Applicability of Social Media Elements in Notification Systems in Large Interconnected Organisations

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***Abstract*—Access to large amounts of information has resulted in users experiencing the effects of information overload, which is the state where users are presented with a much higher amount of information than they can process at a given time. Information overload is also observed in Social Media Platforms (SMP), which has resulted in the invention of mitigation techniques for information overload. Currently, there are many different approaches to deal with information overload. One popular method to deal with information overload and minimize the time spent by users analyzing large amounts of information is using notification systems. Notifications aim to display the most relevant information at a certain point in time to the user without disturbing the daily workflow of an individual. This work focuses on determining aspects of social media that can be integrated into a notification system. These aspects have the purpose to enhance and aid information retrieval, visualization, and distribution capabilities in a notification system and reduce the effects of information overload. As part of this work, we executed a study with 35 participants and presented different use-cases of Social Media Elements (SME) to evaluate their usability. The preliminary results of the study showed that adding social media elements to notifications increased the credibility and clarity of notifications. The participants reacted positively to notifications that were formatted as social media posts, rating them more trustworthy as compared to traditional notifications. SME had the effect of aiding the participants to better determine the difference between fake and real information.**

Keywords*—*Social Media; Notifications; Large Organisations; Hashtags; Microblogs

I. INTRODUCTION

Adoption of modern Information and Communication Technologies (ICT) have increased the amount of generated information and made information easily accessible. However, this also has resulted in users experiencing information overload [1], which can be defined as the state when users are presented with large amounts of information, that exceed the processing capability of the users [2].

One source of information overload is notifications, since users receive a large amount of notifications from multiple applications on multiple devices (e.g., desktop notifications or mobile notifications). Notifications allow applications such as email clients, messaging applications, calendars, and others to inform users of incoming messages from other users, upcoming events, reminders, new emails, and more without explicitly requiring user interaction with the application. Since each application has a specific notification format, the user is presented with a large amount of different information, making it hard to process [3].

Based on a study of 40191 randomly selected participants from different areas of work, users receive on average 44.9 notifications per day from multiple sources. Participants received notifications from 173 applications. Some of the applications were email applications (e.g., Gmail or Outlook), text messaging applications (e.g., Whatsapp or SMS apps), and voice messaging applications (e.g., Google Hangout and Skype) [4]. Findings also shown that high number of notifications, in particular from email clients and social networking applications, correlate with increased stress and the feeling of being overwhelmed. They distract users from executing current tasks and induce negative emotions [5]. Another study based on a sample of high-performing management individuals has revealed that the increase of information overload leads to more stress and negative emotions in individuals [2]. Users acknowledge notifications as potentially disruptive and distracting since they do disrupt the current engagement of the user [4].

Despite the disruptive nature of notifications, users decide to use them because of their benefit in providing relevant information. In this context, notification systems can be beneficial and attempt to aggregate the previously mentioned information from different sources (email clients, news portals, messaging platforms, and others), and deliver it to the user in the form of notifications [6]. Besides providing information aggregation and notification delivery, notification systems enable the management of notifications (e.g., selecting which applications are allowed to send notifications), which reduces the user need to constantly interact with different applications [7]. The success of a notification system hinges on accurately supporting the user with information between tasks, while simultaneously enabling utility by providing access to additional information [8]. Notification systems attempt to keep the users informed by balancing the amount of valuable information provided and the disruption the information causes. It is necessary to find means to coordinate the delivery of notifications from multiple applications across multiple devices or/and display only relevant information at a glance. By bringing multiple sources of notifications together, the user can determine the importance of a notification and reduce the level of distraction [9].

According to [8], there are three critical parameters for the

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creation of a successful notification system:

1) **Interruption** - is defined as an event, where the user has to shift their attention from the main task and switch focus to the notification. Examples of these events are receiving notifications while operating heavy machinery, where the notification should not distract the user from the main task. However, other situations like medical emergency alerts, require that the notification explicitly interrupts the user [10].
2) **Reaction** - is defined as the response to the stimulus provided by the notification. Some examples of user reactions are ignoring notifications, removing them from the notification list, and clicking on the notification.
3) **Comprehension** - is defined as the use of notification systems with the goal of remembering and making sense of information at a later point in time. Based on past reactions, a notification system can show notifications to the users when they are more likely to read them.

While quick and correct reaction to information is important in many situations, it is also important to present the information in a comprehensible way. Notifications should display a balance between the interruption, reaction, and comprehension parameters [8].

One of the main challenges with designing a notification system is learning when and how to display understandable and valuable messages at a glance without explicitly disturbing or distracting the user. This problem has been tackled in different disciplines. Potential practical concepts can be found in social media, especially Social Media Marketing (SMM). The goal in SMM is to present information to the user at a specific time based on previous user behavior and experiences with other similar users. The information contains social media elements and should not irritate the user but stimulate engagement with the content. This SMM information usually has the goal to guide the user to a social media site [11].

Social media sites have become one of the most popular social behaviors among humans, and recent statistics suggest that more than two-thirds of internet users use social media sites [12]. One of the main reasons for its popularity is the user engagement and personalized information it provides to the users. There are also drawbacks such as the lack of security, internet addiction, frequent interruptions from other tasks, information overload, creation of information bubbles, and loss of social contacts [13].

Social Media and SMM concepts related to user engagement and information presentation can potentially be adopted in notification systems to improve message flow to users and enhance user engagement.

Kietzmann et al. [14] identified seven main functional building blocks of social media: identity, conversations, sharing, presence, relationships, reputation, and groups. These building blocks can be identified in various social media applications, like networking sites, photo-sharing platforms, blogging platforms, video-sharing platforms, collaboration platforms, and micro-blogging platforms.

In this paper, we want to identify social media elements based on previously mentioned functional building blocks of social media and explore which of these social media elements can be adopted in a notification system. The goal is to improve user interaction and navigation, information value, information dissemination of notifications, and comprehension of notifications in notification systems. In addition, attention is also given to mitigate possible side effects of social media elements and notification systems, such as wasting time analyzing and reviewing the information provided to the user via the notification system.

Based on the observations stated above, more specifically, the main research questions are: RQ1: Which elements of social media can be integrated into notification systems to display understandable and valuable notifications at a glance without explicitly disturbing the user?, RQ2: Would users prefer to receive notifications with integrated social media elements like hashtags, topic keywords, source information, rating by other users, and groups information?, RQ3: How do users react to notifications with this additional information?, and RQ4: Which emotions do users experience when receiving notifications with and without this additional information?

To this end, the remainder of this paper is organized as follows: Section II covers the literature overview and discusses current topics in social media, notification systems, and their relation and use-cases. In Section III, the methodologies used in the study and the study are explained. Results are presented in Section IV, together with the discussion of the study outcome. Finally, we conclude the work in Section V.

II. Background and Related Work

Inspired by SMM, where the integration of social media elements into marketing information has led to increased user engagement and satisfaction, we propose adopting social media elements into notification systems and notifications [11]. In analogy to gamification applying game design elements in non-game contexts [15], it is proposed to integrate social media elements in non-social media contexts. The application in notification systems aims to improve the readability of notification and increase its informational value.

The remainder of this section assesses the drawbacks and advantages of notification systems, outlines social media elements, and investigates possible integration in notification systems.

A. Notification Systems

There are many different implementation versions of notification systems. The most commonly used are push notification systems for mobile phones, desktop status notification systems, browser-based notification systems, in-vehicle information systems, and others [16]. As mentioned in the previous chapter, notification systems attempt to convey important information to users effectively without creating an unwanted intrusion into current user tasks [6]. Selecting important information for the user is a difficult task. A study of 400+ participants has shown that users are not satisfied with the

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notifications they receive from notification systems because they do not express the user's current interest. This leads to users ignoring most notifications from these systems [17]. Besides determining what is relevant information for the user, an essential concern in notification systems is the display of notifications without a significant interruption of users' main tasks. Visual implementations of notifications that typically are not a user's main attention priority are called secondary displays. Users willingly sacrifice brief interruptions from their primary task to view information of interest in these secondary displays [18].

B. Social Media Elements

The above-mentioned functional building blocks of social media are umbrella terms used to cover many social media elements observed on different social media platforms. Based on the analysis of social media sites and research on social media aspects [14][11][19] we identified and summarized some of the most common elements. Table I displays these elements.

TABLE I
SUMMARY OF MAIN SOCIAL MEDIA ELEMENTS

Social Media Element	Description
Hashtags	A hashtag is a metadata tag type used on social networks to help users find resources with a specific theme or content [19][20]
Microblogs	Microblog services allow users to post and share short textual messages that are then propagated to an audience, which can then quickly interact with the posts and between each other [21]
Content approval/ disapproval	Social cues that send signals of social appropriateness or social acceptance of content to the content creator. Examples of these social elements are Likes, Retweets, Reactions, and more [22]
User Groups	User groups represent the extent to which users can form communities and sub-communities. The more 'social' a network becomes, the bigger the group of friends, followers, and contacts.
User-to-User Relationship	User-to-user relationships express the extent to which users can relate to each other (e.g., friendships on Facebook or Followers on Twitter) [14]
User Identity	It represents the degree to which users expose their identities on social media sites. It includes exposing information such as name, age, gender, profession, location, and other users' identifiable information [14].

Considering the definition of social media elements from Table I and the description of notification systems above, we have decided to exclude user identity from our research and for the review in this section. The main reason for the exclusion of this element is that it is too focused on the individual. Including user identity information in notifications displayed to the user does not improve the information on notifications. Showing this information would be redundant for the user and could not be integrated into the context of notifications without privacy concerns.

1) Hashtags: The content of hashtags can be dynamically generated or user-generated and can only consist of letters, digits, and underscores. Thus, hashtags are iconic features that enable easy retrieval of connected resources [19][20]. They are used to construct a personal word/hashtag vector space of a user by examining the users' linguistic expression [23]. Besides identifying and representing user features, hashtags connect similar resources by assigning tags to provide contextual information [24]. According to [25], linking information on Twitter with information from other sources like Wikipedia led to increased understanding of the information and productivity when consuming the information. For example, in the context of notifications, hashtags could represent the topic of the notification or connect the notification to information related to the topic, making it easy for the user to determine if the notification is related to the current task.

2) Microblogs: Similar to microblog posts, notifications are messages displayed to the users with the intent to share information. These messages contain information from different applications (e.g., email subject and part of email text, new message alert). Based on the above description, it can be concluded that notifications share similarities to microblog post entries. However, unlike notifications which do not contain much additional information in their visual representation, microblog posts contain aspects of social media, which allow the users to determine the importance and validity of a post.Aspects like the number of individuals that have shared, liked, or approved the post, topics related to the shared post, and the type of individuals that have interacted with the post are of crucial importance to assess the value of the post and the information within [26][27].

Hashtags in Microblogging services contain information about temporal trends of the information stream and the topology of the spread of information. This makes hashtags a tool suitable for archiving, tracking, and disseminating information [28][29].

3) Content approval/disapproval: Providing and receiving feedback is a fundamental component of participation in social media. In addition, the popularity of social media has enabled the use of rich user information from Facebook and other social networks to predict users' latent traits for recommendation [30]. Based on the previously mentioned study, users have expressed a need for more personalization in notifications; integrating likes into a notification system as a means to gather feedback from the user related to the notifications could be beneficial for improving the satisfaction rate of users [17].

4) User Groups: A widely discussed relationship group metric is Dunbar's Number, proposed by Robin Dunbar in 1992. He theorized that people have a cognitive limit that restricts the number of stable social relationships with other people to about 150. Social media platforms have recognized that many communities grow well beyond this number and offer tools that enable users management of memberships [31]. The assumption that the vocabulary used to discuss a topic stays similar between different user communities and does not vary significantly over time directly suggests that it is possible to compute the overlap of topics of two or more communities. This community similarity can connect communities from different social networks (e.g., Facebook), facilitate information sharing between communities, and extract community interest [32]. Furthermore, user groups and group behavior information

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infer social cues, including group information (e.g., number of people with the same interests who approved a notification or executed a specific action) in notifications could increase the credibility and information dissemination of notifications.

5) User-to-User Relationship: The type of relationships users form between each other determines what information exchanges between them. For example, when users form professional relationships online, the information exchanged between them will be of professional content and high value, compared to friendly relationships where the information is of a different nature [14]. User relationship information could be used in notification systems to determine the character of information presented to the user.

C. Discussion

Towards our goal to determine how social media elements can enrich notifications with additional information, the section above outlined vital social media elements and investigated their application for this purpose. Table II summarizes how social media elements could be beneficial for notification systems.

TABLE II
SOCIAL MEDIA ELEMENTS AND USABILITY IN NOTIFICATION SYSTEMS

Social Media Element	Usability in Notification Systems
Hashtags	Quick access to topic information; Enables instant classification of notifications by topic; Linking external information to the notification
Microblogs	Social Media Posts provide information representation ideas for notification due to their similarity; Content Sharing does not have a direct use in notifications
Content approval/disapproval	Provide a way for the user to express interest
User Groups	Provide additional information and credibility of information based on the opinion of a group of users
User-to-User Relationship	Provide different types of additional information based on relationships with different users

Hashtags and user group elements provide additional information, potentially enhancing the information in notifications. Integrating these elements could increase the trustworthiness of notification systems and reduce the time needed for a user to evaluate the importance of notifications. Since notification systems lack a direct user feedback mechanism, integrating content approval/disapproval elements could provide it.

For Microblogs, our research focused on two features Social Media Posts and Content Sharing. Due to the lack of applicability in notification systems, content sharing was excluded. However, considering that social media posts share similarities with notifications, we determined that formatting information in notifications similar to social media posts by including hashtags, more personalized text, and information sources, could benefit notification systems.

Even though user-to-user relationships offer great insights into users' interests, knowing the user and connections are mandatory to integrate this element into a notification system. Due to the setting of our initial study, we excluded this element from the evaluation since it was necessary to track user relationships over a more extended period.

To this end, we have selected four social media elements for evaluation based on their applicability in notification systems: hashtags, user group information, content approval/disapproval, and social media posts (formatting the content of the notification as a social media post).

III. User Study

To determine the effects of certain social media elements on individuals, we designed an online study. The user study addresses the above-defined research questions: RQ1 to RQ4.

The study was designed as an AB study including the following parts:

1) General Questionnaire: contains questions listed in Table III that aim to identify the value and effects of additional information in notifications on the user. This questionnaire aims to provide insights to RQ1 and RQ2, by explicitly asking the participants about how they perceive SMEs in the notifications they received.

TABLE III
GENERAL QUESTIONNAIRE QUESTIONS

Question
Q1: Did you find the additional information in the notification valuable?
Q2: When I received notifications with additional information I was more confident in the notification?
Q3: Rank the additional information by importance
Q4: It was easier to understand the notification when I had additional information in the notification?
Q5: Did the notification break your concentration while executing the task?

2) Article Feedback: contains questions listed in Table IV that ask participants to evaluate if the articles are fake or not. The responses determine if notifications with additional information help determine the truthfulness of articles and how users react to notifications with additional information.

TABLE IV
ARTICLE FEEDBACK QUESTIONS

Question
Q1: Do you think that the article "Friends Reunion" is Fake or Real?
Q2: Do you think that the article "Instagram for Children" is Fake or Real?
Q3: Do you think that the article "People live in a 3D-Printed House" is Fake or Real?
Q4: Do you think that the article "3 Reasons Why You Should Stop Eating Peanut Butter Cups!" is Fake or Real?
Q5: Do you think that the article "Us Bacon Reserves Hit 50 Year Low" is Fake or Real?

3) Computer Emotion Scale (CES): used to answer RQ4 by determining the emotional influence of notifications on the participants since it provides one of the most scientific ways for emotion evaluation [33].

4) System Usability Scale (SUS): used to determine if the participants would prefer to receive notifications with additional information, which directly correlates with RQ2 and RQ3. It provides a trustworthy evaluation tool for usability testing [34].

The study was created using the CoDiS Survey Tool [35], which tracked and analyzed participants' behavior and pre-

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sented specific assignments. The CoDiS Survey Tool is a web based evaluation tool. The participants were asked to read articles, mentioned in Table V and execute predefined tasks (share articles, comment on the article, and more). As the participants were doing these tasks, notifications related to the articles were displayed. Notifications were displayed as part of the CoDiS Survey Tool as web elements that appear when the user starts reading an article. Depending on the user group, these notifications were either with additional information or without additional information. The additional information included hashtags, user group information, and social media post formatting. This additional information integrates all selected social media elements from the previous chapter.

TABLE V
ARTICLE TITLE AND VALIDITY

#	Title	Is Fake
1	Friends Reunion	No
2	People live in a 3D-Printed House	No
3	Instagram for Children	No
4	US Bacon Reserves Hit 50 Year Low	Yes
5	3 Reasons Why You Should Stop Eating Peanut Butter Cups!	Yes

The participant target groups for the study were high school and university students. In total, 215 individuals were asked to participate, and only 35 completed the study. The age of the participants varied from 15 to 34 years old, with 57.14% of the participants being in the range from 15 to 20 years, 25.72 % being in the range 20-25, 14.289 % in the range 25-30, and 2.85% in the range above 30 years old. Female participants made 28.57% of the total amount of participants, while male participants made 71.43%. As stated previously the study was designed as an AB study, this is why the participants were divided into two groups (Group A and Group B). The purpose of this division is to reduce bias between users. Both groups received the first article with additional information notifications. The purpose of this was to create a control article and familiarize the users with this type of notifications. Group A received simple notifications on even-numbered articles, while group B received them on odd-numbered articles. After the participants finished reading the articles and the article-related tasks, they had to complete an evaluation.

IV. Findings and Discussion

Analyzing the answers to questions presented in Table III, we have concluded that the participants find notifications easier to understand and share the thought that they have more credibility when presented with additional information. The additional information in notifications has increased the value of notifications to the user based on answers to Q1 from Table III, where 85.71% confirmed the premise. The participants had more confidence in notifications with additional information in comparison to formal notifications, based on answers to Q2 from Table III. Based on Q3 from Table III 77.14% of the participants stated that they find it easier to understand notifications with additional information. With 60% of participants answering with ”Yes” to Q5 from Table III, we can confirm that notifications break user concentration, which validates results of previous research [4][2].

According to [8], the success of notification systems is dependent on the information they convey to the user. The survey participants agree with this as shown in Table VI. It reveals that users care predominantly about the content and source of notifications. It implies that adding additional information to validate the content and source increases their value to users. The results in Table VI also validate our proposal that formatting notifications as social media posts could improve the information presented to the user since the content was formatted to be similar to a social media post. Contrary to our research, group information (e.g., ”22 readers validated text”) was not ranked as highly important by the participants.

TABLE VI
ADDITIONAL INFORMATION RANKING BY IMPORTANCE

Additional Information	Very Important	Not at all important
Information Source	10 (33.33%)	1 (3.33%)
Hashtags	2 (6.67%)	4 (13.33%)
Content of the Notification	10 (33.33%)	1 (3.33%)
Group or Reader Validation Info (e.g., ”22 Readers Validated Text”)	1 (3.33%)	10 (33.33%)
Notification Position	7 (23.33%)	14 (46.67%)

The distribution of SUS answers reveals that most of the users agree or strongly agree with questions Q1, Q3, Q4, Q5, and Q7 of the SUS [34] while disagreeing or strongly disagreeing with the rest of the questions. Due to a large number of neutral answers, the average rating of the scale is 69.78. This is slightly above the limit of 68 set by [34] as the value that is the minimum for a usable system. Based on the results of the SUS, we can infer that the users would prefer to use a notification system with social media elements.

TABLE VII
PERCENTAGE AN ANSWERS HAS BEEN SELECTED ON THE COMPUTER EMOTION SCALE

	None of the Time	Some of the Time	Most of the Time	All of the Time
Happiness	20.95%	31.43%	24.76%	22.86%
Sadness	68.57%	24.29%	4.29%	2.86%
Anxiety	69.29%	18.57%	8.57%	3.57%
Anger	65.71%	21.90%	7.62%	4.76%

The result of the CES is shown in VII, the table contains a list of feelings a participant has experienced. The CES shows that the users were happy most of the time executing tasks and receiving notifications, while none of the time experiencing sadness, anxiety, and anger. Based on VII the emotion anxiety has the lowest score because most of the users rated it with ”none of the time” followed by Sadness and Anger. The best-rated emotion was Happiness where the majority of the users answered with either ”Some of the Time”, ”Most of the Time” or ”All of the Time”. These results do not correlate with previous studies, where users experienced negative emotions and stress while receiving notifications [5].

The participants were asked to determine if the articles

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they read were fake or not. They rated correctly in 57.93% of the cases. The participants that were shown notifications with additional information, selected fake and real news with a 6.61% greater accuracy.

Due to the inability to track the usage of notifications over a more extended period, we could not evaluate all social media elements.

V. Conclusion

In conclusion, this research study displays the potential of social media elements in different disciplines, focusing on uses in notification systems. The initial research study shows how the selected social media elements can potentially increase user satisfaction and the value of information in notification systems. Since time constraints were an issue and restricted the number of SMEs that could be evaluated, future work might include an analysis of user reactions to notifications with additional information over a prolonged period. This would enable a better evaluation of the analyzed SME and additional SMEs that could not be part of this study. Prolonged tracking of user reactions to different combinations of SMEs in notifications might lead to a novel approach in the use of SMEs and notification systems. The survey results could provide the initial steps towards new use cases of social media applications in notification systems and other disciplines.

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