Mobile notifications as an information medium: an ethnographic study of mobile human-information interaction attitudes of Egyptian and German higher education students

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Abstract

This study explores the impact of mobile notifications on the information behavior and interaction attitudes of higher education students in Egypt and Germany. Using an ethnographic approach, the research investigates how mobile notifications serve as a crucial medium for information delivery, transforming user interaction with information. The study identifies significant challenges posed by the influx of notifications, such as information overload, distraction, and stress. It also examines the skills and strategies students employ to manage and prioritize notifications, emphasizing the need for improved mobile information literacy (MoIL). Interviews and observations reveal varied user engagement with notifications, highlighting the dual role of notifications as both end-point information containers and triggers for deeper information-seeking behavior. The findings suggest that while notifications enhance efficiency and immediacy in accessing information, they also necessitate new coping

mechanisms to mitigate negative impacts. This research contributes to the field of information behavior by offering insights into the effective use of mobile notifications and proposing better notification system designs to foster enhanced information literacy in an increasingly connected world.

Keywords

Mobile Notifications, Information Behavior, Human-Information Interaction (HII), Ethnographic Study, Higher Education Students, Mobile Information Literacy (MoIL)

1. Introduction

Information is a ubiquitous aspect of our lives, influencing every activity and thought. Human information interaction (HII) studies how individuals interact with information in various contexts (Fidel, 2012). Exploring how individuals are seeking, retrieving, evaluating, organizing, and using information to meet their needs (Albers, 2008). Among many factors that influence information use, such as context, goals, and resources, technology plays a significant role in HII, as technologies have changed how individuals interact with information. (Jones et al., 2006). Mobile Notifications have become one of the most important technological changes that have altered information interaction; they have become a crucial medium for information delivery, transforming how users interact with and seek information. (Yuan, Zhang, Chatterjee, Yu, & Rosales, 2019). These real-time updates and alerts from various apps keep users constantly informed, making notifications an integral part of daily life. While enhancing efficiency and immediacy in accessing information, this constant influx of notifications also brings challenges such as information overload, distraction, and stress. Consequently, users must develop new skills to manage and prioritize notifications, highlighting the need for improved mobile information literacy. Smartphone notifications are unique due to smartphones' constant availability, intimate proximity to the user, and ease of access. These features have facilitated the frequent use of alerts and notifications, transforming information delivery and enabling the development of new services and features within mobile applications. Users rely on their smartphones to stay informed and be reminded of various tasks, making notifications a fundamental aspect of daily information management.

From an information-seeking perspective, smartphone notifications significantly alter user behavior. They function as an automatic information delivery mechanism, providing information without a user request. Notifications can fulfill specific user needs or prompt further information seeking by encouraging users to initiate additional searches to satisfy their immediate information needs.

2. Research Problem

The surge in smartphone and app usage has led to an overwhelming increase in notifications, posing significant challenges for users in managing and prioritizing these alerts. This can result in reduced productivity, shallow information-seeking behavior, and potential smartphone addiction. Despite the importance of notifications, there is a need to understand how users engage with and respond to them. This study aims to explore user engagement with mobile notifications, identify patterns of information behavior, and uncover users' effective coping mechanisms. The goal is to enhance mobile information literacy and improve the overall user experience in managing notifications.

2.1. Research Question

How do users engage with mobile notifications as an information medium, and what are the patterns of their information behavior in response to these notifications? What are their best practices and coping mechanisms for managing the influx of information?

This study contributes to the field of information behavior by looking at these changes and giving useful information about the skills and strategies needed to get the most out of mobile notifications. The results will help us make better notification systems and teach people how to use information in a world that is becoming more and more connected. This change in the way things are thought about makes it clear that we need new theoretical frameworks to understand and help with the changing ways people do information research.

3. Research Method and Design

This study is grounded in qualitative research, aiming to understand students' information behavior in a normal environment, capturing a better picture and enhancing contextual understanding. Qualitative research allows for the investigation of hidden patterns, feelings, and beliefs that quantitative methods

may miss (Hammarberg, Kirkman, & de Lacey, 2016; Lewis, 2015). The study applies an adaptive nature that allows for adjustments based on emerging insights, which have undergone various developments and refinements. This approach provides a deeper understanding of mobile information literacy among students from diverse backgrounds. Using ethnography as a research method, this study looks at the complicated link between mobile notifications and how people look for information (O'Reilly, 2009). Applying the Thick description ethnographic methodology developed by Clifford Geertz to understand actions within cultural contexts (Geertz, 2003), to capture layers of context and meaning that inform human behaviors and interactions (Kharel, 2015). This approach supports cross-cultural studies by providing a rich portrayal of cultural practices and beliefs, enabling comparisons and contrasts between different societies. It also aids in capturing the emic perspective, which is essential for understanding cultural phenomena from an insider's perspective. (Usunier & Sbizzera, 2013).

The data gathered for this research is part of a larger PhD project studying Mobile information literacy (MoIL) among higher education students (Elzalabany, 2024). The main data collection instrument for this study was interviews, which are considered the most appropriate to capture people's real-life experiences and the strategies they use when dealing with mobile notifications (De Fina & Perrino; Mann, 2016; Peters & Halcomb, 2015). The researcher recorded most of the interviews, which varied in length, ranging from 20 minutes to one hour, and later transcribed them using a word processor. During the unrecorded interviews, the researcher took extensive field notes. The study sample comprised two groups with distinct differences in size; specifically, the sample consisted of two groups of 12 German and 21 Egyptian higher education students. However, the primary focus of this research was not on numerical parity but rather on the richness and depth of everyone's story. The English language was used to conduct interviews with German students, facilitating more seamless interactions. The Egyptian participants were interviewed in Arabic, specifically using the Egyptian dialect, which helped to facilitate more seamless interactions. Nevertheless, the process of converting qualitative data into English presented intricate challenges. The translation took place while transcribing the data as this early stage gives the advantage of a better and deeper understanding of the data (Santos, Black, & Sandelowski, 2015). A Thematic analysis approach was used in this study to code

and analyze the data systematically (Fugard & Potts, 2019; Vani & Permanand, 2016). The coding process utilized a hybrid inductive/deductive approach (Proudfoot, 2023). In addition to Interviews, observation was used to capture the nuances of how users interact with notifications during the interviews, implying an interactive attitude toward by giving the participant tasks to do and ask them to show how do they react an how do they feel.

Although this research utilizes a subsection of data gathered originally for a PhD project aimed at exploring the cross-cultural nuances of mobile information literacy among German and Egyptian higher education students, through the analysis of this study, it became clear that the cross-cultural aspect is more subliminal and passive, particularly when focusing on the specific research question regarding mobile notifications.

4. Literature review
4.1 Information Retrieval and Notifications

Notifications have prompted a shift from traditional linear information retrieval models to more dynamic, nonlinear models (Foster, 2004). Instead of following a fixed order, users now receive and respond to information as it arrives. (Lachmann et al., 2018). This nonlinear approach is indicative of notifications becoming an integral part of daily life, facilitating easier and more passive information acquisition. Push notifications are designed to influence user behavior by delivering timely and relevant information, thereby increasing engagement and knowledge. (Gavilan, 2022). This dynamic information flow has become a crucial research area for understanding the impact of notifications on user information behavior, especially from information-seeking and cognitive perspectives (Pham, Nguyen, Hwang, & Chen, 2016; N. J. Stroud, Peacock, & Curry, 2020). Intelligent notification systems aim to enhance user responsiveness by determining the optimal time and context for delivering information, taking into account user preferences and context (Abhinav & Mirco, 2017). The drawbacks of notifications in information seeking include their potential to narrow the scope of information, influencing users' behavior in ways that may only sometimes be beneficial (Burford & Sora, 2014). Most mobile users show significant reliance on their phones, frequently checking for notifications and experiencing distress

without their devices, indicating a strong attachment and addiction to mobile notifications (Balakrishnan & Loo, 2012).

4.2. Impact of Mobile Notifications on Users

Mobile phones typically use auditory notification cues that are intrusive and demand immediate attention (Rebecca, Peter, & Johan, 2001). Users prioritize suppressing alerts rather than deferring them to minimize unwanted interruptions, often attributing their preferences to the content of the notifications rather than contextual factors (Tianshi, Haines, Miguel Flores Ruiz De, Jason, & Jeffrey, 2022). Users often receive multiple simultaneous notifications from different applications and do not assess them individually. The arrival of a notification can prompt the user to review and handle other notifications, affecting the attention given to new notifications. Therefore, it is crucial to consider the broader notification stack framework rather than focusing solely on individual notifications, especially for applications requiring prompt responses (Liam, Stuart, & Roger, 2019). Pielot et al. found that, on average, mobile users receive 63.5 notifications per day, primarily from messaging and email apps, which are viewed promptly even when the phone is in silent mode due to social pressure. More notifications are associated with negative emotions but also contribute to a stronger sense of connection with others. While avoiding interruptions may be effective for professional communication, managing expectations for personal communication is crucial (Pielot, Church, & Rodrigo de, 2014). Users interact with notifications not only during tasks but also before and after tasks for various motivations beyond mere distraction (Xi-Jing et al., 2023). Despite recognizing the disruptive potential of notifications, many users choose to use them for the perceived benefit of increased awareness (Shamsi & Horvitz, 2010).

4.3. User Perceptions and Preferences

Studies indicate that participants are most receptive to notifications during routine tasks and exercise, particularly in settings such as colleges, libraries, and streets, with communication apps being the most used except during bedtime, sleep, exercise, and religious activities (Abhinav et al., 2017). However, notifications often arrive at inconvenient times, causing disruptions rather than benefits. Mehrotra proposes a framework for intelligent notifications that considers users'

context and preferences to improve timing and delivery (Abhinav, 2017). The timing and content of notifications, user activity, and response time significantly influence the likelihood of notifications being opened (Prasanta, Ming, James, & Soochang, 2017). Users engage with notifications not only during tasks but also before and after tasks for various motivations beyond mere distraction, with 12 distinct motivations identified (Xi-Jing et al., 2023). The perception of notifications varies, with some individuals appreciating their user-friendly nature while others find them insignificant (Licoppe, 2010). Notifications on the Socially app were seen as beneficial for staying informed about friends' activities but intrusive for casual users. User goals influence preferences; those wanting to stay updated found notifications helpful, while casual users found them annoying (Vihavainen & Kaisa, 2013).

4.4. Notification Management Strategies

Users employ various strategies to handle notifications, such as disabling notifications, uninstalling applications, using the do-not-disturb mode, muting devices, or physically distancing themselves from their gadgets. However, few users modify their notification settings, meaning default settings by manufacturers significantly influence how alerts impact users (Alexandra, Dominik, & Henze, 2018). Notifications can cause stress due to excessive information. Requests for notification permissions on iOS often need more clarifications, leading to uninformed decisions, whereas requests with explanations are more likely to be approved. Users rarely modify their notification settings, even if they do not align with their preferences (Westermann, Sebastian, & Wechsung, 2015). Some studies indicate that not all notifications should be treated equally by mobile operating systems. The current generation of notifications needs more diversity and adequately meets most smartphone users' needs and preferences (Jonas & Katsumi, 2013). Effective design and timing for delivering notifications are crucial, considering the broader notification stack rather than focusing solely on individual alerts, especially for applications requiring prompt responses (Liam et al., 2019).

4.5. Information literacy's role in utilizing notifications as an information medium.

Among many literacies, Information literacy services is an umbrella term. The information literacy field has evolved as various scientific domains, including health, business, research, health, data, and digital literacy, have become interested in it. Onyancha (2020) identified 42 variants of literacies from 1975-2018, including digital, media, and computer literacies. Information literacy is considered a "meta-literacy" as it involves understanding how information is produced, disseminated, and consumed, as well as specific content (Ibenne, Simeonova, Harrison, & Hepworth, 2017; Mackey & Jacobson, 2011; Oberg, 2017). Information literacy could be considered as "an essential human information interaction component, with lines drawn from Information-seeking behavior and HEC. Information literacy is concerned with achieving synergy between human and computer capabilities to optimize the interaction with information, why and how users should act in a certain way, and attempting to optimize information seeking" (Elzalabany, 2024). Matula (2020) suggests that Mobile Information literacy (MoIL) refers to the abilities and proficiencies required to efficiently search, analyze, utilize, and distribute information in a mobile setting. This setting differs from desktop scenarios because of the constraints of mobile devices and the user's desire for prompt and pertinent information retrieval. He proposes that the skills of MoIL reside in the overlapping intersection of digital and information literacy.

Information literacy is essential for users to handle smartphone notifications efficiently. This requires the utilization of cognitive abilities to effectively prioritize and disregard notifications, as well as a comprehensive comprehension of their design and functionalities (Liam et al., 2019; N. Stroud, Cynthia, & Alexander, 2019), in addition to the general requirement for information literacy. Additional skills are required to utilize notifications as an information medium, such as promptly recognizing the origin of the notification, assessing its significance and pertinence, ranking various categories of notifications, and comprehending the functionality and customization options of notification systems (Andrew, 2012; Atilla, 2020; Kristin Van, Cédric, Verbrugge, & Marez, 2015; Liam et al., 2019). Users can effectively manage the intricate and diverse notification layers on their devices with the assistance of these skills (Gustavo & Luis, 2016; Yung-Ju, Yi-Ju,

Yi-Hao, Hsiu-Chi, & Tzu-Hao, 2017). Alireza Sahami et al. (2014) emphasize three critical information literacy skills when dealing with mobile notifications: the ability to identify essential and pertinent notifications, the ability to configure notification settings (including the use of blacklists), and the ability to balance the advantages of notifications with their potential for disruption and distraction. Also, the ability to customize notification settings (Alexandra et al., 2018). Pielot et al. (2014) point out that users must possess the necessary abilities to handle large amounts of notifications properly, maintain a balance between the positive and negative impacts of notifications, and utilize them efficiently for information retrieval and social connectivity. Critical thinking is also essential to dealing with notification information (Burford & Sora, 2014; Chua, Radhika Shenoy, & Goh, 2011; Westermann, Wechsung, & Sebastian, 2016). In addition, the ability to keep track of tasks and multitasking is proven to be essential in this paradigm (Shamsi & Horvitz, 2010).

5. Findings and discussions

5.1. What are notifications in smartphones?

A smartphone notification is a type of message that appears on the smartphone's home screen, possibly with a combined alert. App publishers can forward these notifications directly to the smartphone notification center at any time, regardless of whether users are actively using the app at that moment. They can include specific information that the user can use as a final step in their information search, or they can prompt the user to take an action, such as opening a link, browsing a page, downloading content, or informing them about an event or crisis. Almost all mobile platforms have support for push notifications, regardless of the operating system. Since the 1990s, push technology has been evolving. The basic idea behind the technology was to automatically push information to the user without any prior request rather than having him pull it from a server or information service online over the Internet (Franklin & Zdonik, 1998). This technology was revolutionary as it relieved the user of the burden of knowing in advance when and where to seek information. However, the control over what the user can receive has shifted from the user to the service provider.

5.1.1. Pull vs Push technology and information delivery automation.

Classical information pulling relies on user-triggered information-seeking behavior, where the user expresses their information need through a query or request that an information retrieval system, search engine, or even a specific mobile application, feature, or service can process. The user is also responsible for selecting the appropriate application and information resource.
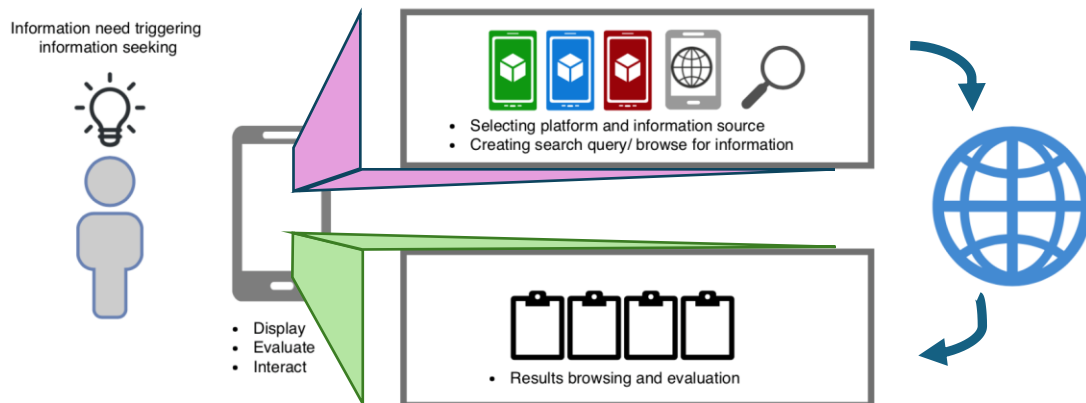

Fig1. Pull information technology via smartphones.

Within this information-seeking model, users must browse, evaluate, and judge results. In most cases, the user must skim or view the entire resource to assess its capacity to provide the information they require. This classic scenario of information seeking serves as a basic approach to information retrieval. Even with smartphones, users have stated that retrieving information represents a significant portion of their daily information-seeking behavior.

Unlike information pulling, information pushing relies on distinct mechanisms. Typically, certain smartphone applications begin by gathering user preferences for information and identifying their information needs. Applications use this knowledge to filter and select information that meets users' information needs. We can use not only user preferences but also some meta-aggregated information from smartphone sensors, such as GPS location.

In that scenario, the application establishes a connection with an online service and begins to receive information whenever this filtering criterion matches certain results continuously. Applications that require interactivity and constant

updates, such as emails and chat, heavily utilize this instantaneous information feed.
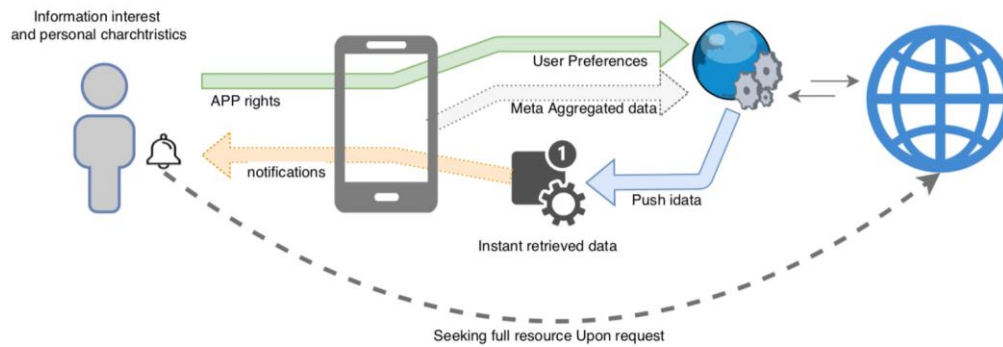

Fig. 2 Information push technology via smartphones

Typically, in push information services, publishers aim to minimize the content of messages while increasing their frequency of dissemination. The timely transformation of information is crucial. On the one hand, the frequent nature of this information necessitates less effort on the part of users, who receive only summarized information yet have the option to refer to the complete version when necessary. Push technology encouraged smartphone developers to start making use of mobile notifications to alert users when new information in their area of interest appears. This notification can use sound, vibration, or any other feature available on a smartphone to draw the user's attention.

5.2. Notifications characteristics

5.2.1. Alerting

Mobile notifications, by default, include an alerting feature that uses sound, vibration, or light to alert the user to the arrival of a new notification. This alert nature has led to different usage patterns for smartphones. The smartphone is typically always on and in close proximity to its user. If not handled carefully, a useful feature like alerting can have a negative impact at the same time, as most users stated.

5.2.2. Temporary

Notifications normally happen on the fly and are not designed to be retained for a long time. By default, notifications disappear once the user becomes aware of them and engages in other tasks on his smartphone. Users can effortlessly override them, even if they do so unintentionally. This nature forces some users to check notifications constantly, fearing losing any updates.

5.2.3. Summarized

The amount of information shown in notifications is limited to certain smartphone features; normally, notifications are displayed in a one-line-sized box on the smartphone screen. We expect this line to deliver concise yet impactful information. This task is not easy, especially when representing a sophisticated or long information resource, such as emails, so most developers use text truncation as a solution.

5.2.4. Text nature

Notifications typically display text content, but occasionally, minimal graphics and icons can aid in identifying the type and category of the notification. Moreover, most notifications include a hyperlink to the application that generated this notification or to a web resource that can give the user more details about the notification resource or information.

5.2.5. Same location and display method

Most smartphones have a unified notification manager, or notification settings, which is responsible for controlling notifications and displaying them in a unified way.
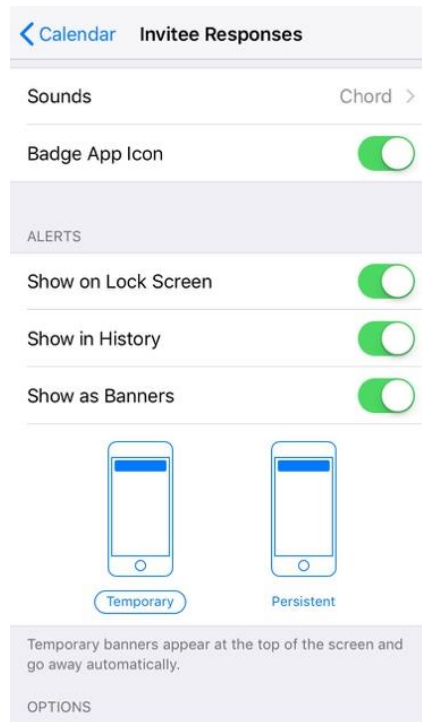
Fig.3 Notification settings for iPhone 8

However, in most cases, notification control offers limited options, such as the ability to prioritize notification sources or distinguish between important and less important notifications. The user should utilize the available options to reflect on their own needs.

5.2.6. Smart triggers "Time, location, communications, other"

Different sensors in smartphones, such as GPS, NFC, Bluetooth, and Wi-Fi, can trigger and affect notifications. Many applications and services rely on such sensors to initiate user interaction and provide notifications automatically. This meta-aggregated data requires, in most cases, user permission to access this information and create notifications according to it.

5.3. Notification types

The importance of notifications for smartphone users varies based on the type of notification and their usage patterns. The analysis of the interviews led to the establishment and arrangement of 11 categories of notifications based on their perceived importance. Among the 32 interviews, at least 30 interviewees mentioned that they use smartphone notifications for information access.
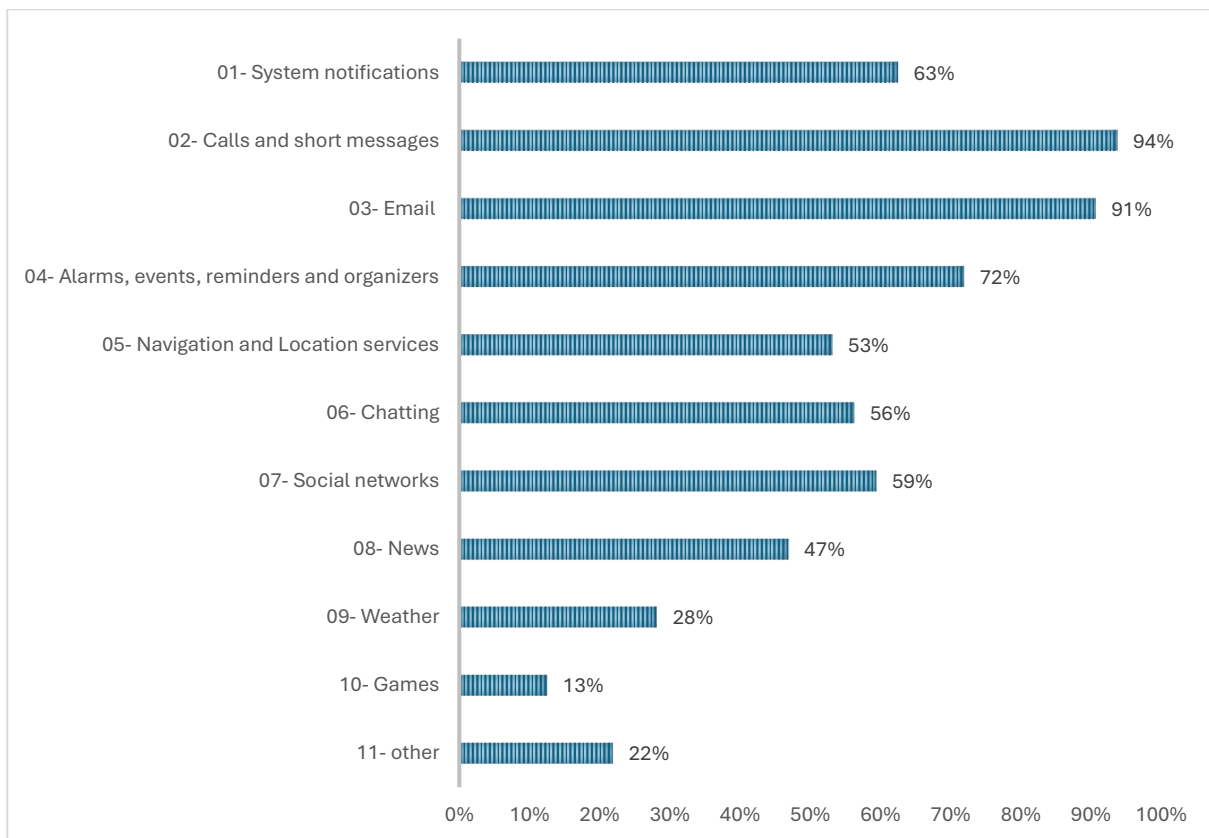
Fig (4) Notification usage ranked by importance according to interviewees.

5.3.1. System notifications

Despite being ranked as the most significant notification type, 63% of the interviewees reported using system notifications. System notifications include messages about system updates, collapse, battery level, network package limit reached, and so on.

> Egy_11: "The most critical notification I receive is a low battery notification. I start panicking when I receive it, trying to find the nearest charger or switch off unneeded features or applications […]. It changes my behavior with the phone, and I re-arrange my priorities, most of the time leaving it for critical calls only."

> Egy_9: I rely on system notifications to let me know when the time is right.

> Ger_8: "I find system notifications the most important [...] if I am using a device, I have to take care of what its system tries to tell me."

> Ger_3: "I use my phone for video recording and photo taking [...] it's essential for me to be aware of the storage limit."

> Egy_2: "network usage limit [...] I set a notification if I reached 75% of my monthly quote so I can rationalize the remaining capacity."

5.3.2. Calls and short messages

Services such as calls and short messages rely entirely on the type of notifications they receive, particularly in the case of a phone call, which necessitates interaction and immediate response. Alternatively, stay informed about missed calls and attempt to reconnect with the caller later. Seeking communication typically relies on the individual's current awareness of contact. Mobile phones were designed to take over this task in the first place.

> Egy_5: "Missed calls notification is so important; the idea of mobile is being reachable all the time, I think, and if not reachable at the time, at least be able to know that someone tried to reach me. [...] same for SMSs, even if my phone was out of reach my service provider send me an SMS about the callers tried to reach me while I wasn't available."

5.3.3. Email

Email is a crucial tool for information exchange and communication, and it's critical to monitor inboxes for new emails regularly. And most email apps can provide notifications of new emails. Interviewees ranked email notification as the second most used notification type, and users ranked it as the third most important notification feed.

> Egy_5: "Email notification is so critical to me; I use the iPhone feature for VIP email senders to keep track of the important emails that I get. And I keep an eye always on it, especially for work."

> Ger_7: "It is sad that my email service provider does not support push technology, which means I have to depend on my phone to check emails every 15 min, and this feature does not work all the time, especially if I'm

running on battery saving mode.[…] it is critical to me to be always updated once I receive the email."

5.3.4. Alarms, events, reminders, and organizers

Smartphones replaced personal organizers that were trendy in the '90s; most users sync their digital calendars with their smartphones so they can still be notified of events, dates, and reminders.

Ger_7: "A cool feature that my phone can detect dates automatically from emails I receive and create an event for me in the calendar; with such integration, I can reduce the risk of forgetting important dates […] nothing is perfect, mistakes happen, and what is not on my phone calendar is not on my activity schedule […] not only totally forgetting to add the event, sometimes I forget to enable notifications, also sometimes the time zone of the event is different so the notification does not appear in the right time ."

5.3.5. Navigation and Location services

GPS sensors in smartphones can automatically detect user places. Map and geolocation applications can automatically start suggesting certain activities for users according to the detected location. Moreover, certain applications can start asking users for reviews.

Egy_4: "I like it when 'foursquare' starts sending me a notification to explore places around me; it is fun that my smartphone thinks smart and is able to suggest something like an eatery or café, liking this to users ranks. […] I depend on that, especially when going to new locations."

Ger_9: "It feels weird to be monitored all the time, as someone watching me and getting evolved in my selections […] for location detection. I turn off notifications […] just feels not uncomfortable with such notifications."

5.3.6. Chatting

Chatting applications are one of the most popular mobile app categories; these applications push notifications to users' smartphones to alert them of conversations and contact attempts.

Ger_2: "WhatsApp notifications are the most notifications I get; I barely use any other communication with my friends; I depend on WhatsApp and Facebook Messenger."

EGY_2: "Chatting is cool, but too many notifications are so bad to me. I normally turn off WhatsApp notifications when I start doing something serious."

5.3.7. Social networks

Keeping connected and up to date with users' social networks is a common task done by smartphones; many users allow social networks such as Facebook to push notifications to their smartphones.

EGY_6: "Facebook notification is too much too me; I cannot handle this information overload, but I cannot turn off its notifications too. […] I have always had the urge to know what is new and keep updated, […] I think it is addiction."

Ger_9: "I spend too much time on Facebook, but turning FB notifications would be a big mistake. […] too much unusual information can create a chaos of notifications."

EGY_9: "Keeping updated is important to me; I used to work as a copywriter on some Facebook pages; for me, it is work more than just entertained and socializing."

5.3.8. News

News feeds are media content that no other media type can match any better with notifications, especially news highlights and breaking news.

EGY_1: "I use mobile app aggregate news from different feeds and push them to me three times daily, […] I control the time intervals for notifications, and this is good enough."

GER_3: "Almost the only news I watch every day is the iPhone news notification feeds. It is smart and concludes."

5.3.9. Weather

Most weather applications send notifications to smartphones at home, normally once per day, at least alternatively, when detecting a new place while the user is traveling.

Weather notifications can be critical in cases of dangerous or unusual weather that requires certain reactions from users. Its importance depends on the context of usage.

> EGY_4: "I go on fishing trips so often, and such notifications can be a lifesaver for a person."

5.3.10. Games

Many games depend on notifications to keep users engaged with the mobile game, a notification with some updates in the game or some promotions to keep playing the games. Games notifications have been mentioned by some interviewees.

> Egy_12 "I'm a games addict; some games require time to open new stages or enable more lives to play. Its notifications inform me of these updates."

However, most of the interviewees mentioned that they do not allow mobile games to push notifications.

5.3.11. Other

Such as marketing notifications, application updates', feature explanations, and so

> GER_5: "I have an application to access my bank account that uses notifications […] it is so useful to be instantly aware of withdrawal and deposit movement via notification."

5.4. Notification reaction

As mentioned before, notifications have an alarming nature that drives smartphone users to have a reaction toward those notifications; this reaction normally varies from neglect to digging deeper for more information about the

notification. The researcher conducted some observations while interviewing the examinees; it concluded that the flow of notification reaction goes as below.

- *Smartphone users check the notification*: *Depending* on the context that the user is involved in, users may decide to check the notification alarmed by its appearance, alerting sound, or buzzing device. Check the patch notifications if you're not alarmed by all at once.
- *Decide to react toward the notification*: *The user* must decide if the notification requires a reaction from him or just out of his scoop of interest. Some notifications have a primitive informative nature that just requires no chains or reactions after receiving them.
- *Ignoring the notification: It happens so often that users ignore incoming notifications, and most of them just swipe the ignored notifications away because they are out of interest or received in an inappropriate context.*
- *Evaluating satisfaction and information completeness*: if the user decides to react to a received notification, normally, he starts to evaluate if the information included in the notification is enough to react to or *if more information is required*.
- If more information is required, the user can start seeking it, and the most direct way to obtain more detailed information is to use the notification as an entry point. In most cases, the notification can direct the user to a certain application or webpage where he can find more details about his information needs. However, in some cases, users have to start the information-seeking process from scratch by selecting the app or searching the web for the required information.

This process is kind of a loop process; the user can dig deeper and move from one information need to another one triggered by this notification until he reaches the point where no more information is needed, and the user can be satisfied with the information he got.

- In the event that *no more information is required, the* user is confident about the information he has and can decide if an action is required according to this information or not. This action can be related to the phone itself, like, for example, charging the phone, turning the Wi-Fi off, or taking

action depending on the notification information that goes beyond the phone, like turning left or right if using GPS, going to a different platform if the railway application sends a notification about a train platform change, etc.

In many cases, user action can deliver more information or trigger new information needs that the user needs to seek in the same context and time using the phone.
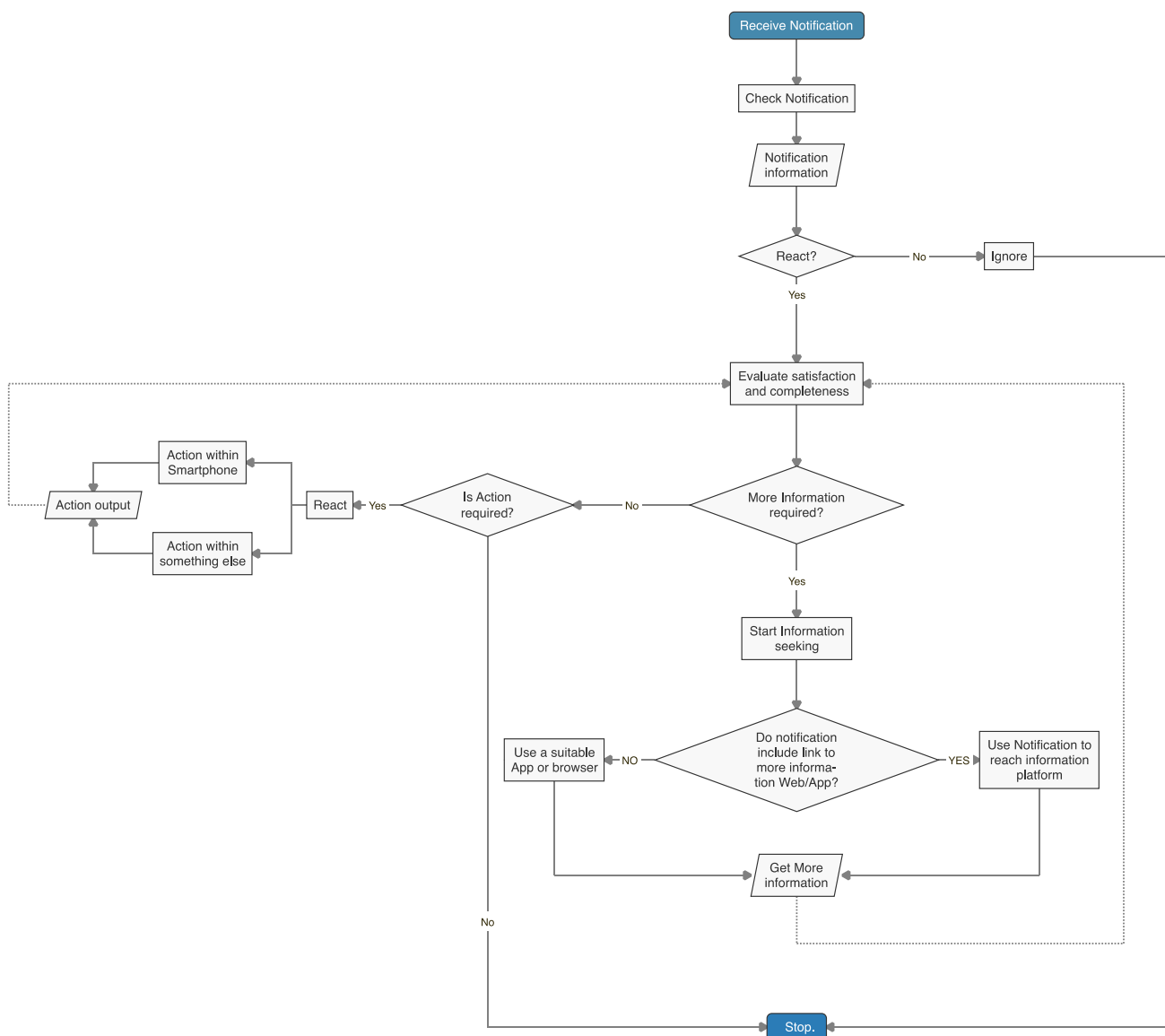

Fig (5) Notification reaction workflow

Based on this analysis, we can distinguish between two approaches to notification in the context of information-seeking:

5.4.1. Considering notification as an end-point information container

Users consider the information in the notification sufficient to respond without further searching or elaboration. Normally, this depends on the type of notification and the subject of the information it includes.

> Egy_9: "Notifications are so useful; I like the summarized information that it provides almost all the time, [...] news and social networks notifications I almost neglect all the time [...] normally system notifications are enough to get information with no need to elaborate more [...] emails are so varying, but it depends on the importance of sender or subject all time [...] sometimes it is not enough when the sender name is too long or subject is not clear I am not very well informed about it but again for emails I check the application itself so often."

> Ger_3: "I think notification information almost all the time is enough. [...] it is so rare I click the notification tap to get more details, but also, I never use the notifications for emails or social network apps."

Despite it delivering useful and condensed information, some of the interviewees mentioned that the notification nature turned their information-seeking behavior into more shallow information-seeking; they mentioned that they tend to have always summarized information and tend not to dig any deeper to extract any more information. Some interviewees mentioned that as a negative impact of notification-wide use and depending on this upper layer of information.

> Ger_7: "I understand that notifications are made for the user's good, but I do not feel that so often, and I tend to ignore them; sometimes, I'm pissed with notifications that can contain useful information just because I did not ask for it!"

It shows that sometimes notifications are overrated, and that users do depend on them to react and wrongly evaluate the information included within.

> Egy_7: "I have no time to check each notification source and track more information, so I have to depend on notifications heavily as the only source of information."

Also, the temporary nature of notifications can cause information loss if you rely solely on them as a source of information.

> Egy_4: "Swiping a notification away can occur to an important one as well […] I just tend to fly over the staff getting notified. […] I cannot concentrate or be motivated enough to dig for more information, especially with social media notifications. […] I tend to feel that there is not enough time to seek more details".

5.4.2. Notifications as a trigger to further information-seeking

In this approach, notifications are only one of the final steps to gather information about the triggering event, as they can trigger a series of information-seeking processes. Smartphone notification centers serve as a type of information interface, summarizing the essential information and concerns for users. It serves as a one-stop access point to various applications and information platforms, and notification itself functions as an entry point to those resources. Interviewees varied in their motives to evolve and develop their information seeking, whether it was a sense of an important information gap, the emergence of new needs, or pure curiosity.

> Egy_8: "It is so a quick and instant way to get summarized information, news feeds, organizer reminders, and important events. It is so helpful to direct my attention towards some more important things occurring while I'm using my phone. […] I tend to switch between applications so often depending on the notifications.

> Egy_12: "The urge to see more is so high […] I think tapping the notification is just a normal behavior; it gets my attention all the time, and it starts to take me from one app to another […] I find it annoying but entertaining at the same time."

> Ger_1: "Sometimes it is so important to get a shortcut to instant information like an important email you were waiting for or so [...] normally what I do not get a notification for I can neglect."

In this case, notification can be considered a triggering factor for further information-seeking behavior.

5.5. Observations about Notifications as triggers for information seeking

Interviewees were asked to express the annoying parts and pros of mobile notifications. This question prompted some interesting observations about the notifications.

5.5.1. Predicting User Needs

Some interviewees stated that one of the strong characteristics of notifications might have been the prediction of user needs.

> Ger_11 "I like it when Foursquare [a locale recommendations application] detects my place and starts suggesting some restaurants around or attractions."

Positive user needs prediction increases the user's attachment to smartphones. But this is not the mainstream point of view.

> Ger_7 "I feel weird when my phone asks me if I'm near 'Potsdamer Platz' and starts to ask me questions about how I rate the place or ask me if I'm riding a bus line and asks about how many free chairs available in the bus [...] that feels creepy, and I feel uncomfortable with that."

Some incorrect needs predictions or inappropriate context for notifications can significantly negatively impact the user. Some users express security concerns about smartphones tracking them constantly, and currently, there is no compromise between allowing smartphones to gather meta-information about user behavior and predicting user needs.

5.5.2. Preferences and more settings are needed

Most mobile applications have a notification option. With an enormous number of applications that the user can install on his smartphone, the user needs to edit the preferences of the notifications, which can be done for almost every

application also can be done for all notifications. For many users, editing each application notification is considered an overwhelming process.

> Egy_4: "I'd rather turn the app notifications off instead of editing and customizing its features."

> Egy_6 "I use notification general settings to manage the notifications that I need to see on my phone, but I'd prefer to turn off all notifications when I do not need them […] it is rare to turn off each app's notifications."

5.5.3. Once needed, always alerting

One criterion related to enabling notification or not is the temporariness or its permanentness. Users tend to enable notifications if they find a permanent and lasting need for this type of information.

> Ger_11 "I give myself a moment to enable an application notification. Once it is enabled, it will keep alerting me every now and then. I evaluate it. I need this notification only for a short time, so I disable the notifications; otherwise, I enable it."

Despite the constant ability to modify notification settings, numerous users expressed their frustration with notifications, leading them to uninstall the application that generates them.

5.5.4. All-time engaged

Application developers use notifications to ensure constant user engagement and increased application usage, both of which are considered application success metrics. A study involving over 1.5 billion devices and 28,000 apps revealed that notifications increase application usage by 88% (Localytics, 2014). The primary purpose of notifications is to maintain user engagement with the application. Gaming and e-commerce applications heavily utilize this keep-engaged model. Mobile notifications cause many users to lose all-time engagement.

> Egy_1 "I feel like walking in circles, […] notification keeps me involved with many domains, […] no need to tell how much time is wasted and how many times I get distorted thanks to this notification."

This approach by application developers increases mobile addiction and adds more stress on mobile phone users. Many empirical researches linked smartphone addiction and user stress to this approach (UrbanAirship, 2017) that constant notifications create stress because of information overload.

5.5.5. Spammy content

Most of the interviewees mentioned that at least once a day they feel annoyed by the notifications they receive. Smartphone users typically receive numerous unwanted notifications. In fact, notifications can serve as a platform for easy advertising and direct customer reach. Many applications are beginning to use the notification privilege to push some spam content to the smartphone notification center. Some survey studies (Localytics, 2015, 2018) showed that 50% consider notifications annoying. And 58% of smartphone users feel nervous and harassed by mobile notifications. According to the study, notifications can lead to users completely uninstalling the application.

Many interviewees expressed the spammy nature of many notifications.

> Egy_7 "Sometimes notifications are meaningless, neither in my interest range nor in the right context or time."

> Ger_9 "I stopped counting how many Applications I removed to avoid notifications pushing."

> Ger_4 "I only keep Phone and human communication notifications on […] I stopped using other notifications a while ago, and life is easier."

5.5.6. Control, Selection, and information flow reduction

Despite the fact that almost all smartphones have features to manage and control notifications, many interviewees exhibited overly extreme reactions towards notification control, such as disabling all notifications, powering off the smartphone, or even uninstalling the application.

Egy_2 "If I'm in a lecture or so and need full attention, I turn off my phone totally [...] notifications even if just vibration or screen light on reminds me that I have a device to use."

Ger_3 "Normally, I turn on flight mood while studying to get rid of notifications."

The interviews revealed a common behavior of not controlling the notifications. The user may not know a better way to control the notification flow, find it too complicated to modify the notification settings, or lose trust in these management tools.

5.5.7. Summarized information, information loss vs. information summing.

As mentioned before, there is an approach to considering the notification information as a final result information without seeking further information. The problem lies in the notification's limitations, which limit the volume of data it can display and process. For instance, the iPhone is limiting the push notification to 2 kilobytes of data(Stackoverflow, 2012) and no more than 140 characters; some Android devices can even display less than 50 characters per notification(UrbanAirship, 2017). That causes, most of the time, information truncation in a disruptive way that impacts the full understanding of the information. One obvious case for email notifications is that the limitation is insufficient to display the email subject, especially if it is somewhat lengthy. Despite this limitation, many users have reported that they sometimes attempt to anticipate the truncated information instead of opening the email application. This suggests that heavy notification usage has made users more tolerant of data loss and truncated information.

5.5.8. All notifications are same priority

Normally, notification orders on the display screen are just time-sequenced; the most recent notification is displayed at the top, regardless of its importance. On most smartphones, there is no ranking mechanism for notifications.

> Egy_9 "You can find a game notification on the top of the notifications queue, followed by an important email notification, then weather change notifications […] it is not proper prioritizing for notifications."

5.5.9. Start surfing, then cast away

Many smartphone users encounter difficulties when navigating their devices and seeking information. While the user's trigger for seeking information may be known and obvious, the landing point may be unknown to them. It is logical that this issue can be more effective because notifications serve as information triggers. Users constantly receive notifications, which can trigger internet browsing and trap them in a never-ending cycle of information seeking. The constant availability of smartphones can magnify the impact of aimless surfing, leading to a loss of pathways to find the required information.

> Egy_7 "A lot of times I do not know where to stop; I even stop noticing what triggered my information seeking after a while […] and while I'm seeking information, I get a new notification that terminates my current information seeking to initiate a new one."

> Ger_3 "it happens so often that I cannot remember anymore what I need to know while I'm seeking information."

Notifications can have a big impact on users' uncertainty and distraction while seeking information via smartphone.

6. Conclusion

The study underscores the significant influence of smartphone notifications on user behavior and information-seeking patterns. Notifications are a critical yet intrusive medium for information delivery, distinguished by their alerting, temporary, summarized, and textual nature. They are universally integrated into smartphones, utilizing a variety of sensors to deliver contextually relevant and timely alerts. Nevertheless, the continuous inflow of information presents substantial obstacles, such as information overload, distraction, and stress.

Users engage with a variety of notifications, including system updates, communications, social networks, and gaming alerts. While system notifications are considered the most critical, social network notifications, despite their popularity, frequently result in information overload. Although notifications are beneficial for the rapid dissemination of information, their temporary and condensed nature can lead to shallow information-seeking behavior and information loss.

User responses to notifications are inconsistent; they may be disregarded or employed as entry points for additional information acquisition. This behavior emphasizes the dual function of notifications as both end-point information containers and triggers for deeper engagement with information. Nevertheless, the absence of prioritization in notification delivery can result in the overshadowing of critical messages by less important ones, resulting in inefficient information management.

The research also indicates that notifications can predict user needs and improve engagement; however, they frequently result in unintended consequences, including increased stress, smartphone addiction, and exposure to spammy content. Users expressed frustration with the continuous alerts, which prompted them to take extreme measures such as disabling notifications or uninstalling applications.

In order to address these challenges, it is imperative to improve mobile information literacy MoIL. To ensure that they receive timely information without experiencing its adverse consequences, users must acquire the ability to manage and prioritize notifications effectively. This encompasses the comprehension of notification system functionality, the adjustment of settings to meet individual preferences, and the implementation of strategies to balance the benefits of notifications with their potential for disruption.

In conclusion, the management and impact on user behavior of smartphone notifications require a more nuanced approach despite their critical role in the dissemination of modern information. Users can optimize their information-seeking behavior and overall user experience by navigating the complexities of notifications and implementing intelligent notification systems, which fosters better mobile information literacy.

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