



Automatic, Manual, or Hybrid? A Preliminary Investigation of Users' Perception of Features for Supporting Notification Management

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ABSTRACT

Mobile notifications, crucial to our daily activities and informational needs, are often undermined by insufficient management features. Previous research has suggested enhancements like automatic sorting, filtering, and categorization, but empirical evidence supporting these strategies is yet to be seen. This study bridges the gap, developing an Android application to assess these proposed features' efficacy in improving notification management efficiency and user experience. We utilized the Experience Sampling Method (ESM) for in-depth user insights, and our preliminary findings indicate a perceived superiority for a hybrid system combining automatic and manual functionalities, over systems solely dependent on either approach. This research paves the way for an optimized notification system, better equipped to assist users in managing mobile notifications effectively.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in ubiquitous and mobile computing.**

KEYWORDS

notification management; notification display order; sorting; categorization; pinning

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1 INTRODUCTION

Mobile notifications, integral to our modern digital landscape, serve to keep users updated on various events. However, users may not always be available when notifications arrive [2, 13] or may not desire to attend to or respond to these notifications immediately [3, 4]. Indeed, given the varying levels of importance assigned to notifications by users [8, 12, 15], it's inevitable that some notifications accumulate within the notification drawer [17]. Yet, managing this deluge can be challenging, particularly when the display order does not align with user preferences [10].

Furthermore, notifications play diverse roles in our daily lives, functioning as task reminders, updates, or cognitive refreshers, each with varying degrees of urgency [3, 10]. This diversity calls for an efficient notification interface that can cater to these multifaceted functionalities. Prior research has proposed features such as improved notification sorting [10], deferred handling of notifications [1, 10, 16], and notification categorization [10]. There have also been explorations of intelligence-driven features that present or deliver notifications based on learned user behavioral patterns or preferences [5–7, 9, 11, 13]. Nevertheless, it remains uncertain whether these enhancements actually facilitate users in better managing their notifications and how users perceive their effectiveness. Furthermore, user perceptions regarding the effectiveness of automatic and manual notification management methods for specific practices remain uncertain. Consequently, the optimal balance between these management methods has yet to be firmly established. A clear understanding of users' preferences towards these management modes could offer valuable insights for the design of future notification systems that align with user needs and preferences.

Addressing these knowledge gaps, we present NotiManager, a research application designed to examine users' experiences with automatic and manual notification management features, including sorting, categorization, and pinning. Our goal is to investigate user

perceptions of automatic, manual, and hybrid notification management modes, and their efficacy in helping users handle their notifications more efficiently. In this paper, we report on the preliminary results from a pilot study of NotiManager, consisting of 35 experience-sampling (ESM) responses from 3 users. Our initial results from the pilot study indicate that NotiManager exhibits promise, as several participants actively utilized its management features, echoing previous research that posits these tools provide benefits to a certain segment of users.

The anticipated contribution of conducting a larger-scale study to evaluate the system encompasses determining which management features are deemed beneficial and elucidating how users employ these features to handle their notifications. Such an evaluation would not only underscore the utility of specific tools but also shed light on user interaction patterns, thereby providing crucial insights to enhance the user experience and effectiveness of notification management.

2 NOTIMANAGER

We devised NotiManager, an Android application that replicates the traditional smartphone notification drawer while incorporating both manual and automatic notification management features. NotiManager operates by migrating incoming notifications from the native notification drawer to its own interface, a process triggered by the detection of notification arrival events using the Android Notification Listener Service API¹. NotiManager mirrors the basic functionality of standard smartphone notification drawers, such as opening notifications via clicking and removal of notifications by swiping or batch operation [14, 17]. Furthermore, it integrates several notification management features previously proposed in the literature. This allows us to investigate users' real-world interaction with these features and their perceptions of manual versus automatic management methods in a field experiment. We detail these features and the NotiManager interface in the ensuing sections.

2.1 Notification Management Features

- *Sorting* is a feature that enables users to rearrange the order of notifications in line with their preferences. We implemented this in two modes: automatic and manual. In automatic sorting, notification order is transmitted to a remote server designed to sort notifications whenever a new notification arrives. This process is facilitated by NotiManager's interaction with a predictive model located on the remote server. This model, trained with a pre-trained BERT model², is based on the notification-sorting dataset collected in Lin et al.'s study [10], where participants rearranged notifications according to their preferences. The model uses features such as the notification's title, content, the originating application, the predefined category of the application, and user context (time of day, self-reported activity from ESM) for sorting. The sorted results are then sent back from the remote server and replaced with the original order, presenting a newly arranged display in NotiManager.

¹Notification Listener Service API: <https://developer.android.com/reference/android/service/notification/NotificationListenerService>

²BERT model documentation: https://huggingface.co/docs/transformers/model_doc/bert

Manual sorting, on the other hand, provides users the ability to manually adjust the display order by dragging and dropping notifications to any desired position. NotiManager memorizes these changes and preserves the adjusted positions of the notifications, regardless of the arrival of new notifications. Hence, manually sorted notifications retain their assigned positions, even in the face of new incoming notifications.

- *Categorization* is another feature designed for the classification of notifications, available in both automatic and manual modes. Automatic categorization operates by classifying notifications based on app categories established by the Google Play Store and as suggested by prior research [15, 17]. For instance, notifications from Instagram and Twitter would be classified under the "Social" category. Manual categorization permits users to classify notifications according to custom categories they define themselves. Whether using automatic or manual categorization, users can choose to view notifications within specific categories, providing a more tailored experience compared to viewing all notifications indiscriminately. For added flexibility, NotiManager enables users to rearrange the order of categories displayed in the category menu.
- Lastly, the *Pinning* feature enables users to anchor specific notifications within the NotiManager interface. By selecting the "pin" icon (see Figure 1(b)), users can ensure the pinned notification remains visible, unaffected by any actions such as clicking or swiping off. The pinned notification can only be removed by deselecting the pin. This feature is designed to allow users to retain notifications that they may wish to revisit or reference later within NotiManager, fulfilling a need identified in the literature for a method to remind users to revisit notifications or to undertake specific tasks related to the notifications.

2.2 Interface Overview

The interface of NotiManager is shown in Figure 1, briefly introduced below:

- *Notification Display*: This interface, replicating the presentation style of current smartphone notifications, serves as a hub for viewing and managing notifications. Each notification is accompanied by a sorting (Figure 1(c)) and pinning icon (Figure 1(b)). The sort button facilitates rearranging notifications within the display through a drag-and-drop function. Additionally, when in manual mode, long-pressing a notification allows the user to either create a new category or change the existing category of the notification (see Figure 1(g)).
- *Category Menu*: This sidebar menu (Figure 1(f)) lists all the categories created either manually by users or automatically by NotiManager, contingent upon the application mode (automatic, manual, or hybrid) the user is provided with. Upon selecting a category name, users can view all notifications assigned to that category. By default, the user is presented with the "All notifications" category, where they can view all incoming notifications.

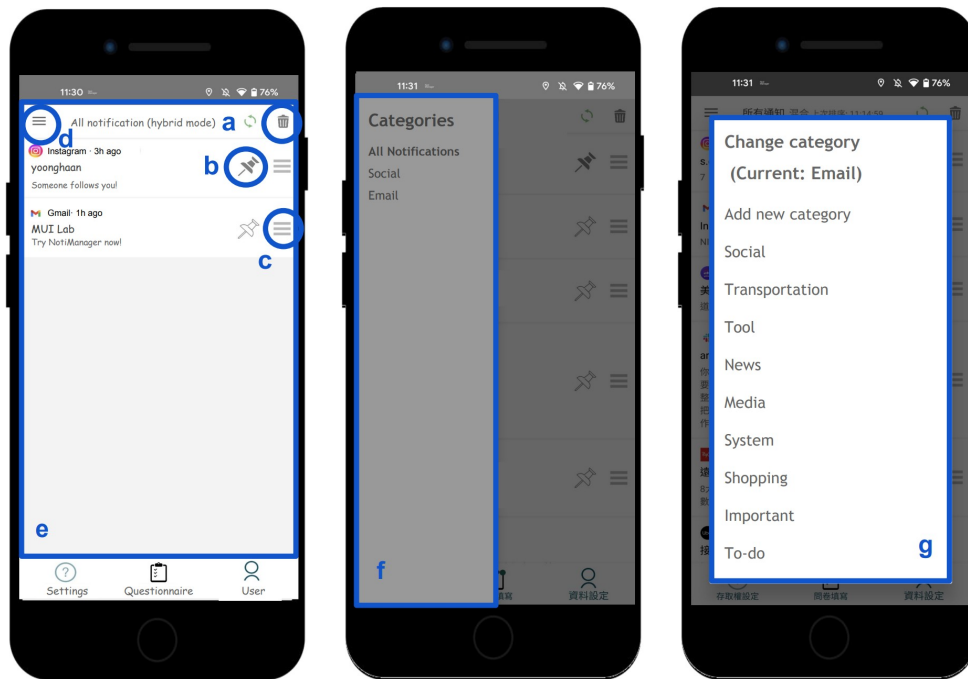


Figure 1: NotiManager interface includes (a) "Delete all notifications" button (b) "Pinning" button (c) "Sorting" button (d) "Category menu" button (e) Notification drawer (f) Category menu (g) "Changing category" interface

3 PILOT STUDY

In order to obtain preliminary insights into users' experiences and perceptions of the notification management features in NotiManager, we conducted a pilot study with 3 Android smartphone users (2 females and 1 male, aged between 18 and 60 years). The purpose of this pilot study was to gain preliminary insights into user behavior and feature use, facilitating the design of a more comprehensive field experiment. This poster paper presents the results of this initial pilot study.

3.1 Study Design

In the pilot study, we assigned different notification management modes to participants in order to observe and compare manual notification management with automatic management. Each participant experienced two modes: all participants used the hybrid mode, while being assigned to either the manual mode or the automatic mode. To reduce order effects, we counterbalanced conditions and randomly assigned the order of modes to participants.

We implemented the Experience Sampling Method (ESM) to gather participants' firsthand reports on their experiences, intentions, and contextual background when using specific management features, as well as their assessment of the notification display order. NotiManager, in particular, was designed to record incoming notifications on participants' smartphones, monitor the use of notification management features, and log data from phone sensors. Upon the usage of at least one notification management feature, NotiManager recorded the details of the notification and the time of feature usage, to determine if triggering an ESM questionnaire was warranted.

An ESM questionnaire would be prompted if more than an hour had lapsed since the last questionnaire completion and if any management feature had been utilized within the preceding 30 minutes. If no ESM triggering criteria had been met for a span of two hours or more, the ESM questionnaire then asked participants to evaluate the most recent notification display order observed during their use of NotiManager.

Specifically, participants were presented with two variations of display orders—an original and an adjusted one—to compare and evaluate which of the two orders aligned more closely with their ideal display order. Then, they were then asked to provide an explanation for why they believed one of the orders was superior to the other. Importantly, the order of presentation of the two notification display orders was randomized, and participants were not informed of which one was the original or the adjusted one. This design approach was adopted to mitigate any potential bias participants might harbor towards the original versus adjusted display orders.

To mitigate any potential disruption caused by the ESM questionnaires, participants were requested to select a time window of at least 12 hours, during which they would feel comfortable receiving the ESM questionnaires, upon their installation of the app. At the conclusion of each day, participants were given a diary questionnaire that provided a summary of their usage of the notification management features throughout the day. This end-of-day questionnaire also solicited participants' opinions regarding the effectiveness of various management features and their overall feedback on NotiManager.

3.2 Procedure

Each participant was invited to an individual pre-study meeting where the research team elucidated the study procedure, and then guided the participants through the installation process of NotiManager and its use for interacting with notifications. The study lasted six days. For the first two days, each participant utilized the app in a baseline mode, i.e., without any management features, to familiarize themselves with viewing and handling notifications within NotiManager. On the third day, NotiManager automatically transitioned to the next mode, which could be either the manual/automatic notification management mode or the hybrid notification management mode. The sequence between the manual/automatic mode and the hybrid mode was randomly determined. Furthermore, the assignment of participants to the manual versus automatic mode was also randomized.

Prior to the shift to the next mode, participants were briefed about the upcoming mode switch and were introduced to the notification management features within the upcoming mode. Throughout the study, participants received ESM and diary questionnaires during their self-selected time intervals for questionnaire reception. At the conclusion of the study, participants were interviewed to garner their feedback and to understand their experiences using NotiManager.

4 PRELIMINARY RESULTS

4.1 Evaluation of Notification Display Orders

The pilot study resulted in a total of 35 ESM responses and 8 diary responses from the three participants. Collectively, according to their self-reported experiences, the display order of notifications under manual mode was perceived to be more closely aligned with the participants' ideal display order in comparison to the baseline mode.

For those participants who were assigned the automatic mode, they reported that nearly half of the time (0.476), the automatically arranged notification list corresponded with their ideal display order. However, in approximately a third of instances, the auto-arranged notification list diverged from their desired order. When compared with the baseline and hybrid modes, both of which met the notification order expectations over 50% of the time, and had a less than 25% rate of non-ideal order occurrences, the automatic mode was found to be slightly less satisfactory. When assessing whether the notification order in baseline mode or the automatically sorted notification order was more in line with their ideal, participants in the automatic mode group slightly favored the order from the baseline mode (0.59) over the manual mode group (0.5). However, one participant in the automatic mode group reported that the baseline mode was more aligned with their ideal order more than half of the time (0.533), but noted in diary responses that they found the automatic sorting feature to be useful.

However, when using the hybrid notification management mode, participants reported that the notification order aligned with their ideal 75% of the time. Notably, throughout the study, none of the participants using the hybrid mode indicated that the sorting order did not meet their ideal. Diary responses revealed that one participant

found the functionalities in the hybrid mode complementary, allowing for manual sorting adjustments when the automatic feature was deemed unsatisfactory.

When evaluating whether the notification order met their expectations, participants primarily considered the prioritization of important or urgent notifications. Participants who reported that the notification order met their expectations via the ESM all indicated that important or urgent notifications were given high priority.

4.2 Practices of Using Management Features

Participants in our study particularly appreciated the "pin" feature provided by NotiManager, as it allowed them to quickly locate and revisit specific notifications at a later time. This functionality facilitated the deferment of full assessment and action upon the pinned notifications, proving advantageous when participants were unavailable or it was inconvenient to address notifications immediately. In line with Chang et al.'s research [3], participants often chose to manage notifications when there was a more opportune moment to handle them.

The types of notifications most commonly managed fell into the categories of Instant Messaging (IM), Email, Phone Calls, and Text Messages. This finding aligns with prior research that communication-related notifications in these categories are often deemed more important and urgent than others. Consequently, participants preferred to have notifications from these categories sorted in their priority viewing position in the notification order.

In addition to important and urgent notifications, reminder-type notifications, such as those from calendar apps, were also preferred for management by participants. In our study, all of the managed notifications in this category were facilitated using the pin feature.

5 CONCLUSION

In this study, we delved into how users interact with their notifications across manual, automatic, and hybrid notification management modes. Our initial results from the pilot study indicate that NotiManager exhibits promise, as several participants actively utilized its management features, echoing previous research that posits these tools provide benefits to a certain segment of users.

In the future, we plan to carry out a more extensive and comprehensive field ESM study to gain a deeper understanding of how NotiManager can better assist users across different notification management methods. Our focus will be not only on deciphering user habits and preferences but also on uncovering ways to improve the design of mobile notification management interfaces. This way, we aim to refine the system and maximize its potential in addressing the needs and improving the experience of mobile device users.

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