

Oh App, Where Art Thou? On App Launching Habits of Smartphone Users

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ABSTRACT

In this paper, we present the results of a four-week real world study on app launches on smartphones. The results show that smartphone users are confident in the way they navigate on their devices, but that there are many opportunities for refinements. Users in our study tended to sort apps based on frequency of use, putting the most frequently used apps in places that they considered fastest to reach. Interestingly, users start most apps from within other apps, followed by the use of the homescreen.

Author Keywords

app launch; smartphone; logging study

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation: User Interfaces - Evaluation/methodology.

General Terms

Human Factors; Measurement.

INTRODUCTION

Smartphones have become indispensable companions, serving many different purposes, including communication or business. In order to support these types of use, a diversity of applications is available. For instance, the Google Play store has more than 600,000 apps for Android devices¹, whereas the Apple App Store distributes over 500,000 apps². According to Nielsen, the average number of apps per smartphone has increased by 28%, from 32 in 2011 to 41 in 2012 [4].

There is little work on how users make use of current smartphone concepts to organize and launch apps. Earlier research on hierarchical menus by Jeon et al. [3] shows that most users make shortcuts for favorite functions (e.g. alarm clock, etc.) by adding these to a customizable menu. The use of such

¹<https://play.google.com/about/features/index.html>
(Last accessed: 2013-02-14)

²<http://www.apple.com/iphone/built-in-apps/app-store.html>
(Last accessed: 2012-09-14)

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Figure 1. Screenshot of an original homescreen (left) and a custom homescreen using ADW Launcher (right).

features depends on the mental model that users have about cellular phone menus as depicted by Ziefle et al [8]. They emphasize that users of different ages have distinct mental models about cellular phone menus, which affects task performance. Further influencing factors are found by Oulasvirta et al. [5], who compared task performance on smartphones of novice, casual and expert users. They observed faster navigation for the two latter groups. Despite this research, little attention has been paid to launching concepts on more recent smartphone operating systems. Most research focuses on application usage and organization (e.g. [1, 2]), or propose new concepts (e.g. [7]), but neglect to consider how users actually reach and launch apps on smartphones using currently available concepts (e.g. homescreen panels, docks, etc.) and if these concepts are used at all. This is important to identify areas for improvements and to understand their implications for the design of app launchers. This allows us to support users in their individual needs during smartphone usage.

Therefore, we developed an Android application collecting information on the locations from which apps are launched. We performed a four-week real world user study. The results show that users have a good self-assessment about navigation speed. Surprisingly, the majority of apps are started from within other apps, followed by the use of homescreen panels, where most apps are opened from the main screen. The main contribution of this work is to provide first insights on how users utilize launching concepts on current smartphones, why they use them and to reveal areas for refinement.

PROTOTYPE

Android devices provide a variety of possibilities to launch and switch between apps. Though the following descriptions focus on Android devices, similar concepts can also be found on other platforms, like iPhones or Windows Phone 7.

The lockscreen is the first screen that appears when switching on the smartphone and is used to unlock the device. Some devices allow shortcuts on this screen to start applications without unlocking the device. Once the device is unlocked, a homescreen panel appears (which is an equivalent to the desktop found on personal computers; see figure 1). Users can have up to seven homescreen panels. Swiping to the left or right enables users to switch between them. Homescreen panels can be used to arrange apps, widgets (apps that run on homescreen panels) or folders. Folders can be used to group apps. Each homescreen panel has a dock at the bottom which usually provides shortcuts to apps and the app drawer. The latter lists all apps that are installed on the smartphone.

Another possibility to launch an app is the notification bar. It collects arriving notifications and status messages, e.g. missed calls. Selecting one of the notifications opens the corresponding app. There is also a feature that displays all recently started apps and enables the user to switch between them (recent apps view). There are various possibilities to initiate the recent apps view (e.g. pressing the home button of the device for a couple of seconds). Finally, Android has the concept of shared intents, where apps are started from within apps, e.g. the search bar, which is another launch concept where users can enter the name of an app to launch it. Figure 1 depicts the most common launching options.

To log these activities, we implemented an Android application by extending the ADW Launcher³, an open source software available from the Google Play store, with a logging tool. This was necessary to perform logging and required users to replace their launcher with our version. Logging only took place during the users interaction with their smartphones (meaning that the smartphone was not in idle state). Two types of information were collected:

- *Event-based information*: Data from events triggered by users (touch coordinates, swipes/scrolls, screen changes, app starts, package events, display state, etc.).
- *Polling-based information*: Data periodically parsed from system logs (activity, lifecycle, source PID and name, etc.).

All data was stored on the device and automatically uploaded to our server whenever the smartphone was plugged into an external power supply and connected to WiFi.

To avoid technical problems during the main study, we conducted a preliminary study. Three participants with an average age of 28 years (all male) tested the application over a period of nine days. Then, we interviewed them about problems and suggestions for enhancements. Their input was used to improve the prototype.

³<http://code.google.com/p/adw-launcher-android/>
(Last accessed: 2013-02-14)

USER STUDY

We conducted a four-week user study in the field. Participants used their own Android smartphones together with our application. The advantage of this approach is that we could gather data under real world conditions.

Procedure

Before the actual study started, we invited all participants to an individual meeting, during which the details of the study were explained. We also installed the study software during this meeting and asked participants to fill out a questionnaire with demographic information.

Before the installation, we took photos of each screen to reconstruct the participants' arrangement of apps and widgets in the newly installed launcher. Some manufacturer-specific widgets were not supported by the application launcher. In this case, similar alternatives were used instead, in order to provide a usage experience equivalent to the original launcher. Figure 1 shows an example of an original homescreen (left) and a reconstructed homescreen (right).

Large-scale studies like [6] had adaption periods of six to eight weeks. However, the participants in those studies received new smartphones to which they had to adapt. We set the adaption period to two days, since the migration effort from the standard to the custom launcher was minimal. This is supported by self-reported data. Most of the user stated that little effort was required to adjust to the new launcher. After four weeks of data collection, participants received a notification on their smartphones, which asked them to fill out an online questionnaire. As an incentive, all participants had the possibility to win one of four gift vouchers.

Participants

Altogether, we recruited 22 participants for the study. The data of one participant who stopped using the new launcher was excluded. Thus, we analyzed the data of 21 participants with an average age of 26 years (range: 22-31), five female. All of them had a western background. Most of them were students (81%). The remaining participants were employees from different sectors (IT, consulting, or investment 19%). All participants owned an Android smartphone, with an average smartphone experience of 24.1 months (range: 3-70). For some analyses, the data of only 13 participants could be considered. One of the reasons was the missing source process ID (PID) that is required to identify the various launch types. This will be clearly stated for the corresponding analyses.

Results and Discussion

For the evaluation of the collected data, a launch is defined as the start of an app by the user. Overall, we registered 50590 app starts by 21 participants (median = 2028; IQR = 2780-1769), with 5637 (11.1%) being the highest and 753 (1.5%) the lowest number of app launches per user.

Launching Behaviour

In order to capture the actual app launching behavior, we compared app starts from the launcher, notification bar, lockscreen and from within other apps (see figure 2). For this analysis we analyzed the data of 13 participants.

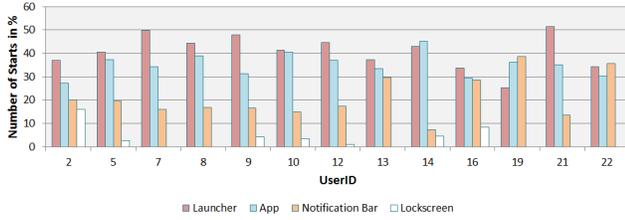


Figure 2. Number of apps started from launcher, app, notification bar and lockscreen (normalized).

Nearly all participants performed most app starts from the launcher or from within apps. Some users (ID 19 and 22) exhibited a different launch pattern by using the notification bar more often. The lockscreen was barely used, with the exception of one user (ID 2) who used it for 16% of all app starts. The remaining participants, who owned an Android device that supported the access to apps through the lockscreen used it on average only for 4.85% of app starts. The recent apps view could not be logged, but according to the users' self-assessment, the majority use it seldom or never. The app search functionality was not used at all.

At first glance, the launcher ranks first, followed by starts from within apps, the notification bar and the lockscreen. However, the launcher consists of different launch types: homescreen panels, app drawer, folder, widget and dock. Each of the different launch types ranks lower than the starts from within other apps. For instance, within app starts occur when selecting a link within an email app that is opened in a browser app (active start). This also happens when an app automatically opens another app (passive start). Unfortunately, our method cannot differentiate between active and passive app starts (meaning app starts initiated by a user and app starts caused by an app).

Figure 3 breaks down the number of app starts for each launch type from all 21 participants. About two-thirds accessed most apps through homescreen panels. Those participants used the dock complementarily, but barely used other navigation possibilities. One user (ID 5) showed an extremely low percentage of app starts from homescreen panels. The reason is the user's organization of most apps into folders that are located on the homescreen panels. Other users (ID 6, 7, 18 and 19) opened apps through the dock more often; some of them even used it as the main navigation to reach apps.

The results show that participants have common navigation patterns with individual traits. The homescreen panels are an important navigation support for mostly all users. The dock, which is one of the fastest means, is only used by few users as main navigation. It is mostly utilized as complementary solution, probably due to the limited space that the dock provides. Users reserve this space for functions that need to be accessed quickly, but not necessarily often. The same reason may apply to the lockscreen. No assumption can be made about the recent apps view and the starts from within apps. They might or might not be part of common navigation patterns or individual habits. Nonetheless, this does not change the fact that users have common navigation patterns and individual traits.

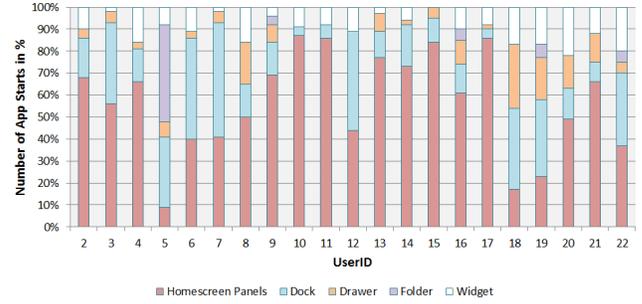


Figure 3. Number of apps started from different launch types.

Navigation Time

We measured the time that participants needed to navigate to apps. The measurement started when the navigation type was opened (e.g. app drawer) and ended when an app was started. The fastest average navigation time was 2s, the longest lasted 5s (by user 18, who used the app drawer more often). User 5 needed on average 4.5s. This is due to the organization of apps in folders that requires at least two interaction steps (open folder and navigate to app). Comparing the average navigation time of the different launch types, the dock was the fastest (2.24s), followed by homescreen panels (2.65s). Folders (4.66s), vertical (5.55s) and horizontal app drawer (7.21s) were the slowest.

Since users who used the vertical drawer did not use the horizontal drawer, a single statistical test with all launcher types together seemed not appropriate. Thus, we performed three tests. A one-way repeated-measures ANOVA for the types homescreen panels, dock, and vertical app drawer (meaning app drawer that scrolls vertically) showed highly significant main effects of types ($F_{(1.10,14.26)} = 20.70, p < .001, r = .76$, *Greenhouse-Geisser corrected*) with homescreen panels and dock being significantly faster than the vertical app drawer (both $p < .005$). Another one-way repeated-measures ANOVA for the types homescreen panels, dock and horizontal app drawer (meaning app drawer that scrolls horizontally) showed highly significant main effects of the types ($F_{(2,10)} = 34.76, p < .001, r = .92$) with homescreen panels and dock being significantly faster than the horizontal app drawer (both $p < 0.005$). The t-test between horizontal and vertical app drawer is not significant ($t(18) = -1.15, p = .27, r = .26$).

Self-Assessment

We asked participants about their subjective opinion on their smartphone navigation. Participants seem to be satisfied with the time they need to navigate to apps. On Likert scales from 1 (very slow) to 5 (very fast), almost half of them (47.6%) rated their speed only as average. The other half assessed their speed as fast (42.9%) or even very fast (9.5%). While all participants claimed to have a high homescreen panel usage (95.2% use it very often or often), there seems to exist individual launching habits. For example, some participants (42.9%) stated to use the notification bar very often or at least often, while 38.1% of them seldom or never use it. When asked about other app launching possibilities, one participant stated that she very often uses widgets to start apps.

When asked why they preferred homescreen panels and dock over the appdrawer, participants stated to perceive it as faster and, equally important, better to reach. Some participants noted that they had only few active apps that all fit on the homescreen panels. "Active apps" refers to apps that are actually used as opposed to apps that are installed, but not used.

The results for navigation times mostly comply with the self-assessments. Participants were quite fast and mostly use fast navigation types (e.g. homescreen panels).

Homescreen Panels Arrangement and Rearrangement

According to [6], users utilize their top ten apps 90% of the time. Thus, we analyzed the starting locations of these apps. Most are placed on homescreen panels, followed by the dock. Some users only have one of their top ten apps located in the dock, even though it is one of the quickest ways to start an app. Two users (ID 12 and ID 15) used the app drawer to start some of their top ten apps, while one user (ID 5) organized 50% of her top ten apps in folders. Most apps on homescreen panels are started from the main screen, followed by the screens next to it.

There is a tendency for the screen on the right of the main screen to be the second most used screen. One user (ID 18) barely uses homescreen panels. If she started an app from homescreen panels, they were located two to three screens away from the main screen. The screens in-between contained widgets. In general, users who started apps from homescreen panels only started the same apps from the app drawer for 1.2% of the time, meaning that frequently used apps are mostly placed on the main screen or close to it.

During the study, we observed the changes users made to homescreen panels, in particular if they added, moved or deleted apps. One-third of users never changed their homescreen panels during the study. Two users (ID 12 and ID 19) showed a very high number of changes (190 and 33 changes). On average, users made eight changes (mostly moving or adding apps). The changes are seldom related to new installations, but support the idea that users try to improve the app arrangement for better reachability or better memorability (e.g. logical grouping of apps). The results also support the participants self-assessment. All but one stated that they seldom changed the homescreen panels arrangement. Only one participant noted that she often changed the arrangement to integrate new apps and widgets.

CONCLUSION AND FUTURE WORK

The presented results are based on information collected from Android devices. Thus, we cannot make assumption about concepts that are not found on Android but on other platforms, like the live tiles provided by Windows 7. However, most concepts (e.g. homescreen panels, dock, notification bars, etc.) that we analyzed on Android devices can also be found on other platforms like iphone or Windows Phone 7, which makes the insights generalizable to some extent.

In this work we showed that smartphone users have similar navigation patterns (e.g. use of homescreen panels), but with individual traits (e.g. use of folders). Current concepts found on smartphones support the navigation well, but leave space

for improvements. Due to the individual traits, the design of app launchers should not follow a "one design fits it all" approach, but should take users' personal preferences into account (i.e. using existing launching concepts and complement them with adaptive solutions). While someone who organizes apps in folders sets value on logical grouping, someone who often rearranges the homescreen panels prioritizes quick access to apps. It might be of interest to differentiate these traits and adapt the arrangement of apps accordingly, e.g. by asking users corresponding questions when setting up their phone for the first time. The individual traits also hint at the location where adaptation could take place. For someone who most of the times uses the notification bar, it might be useful to put the top ten apps within the notification bar, while it might be better for someone who prefers folders to provide an adaptive folder on the homescreen. With respect to the individual traits, we believe that paying attention to outliers instead of analyzing the general population yields intriguing insights.

If you are interested in getting access to the (anonymized) data of the user study, just contact the first author of this paper.

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