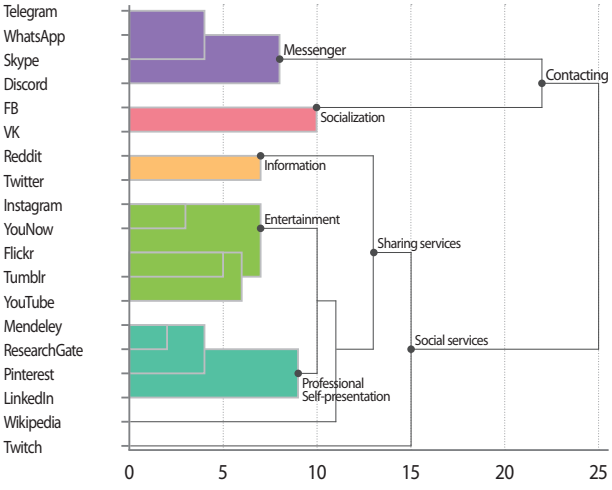

Fig. 6. Dendrogram representing cluster analysis results regarding the web applications of social media services and messengers.

profiles for self-presentation in one's own specific field of work. However, Pinterest is also clustered into this class, although it does not match the general conditions showcased by the other services.

4. DISCUSSION

The purpose of this research was to empirically classify social media services and messengers according to similarities in their functionality scope. Moreover, rankings were established, providing information on which services comprise the highest number of functions and which functions are particularly often implemented in different services.

Regarding clustering, this paper introduces a new functionality-based classification system for social media services and messengers. While previous classification models categorize social media services intuitively (Aichner & Jacob, 2015; Bruhn et al., 2011; Kaplan & Haenlein, 2010; Linde & Stock, 2010; Schmidt, 2018), the present research is the first attempt of clustering them empirically by their functionality. Therefore, this approach investigates whether the existing theoretical classification models are reasonable with respect to practice.

As mentioned by Weller (2015), most social media studies focus on popularity which means that less popular services like Tumblr are ignored. In contrast, this research inspected the whole scope of functionalities of social media services, also taking some of the less popular web and mobile applications into consideration. Here, six clusters for the mobile and five for the web versions of the applications were introduced based on the overlapping functions of the different services.

Previous social media classification models and theories are applicable to these findings. One of these theories is the uses and gratifications theory introduced by Katz et al. (1973). It is used to label the clusters by providing four labels which are frequently recurring in research regarding the purpose of social media usage: *Socialization*, *Information*, *Entertainment*, and *Self-Presentation/Self-Expression* (Shao, 2009; Whiting & Williams, 2013). All these aspects are found in the classification created by the clusters at hand. Additionally, the labels *live streaming*, *single purpose services*, and *messenger* were introduced on the lowest hierarchical level and strayed from the labels taken from the uses and gratifications theory.

The four main classes intuitively defined by Linde and Stock (2011) are *social networks*, *sharing services*, *knowledge bases*, and *bookmarking services*. By investigating the functionality scope of different services empirically, it is possible to confirm the validity of these types of social media – though with limitations. Social networks like Facebook focus on users and their profiles with the purpose of connecting them to others (Schmidt, 2018). Furthermore, it is possible to distinguish between professional self-presentation services like LinkedIn and networks which mainly focus on the creation of private profiles such as Facebook (Sander et al., 2017). This is also reflected in the introduced clusters as the web applications explicitly build a cluster of professional self-presentation services, as opposed to social networks which are labelled with socialization in this approach.

As sharing services concentrate on content per definition, they focus on uploading, sharing, commenting, and liking, mainly of photos and videos. Clustering these functions proves the focus correct as the most popular representatives of this group are currently YouTube, Instagram, and Snapchat (Schmidt, 2018), resulting in a cluster of their own.

Knowledge bases can be further subdivided into collaborative ones as well as blogs and microblogs. The most prominent representative collaborative knowledge base is Wikipedia, which is one of the investigated services in this research (Linde & Stock, 2011). As Wikipedia forms its own subcluster in the dendrogram of the services' web versions and belongs to a different cluster than Twitter with respect to the mobile versions, it becomes apparent that collaborative knowledge bases and blogs are quite different types of social media.

Only one of the four main classes does not appear in the results of the clustering: bookmarking services. Although Mendeley and Pinterest were taken into account in this study, they were sorted into different clusters. After all, the scope of functions unique to bookmarking services is rather slim, especially if compared to the amount of other functionalities held by the respective services. For example, Mendeley in its mobile version did not show any proper bookmarking functions, while the web version's function scope matched that of a fully elaborated social network. Therefore, the validity of the fourth class cannot be confirmed while focusing on cluster analysis only.

Clustering mobile applications revealed a clear distinction between social media services and messengers. While messengers overlap in functionality, they were separated from the social media services.

Looking at Kietzmann et al.'s (2011) seven functional blocks of social media, reputation and presence can be combined to create the self-presentation cluster, while sharing is mostly part of the entertainment and information clusters. Relationships, on the other hand, are frequently built in socialization services.

There are two services forming their own clusters: the web versions of Twitch and Wikipedia. This can be explained by looking at the ranking positions where Twitch ranks third place among all investigated web applications. With 188 out of 640 functions, it has a larger functionality scope than the only other

pure web live streaming service YouNow. On the other hand, Wikipedia's web version separates itself from the other web services by many wiki-exclusive functions like wiki-creation, inserting specific symbols such as hieroglyphics or musical notations. Consequently, there is no comparable service in the sample, rendering Wikipedia non-clusterable with other web applications.

The comparison between the clusters of web and mobile applications shows that two applications of the same service do not necessarily get assigned to a similar cluster. One reason for this phenomenon can be found in the different sample sizes of 25 mobile applications versus 19 web applications, which leads to more clusters for the mobile applications. Moreover, the purposes and user needs of some services can be crucially differing. One example is Mendeley, which is mainly used in the web version in order to save and manage literature bookmarks. However, the mobile version's core functionality is exclusively limited to serve as a PDF reader for the bookmarked literature. Similarly, Instagram's mobile version satisfied its core functionalities by being mainly used to share and present information about oneself and self-presentation in the form of photos, while the web version is reduced to the consumption of other users' contents. Consequently, this focus on different functionalities in mobile and web applications results in two different cluster assignments for both versions.

Another goal of this research is the evaluation of social media services regarding their functionality scope. While there are many other aspects of importance in a qualified evaluation of an information service, functionalities serve as an indicator for the quality of each service and can therefore be used for a simple objective ranking. Facebook (Baran & Ghaffari, 2017) and VKontakte (Baran & Stock, 2015) take the top spots in the web and mobile rankings. Both services basically serve the same purpose, but VKontakte is mainly used in Russia. In addition, both services are the only ones exceeding 200 functions in both versions, covering almost every functionality area like chatting, streaming, videos, pictures, profile options, and account settings. The third places are assigned to Line for mobile and Twitch for web applications. These services, with their large quantities of functions, showcase that single purpose driven services do not need to be limited in their functions. Focusing on Twitch, there is a notable gap of 101 functions between the web and mobile version. Such gaps also occur in other services like Wikipedia, Twitter, or Mendeley and lead to the conclusion that web and mobile applications focus on different kinds and amounts of functions. This makes sense given that the derivation of mobile applications from existing web services is not a mere copying process (Barroca Filho & Aquino Júnior, 2016).

The rating indicates that the most important social media functions are *help*, *support*, and *profile*, as well as *account setting*. These functions are substantial for every kind of social media and build the base of the applications with the former being implemented in all but one of the inspected services.

Summing up the results of the cluster analysis, it becomes clear that empirical approaches can be combined with existing theoretical research by substantiating them. Moreover, investigated functions mostly cover the purposes of classes in previous classification approaches. Consequently, the introduced research model with functionality-based clustering is a reasonable complement for existing social media classifications. It provides a successful new way of empirically classifying social media services and messengers. Furthermore, rankings of the services as well as their functions were created.

The study has theoretical implications for information science and system sciences as it enters the new research area of empirical investigations on functions and their distribution among social media and messaging services. It has practical implications for companies offering social media or messaging services in order to check their amounts of functions in comparison to other services and to optimize their own services. Furthermore, the study can find practical implications among social media services developers, as it demonstrates which functions need special attention in order to ensure their usability and, therefore, the users' satisfaction with a service.

4.1. Limitations

Although the research shows reasonable results, there are some limitations connected to the presented approach. Firstly, it was impossible to investigate all existing social media services and messengers currently on the market, as not all necessary languages are known well enough by the research team for such a detailed analysis. This means that some services like the Chinese Weibo were not available for the present functionality analysis. Hence, only services available in English or German were compared. Furthermore, due to the extensive landscape of social media, not all types could be considered as part of this study. One prominent example is dating apps. Lastly, while the resulting clusters were not formed randomly, an automatic clustering approach does not guarantee a perfect result. This becomes evident in the case of Pinterest, which is clustered alongside LinkedIn, Mendeley, and ResearchGate. While the cluster was coined after the key concept of professional self-representation, Pinterest itself does not offer any function suiting this classification. Additionally, Pinterest does not have many similarities to LinkedIn or ResearchGate, leading to the assumption that it was solely sorted into this cluster due

to its shared main functionality of social bookmarking with Mendeley.

4.2. Further Research

The introduced cluster analysis can serve as the foundation for further research regarding the evaluation or classification of social media services and messengers. As services in Chinese, Japanese, Korean, and other Asian languages were not investigated, the study should be replicated for Asian languages. With such a study, an inter-cultural comparison between services in Asia and in the English-speaking world becomes possible. On another note, as not all types of services, such as dating apps or review sites, have been investigated in this study, they could be included in future research to further enhance the scope. It is also possible to take a look at the results of the functionality ranking to investigate – for example, by means of a usability test – which of the top ranked functions are commonly used by social media users and are therefore important for the services. This would improve the quantitative analysis and the ranking process even further, as it would bring the concrete usage of the implemented functions into focus and allow an even more advanced evaluation of the social media services. Moreover, with respect to these findings, users could be asked to name the most important functions for different types of social media services. Such user interviews could also reveal which information systems subjectively provide the most advanced functionality scope and are thus considered to be the most user-friendly ones.

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