

Investigating Country Differences in Mobile App User Behaviour and Challenges for Software Engineering

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Analysis of app store data reveals what users do in the app store.

- We want to know *why* users do what they do.
- We want to know what users do *after* they leave the app store.

Motivation

- Existing research in market-driven SE and IS study country differences in software systems usage
- Findings used to inform developers when building software for different countries
- Apps are sold worldwide
- No studies on country differences in mobile app usage

Hypothesis: Differences exist in mobile app usage behaviour between countries.

These differences bring new challenges to market-driven software engineering.

Research Questions

- RQ1: User adoption of the app store concept
- RQ2: Their app needs
- RQ3: Their rationale for selecting or abandoning an app
- RQ4: Differences in behaviour (RQ1-3) between countries

RQ1: App Store Adoption

- RQ1.1 What is the distribution of users across mobile app platforms?
- RQ1.2 How frequently do users visit their app stores to look for apps?
- RQ1.3 On average, how many apps do users download per month?
- RQ1.4 How do users find apps?

RQ2: User Needs

- RQ2.1 What triggers users to start looking for apps?
- RQ2.2 Why do users download apps?
- RQ2.3 What types of apps do they download?

RQ3: Influencing Factors

- RQ3.1 What are the factors that influence users' choices of apps?
- RQ3.2 Given that ratings influence app selection, why do users rate apps?
- RQ3.3 Why do users pay for apps?
- RQ3.4 Why do users stop using an app?

RQ4: Differences between Countries

- Revisit all the previous research questions to identify differences across countries. E.g.:
 - Do users in different countries have different approaches to finding apps?
 - Are they influenced by different factors when they choose or abandon apps?

Methodology

- Target top 15 GDP countries

USA, China, Japan, Germany, France, Brazil, UK, Italy, Russia, India, Canada, Spain, Australia, Mexico, and South Korea

- Online survey
 - Construct questionnaire (close-ended with “other”, language for 12+)
 - Pilot study
 - Translate questionnaire from English into 9 other languages (Spanish, German, French, Italian, Portuguese, Russian, Mandarin, Japanese, Korean)
 - Verify translated questionnaire

Questionnaire

- 31 questions
 - App usage
 - Demographics (gender, age, marital status, nationality, country of residence, first language, ethnicity, education level, occupation, and household income)
 - Big 5 personality traits (openness to experience, conscientiousness, extraversion, agreeableness, neuroticism)

What mobile device do you use?

Manufacturer name (e.g., Nokia)

Model name and number (e.g., E71)

Which app store do you use?

- Blackberry App World
- Google Play / Android Market
- Nokia Ovi Store
- Windows Phone Marketplace
- Apple iOS App Store
- Samsung Application Store
- None - my mobile device cannot run apps
- I don't know
- Other (please specify)

0% 100%



당신이 사용하고 있는 모바일기기는 무엇입니까?

제조사 이름 (예, 노키아)

기기 모델명과 번호(예, E71)

어떤 앱스토어를 이용합니까?

- 블랙베리 앱 월드
- 구글재생 / 안드로이드 마켓
- 노키아 ovi 스토어
- 윈도우 폰 마켓
- 애플 앱스토어
- 삼성 어플리케이션 스토어
- 내 휴대 기기에 앱을 실행할 수 없습니다
- 잘 모르겠습니다
- 기타(구체적으로 기재)

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Каким устройством мобильной связи вы пользуетесь?

Производитель (например, Нокia)

Название и номер модели
(например, E71)

Каким магазином приложений вы пользуетесь?

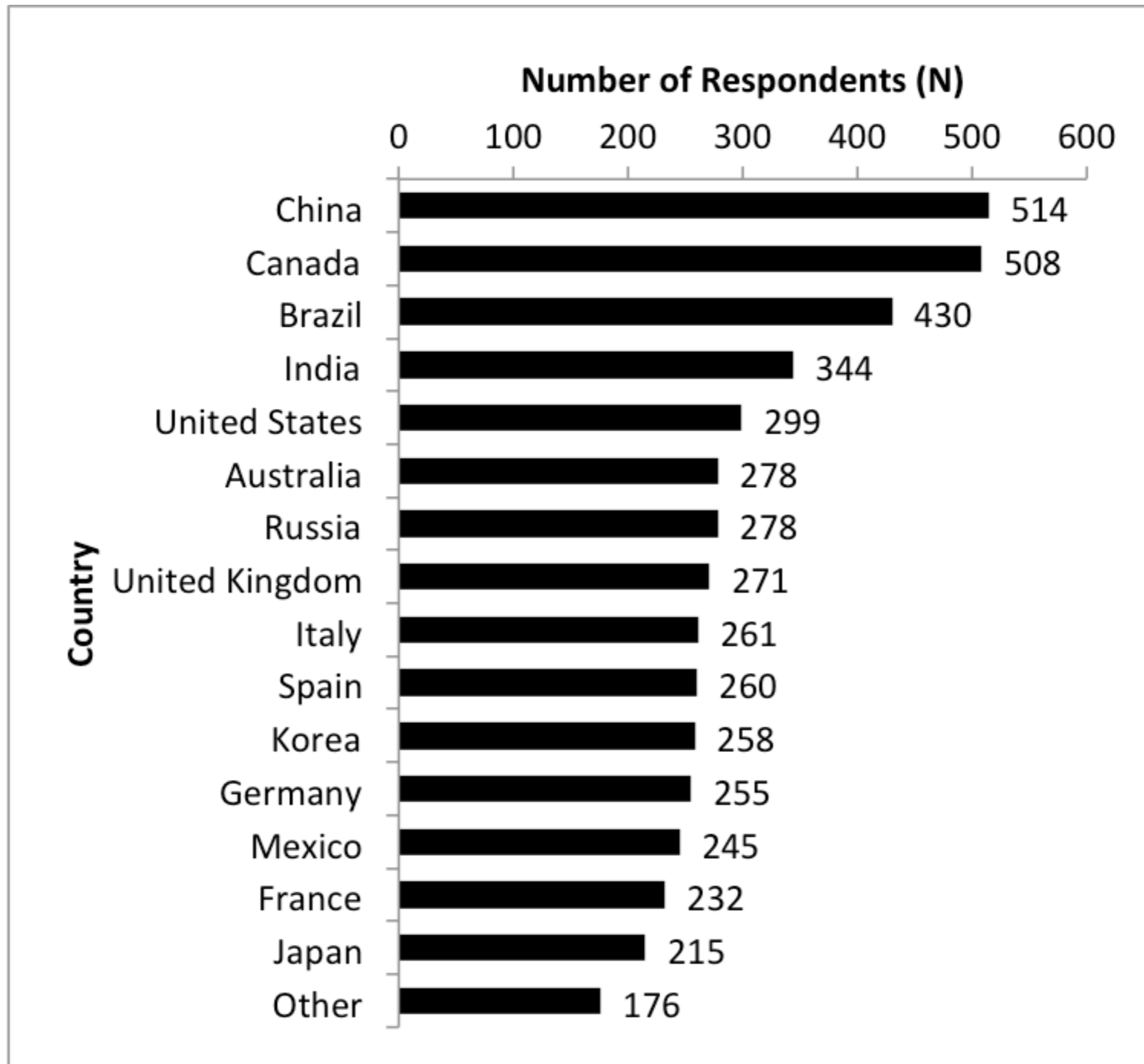
- Blackberry App World
- Google Play / Android Market
- Nokia Ovi Store
- Windows Phone Marketplace
- Apple iOS App Store
- Samsung Application Store
- Никаким - на моем устройстве не запускаются никакие приложения
- Не знаю
- Другими (Просьба указать)

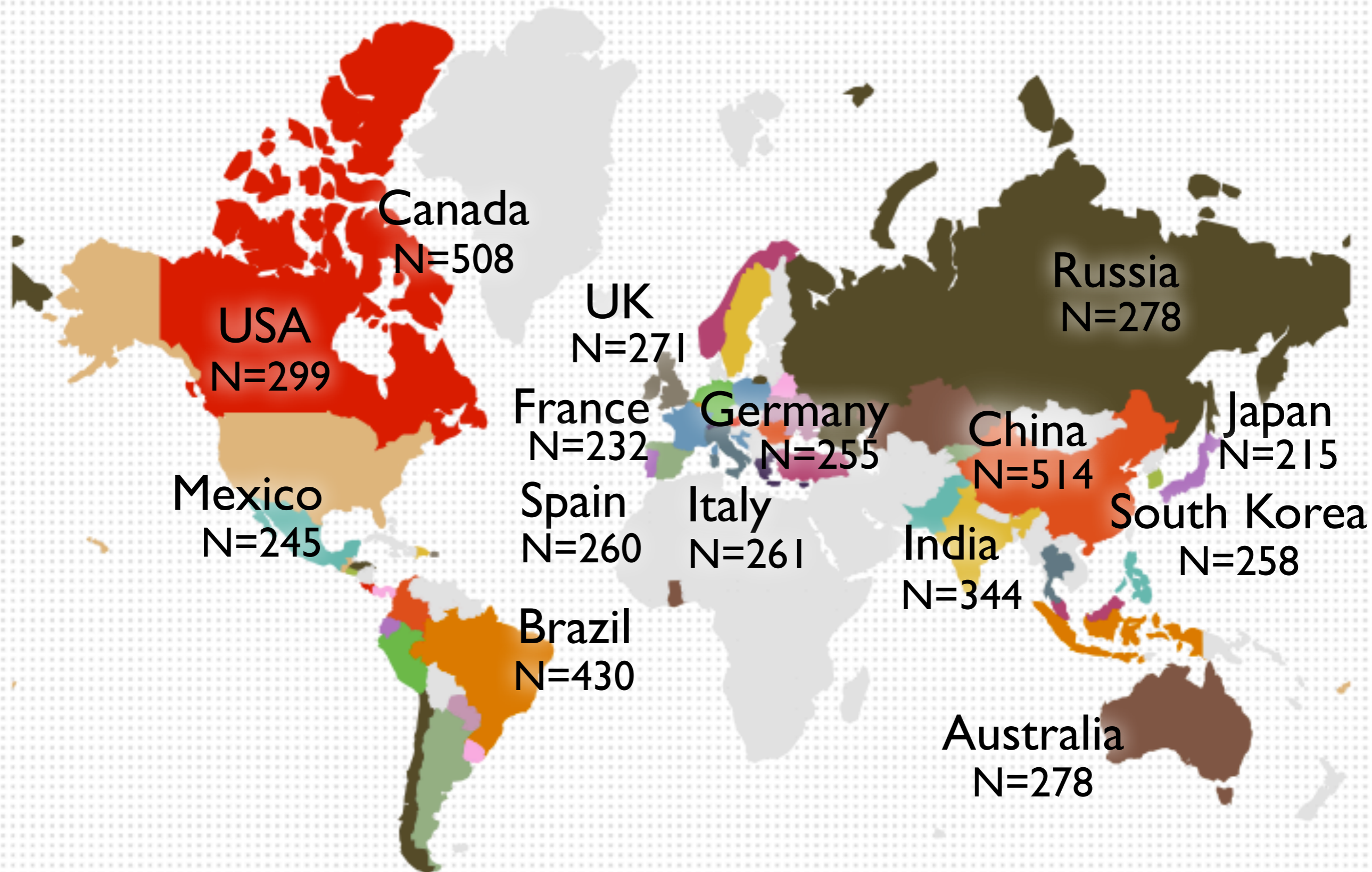
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Data Collection

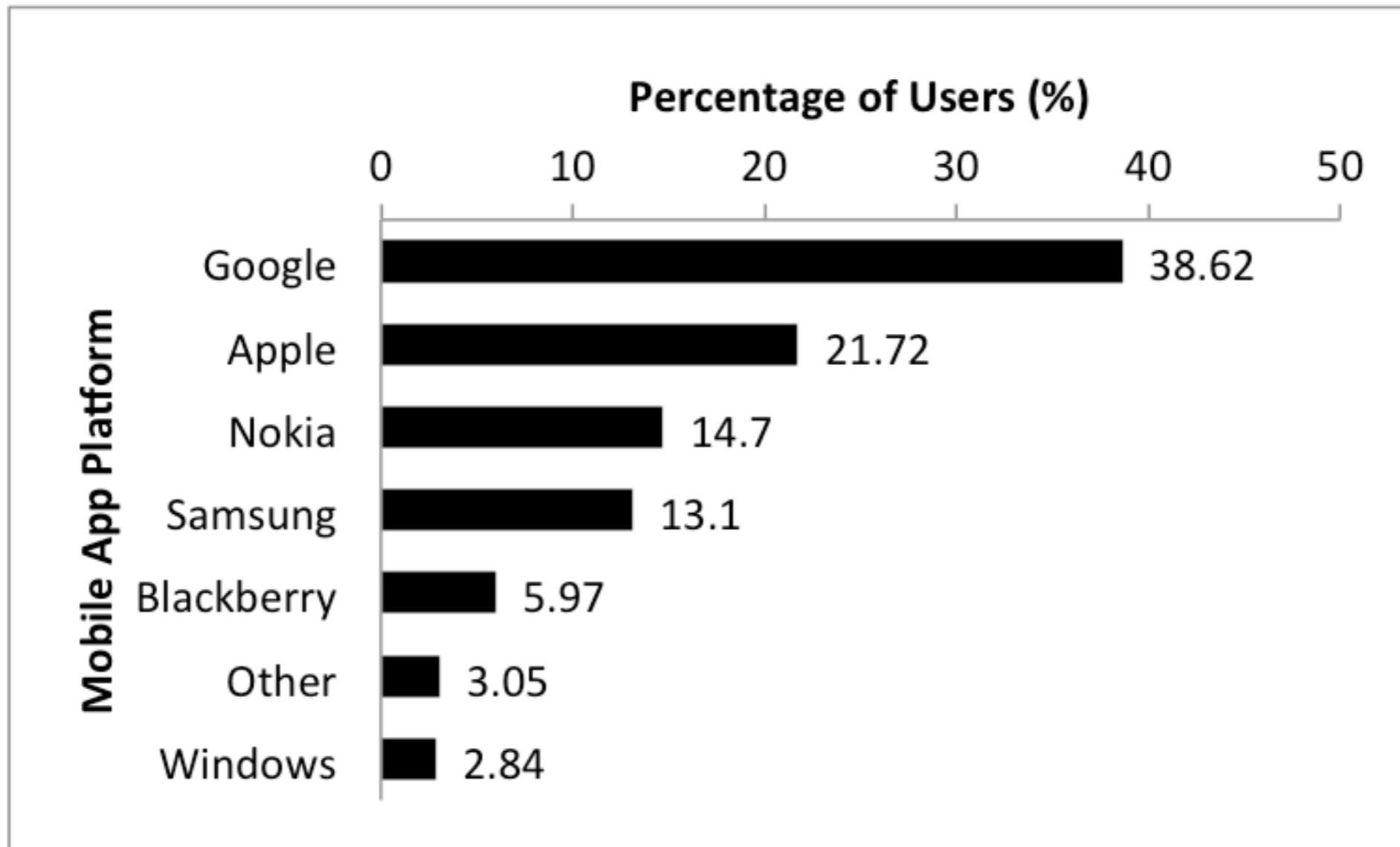
- Total participants: >30,000
- Total responses: >10,000 (30% response rate)
- Screened out people who don't use apps & incomplete responses
- N = 4,824
- Male = 2,346 (49%), Female = 2,478 (51%)
- Aged 11-87 (avg = 34.51, std = 15.19)





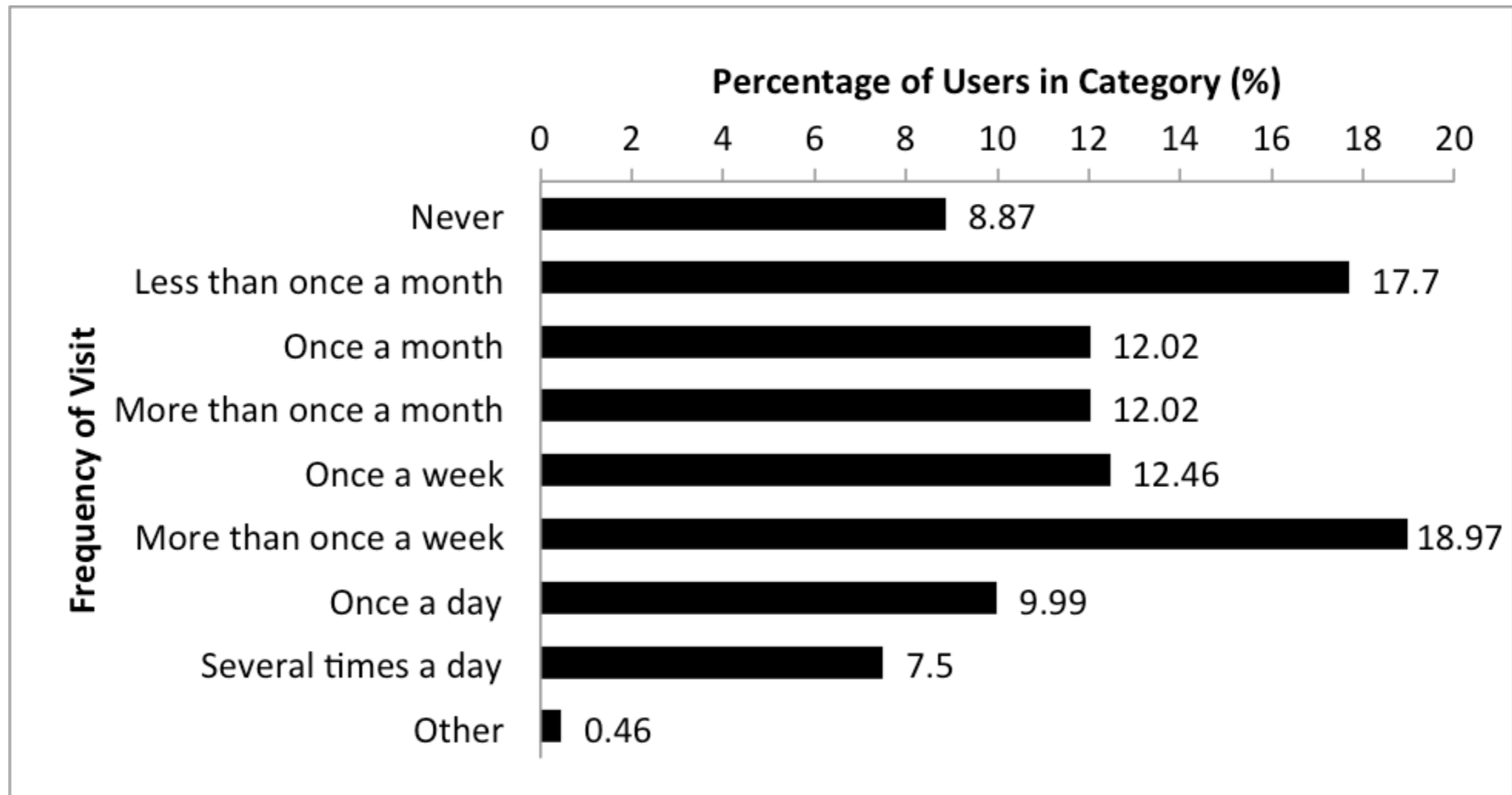
Cyprus, Malaysia, Belarus, Ukraine, Colombia, Costa Rica, Indonesia, Vietnam, Sweden, Guatemala, Kazakhstan, Singapore, Chile, Puerto Rico, Thailand, Argentina, El Salvador, Peru, Philippines, Croatia, Ecuador, Greece, Norway, Panama, Paraguay, Romania, Austria, Belgium, Bolivia, Caribbean, Dominican Republic, Fiji, Ghana, Honduras, Ireland, Ivory Coast, Kyrgyzstan, Mauritius, Netherlands, Pakistan, Poland, Portugal, St. Vincent, Switzerland, Taiwan, Turkey, Uruguay, and Venezuela.

RQ1.1 User Distribution

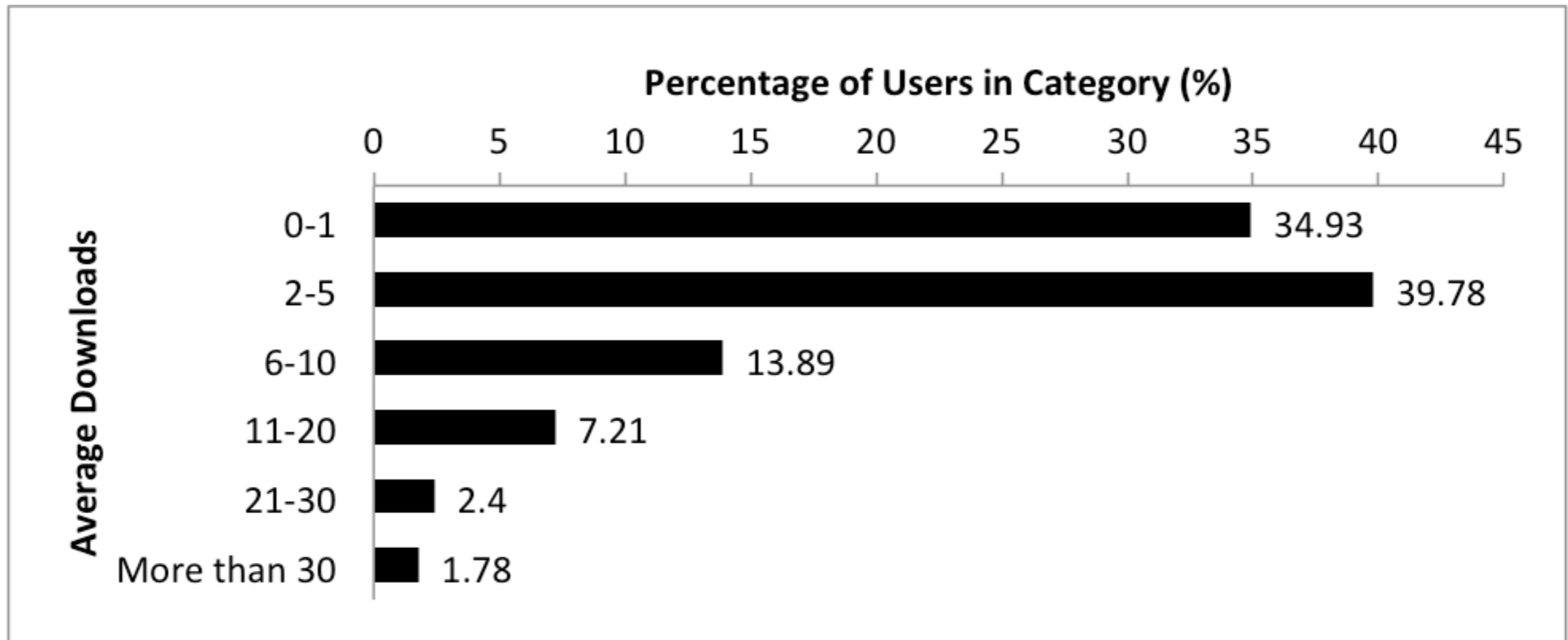


15% did not know what their app store was

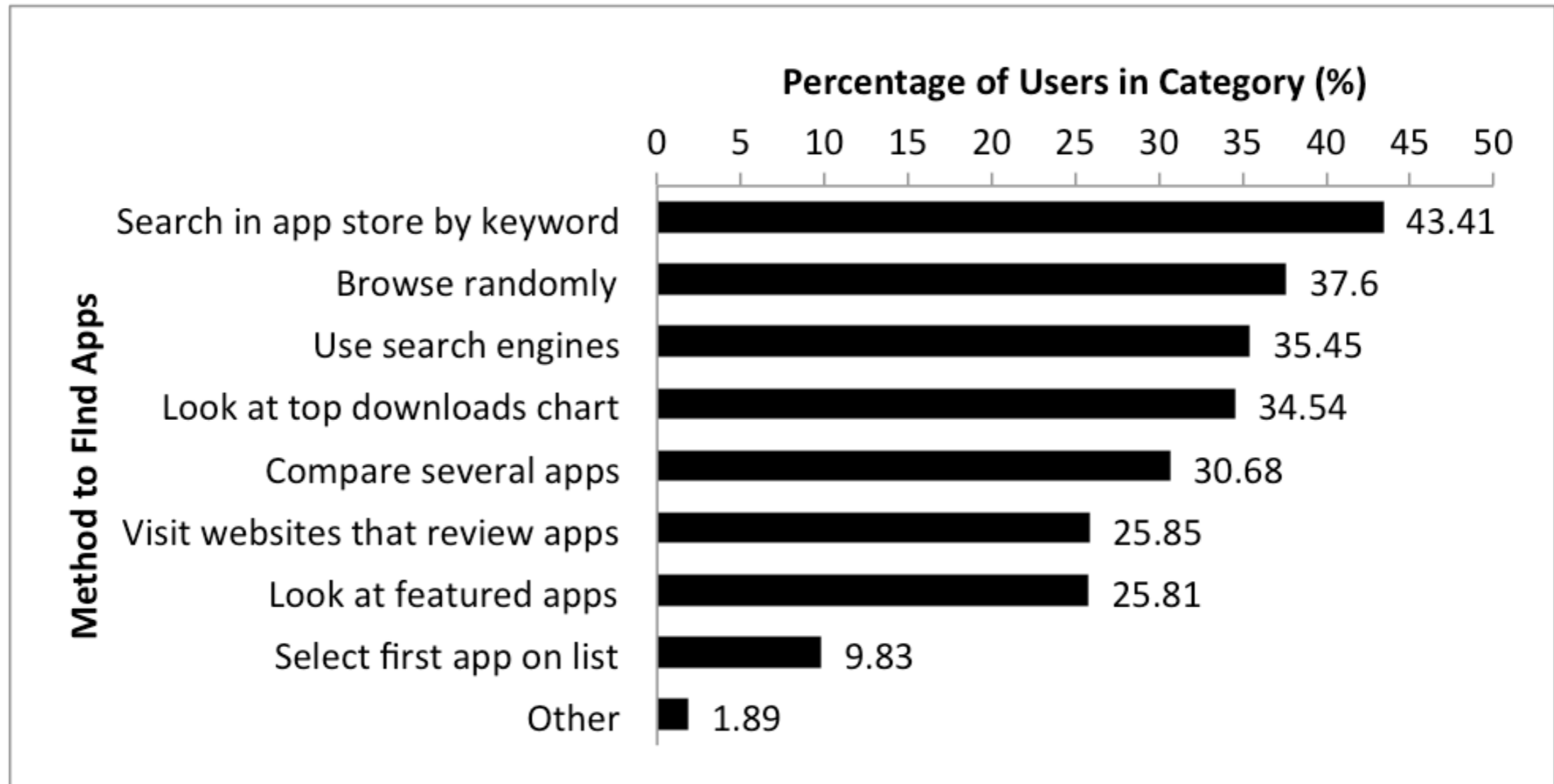
RQ 1.2 Frequency of Visit



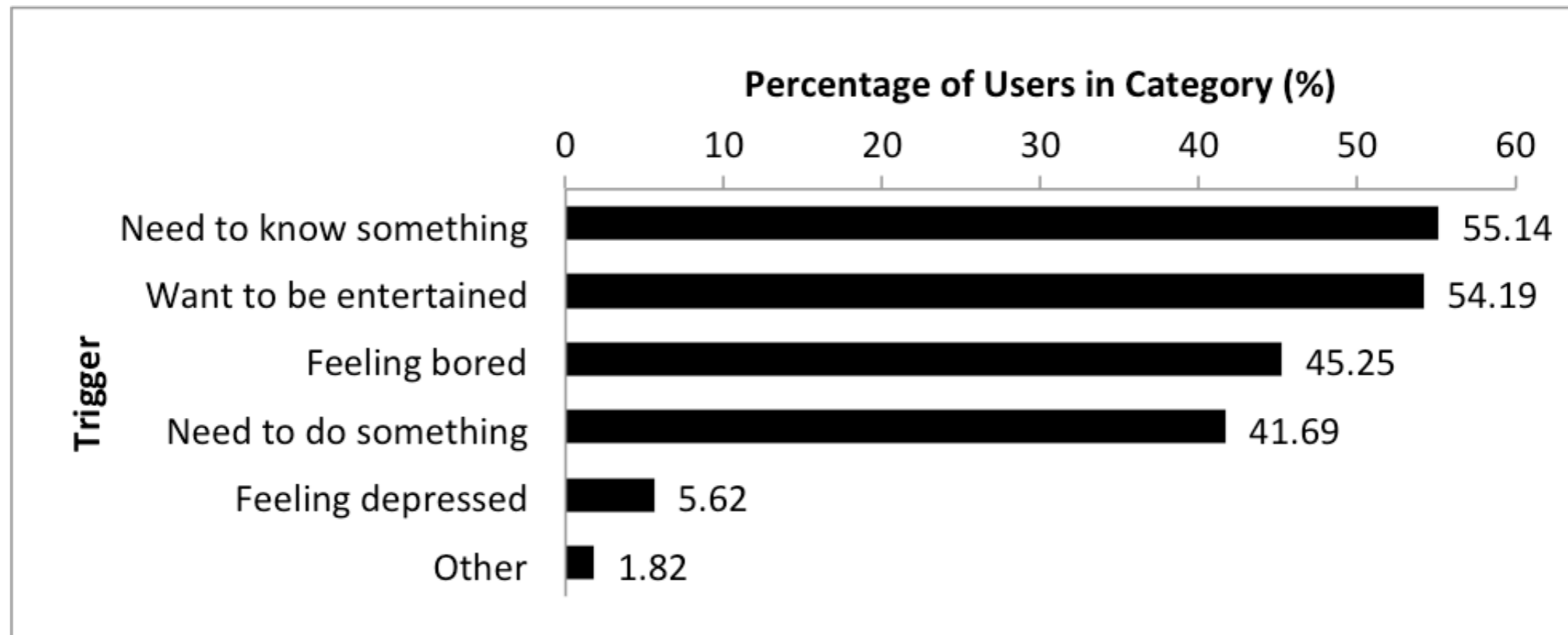
RQ I.3 Average Downloads



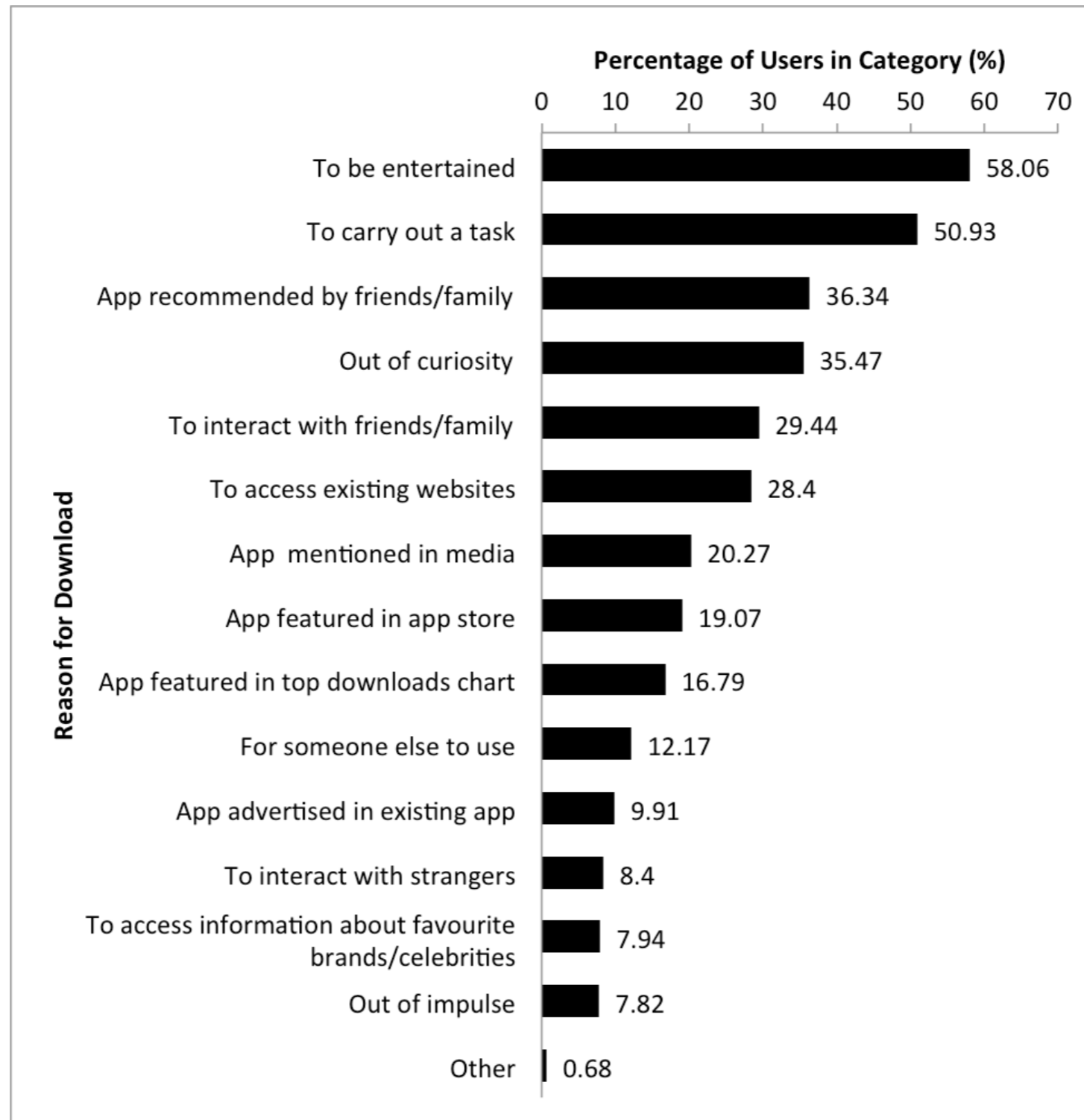
RQ1.4 Finding Apps



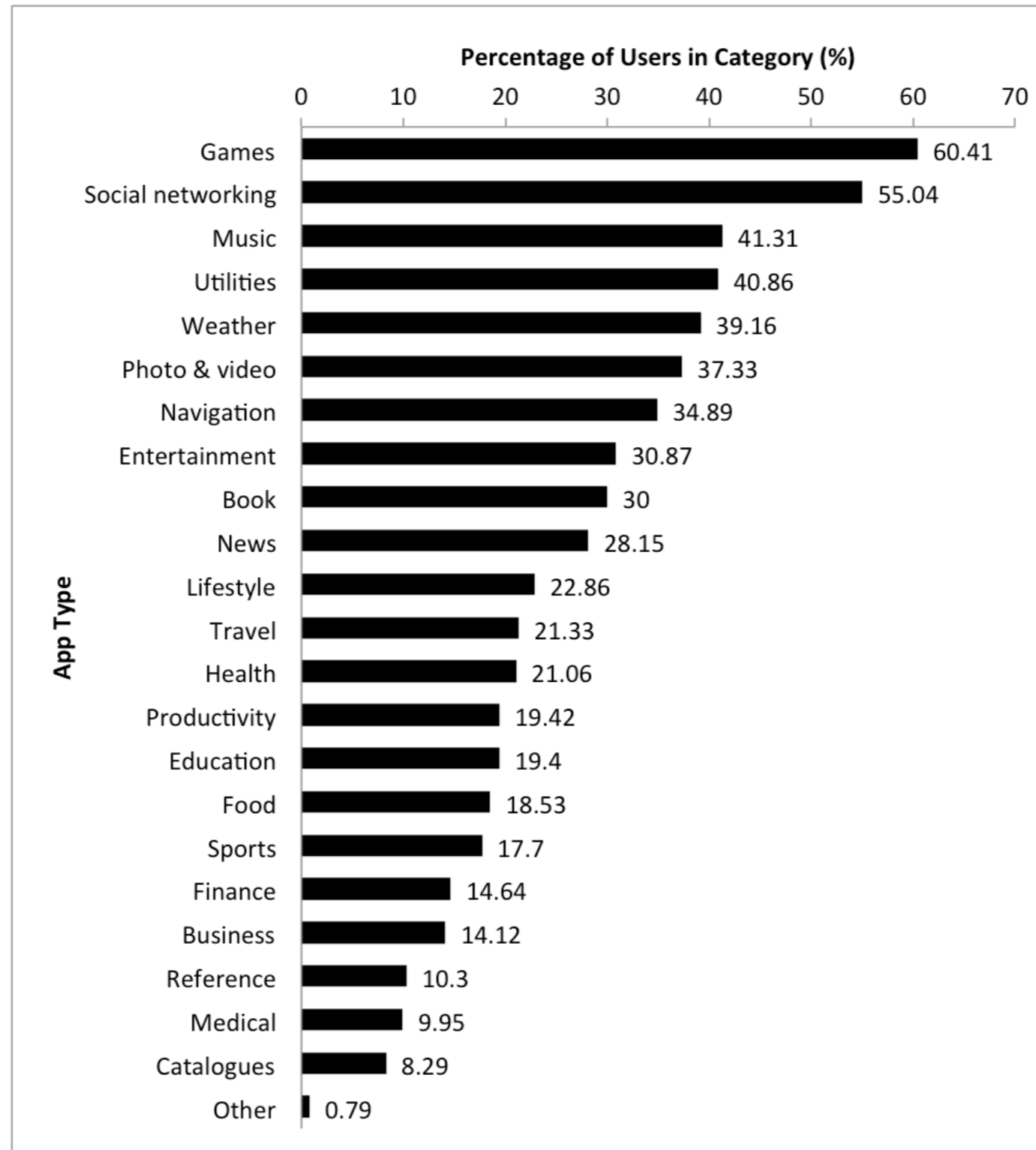
RQ2.1 Triggers



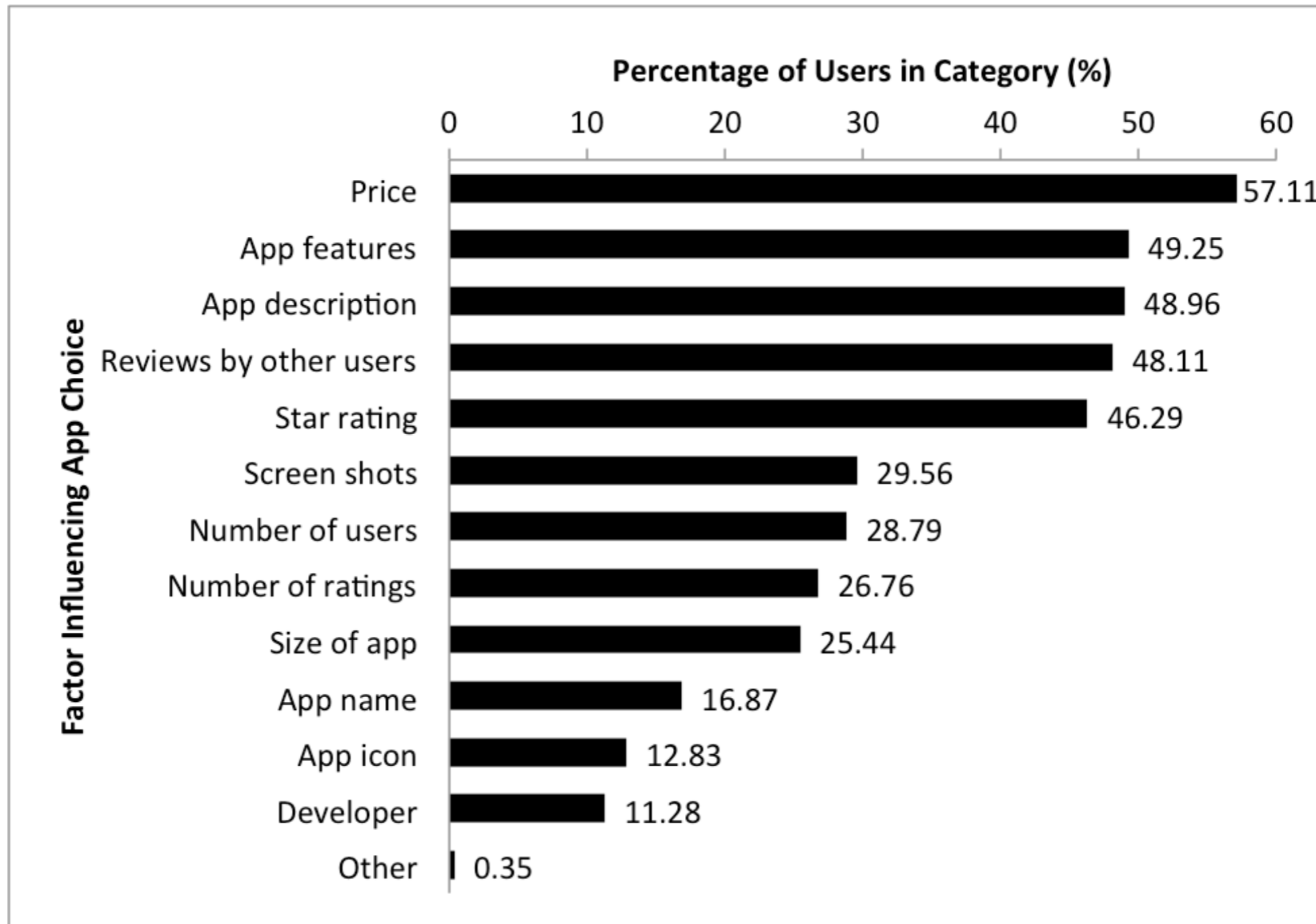
RQ2.2 Reasons for Download



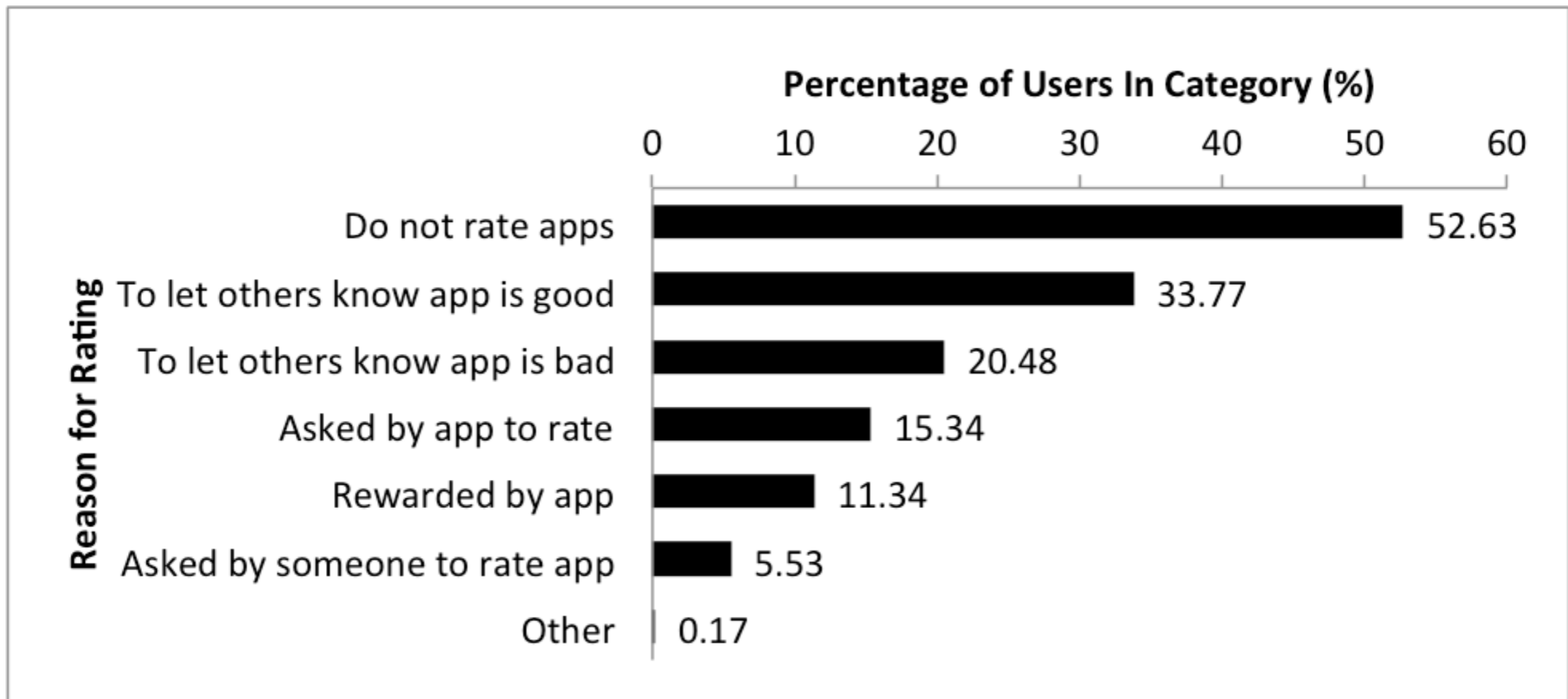
RQ2.3 App Types



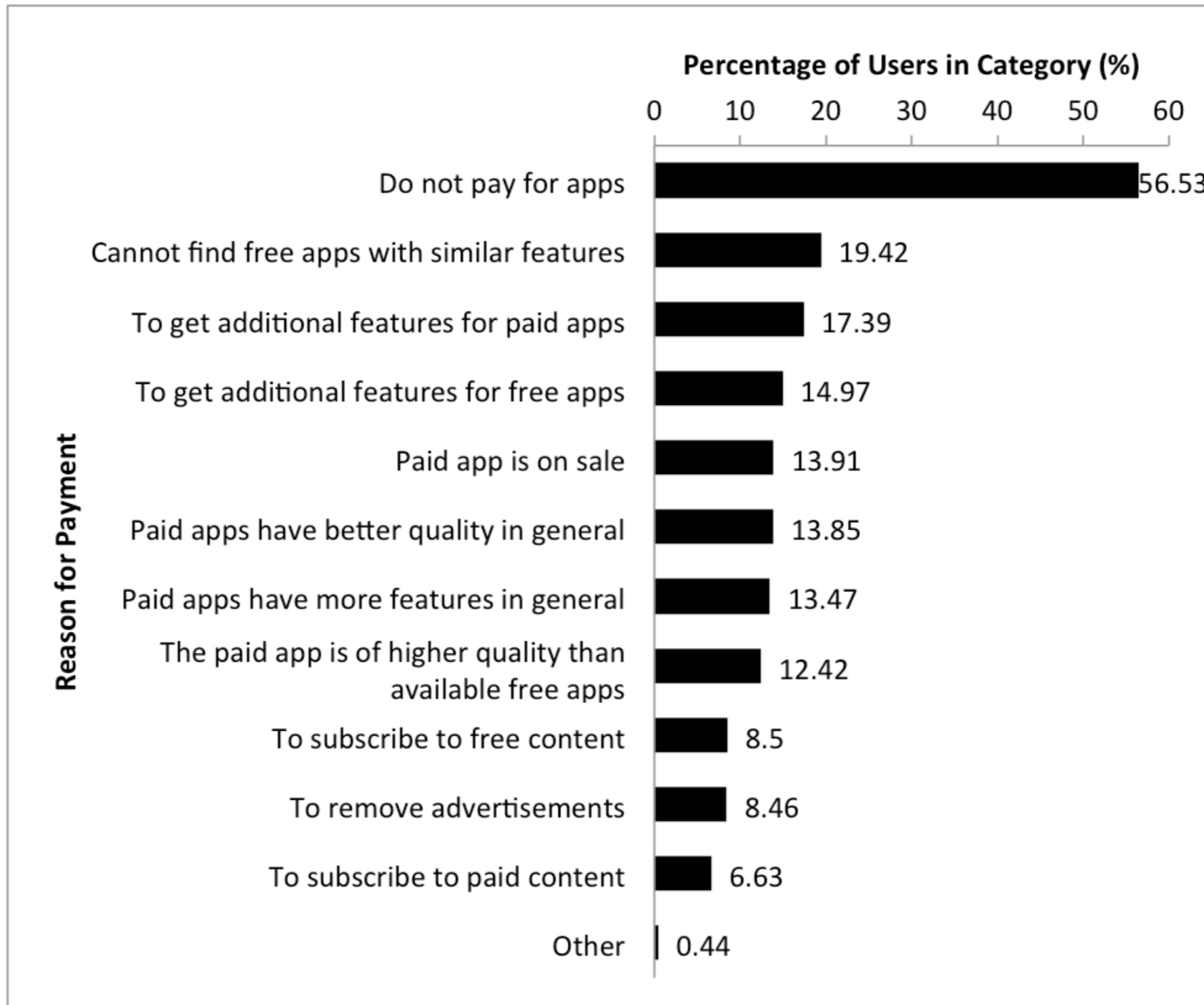
RQ3.1 Choice



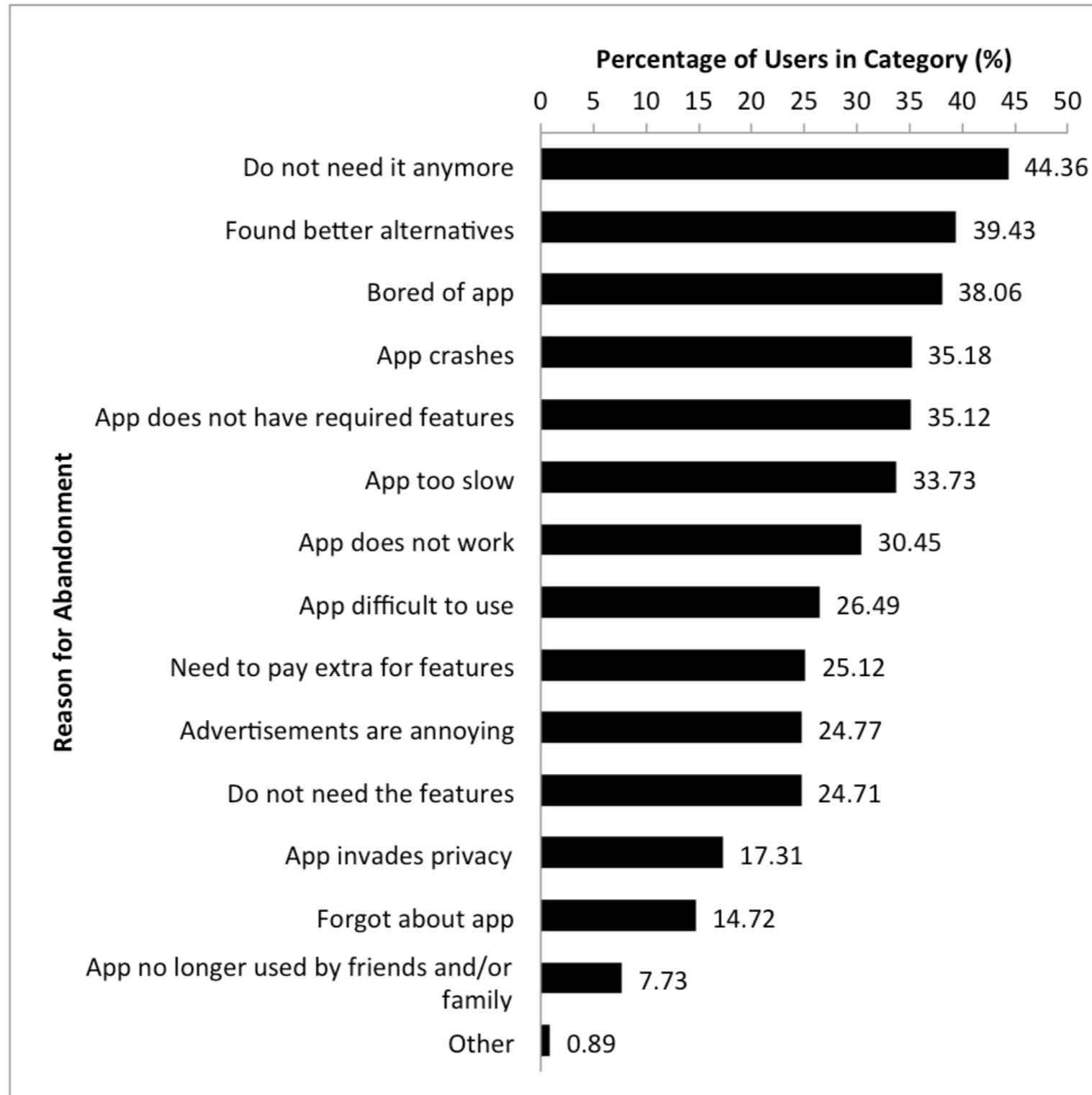
RQ3.2 Rating



RQ3.3 Payment



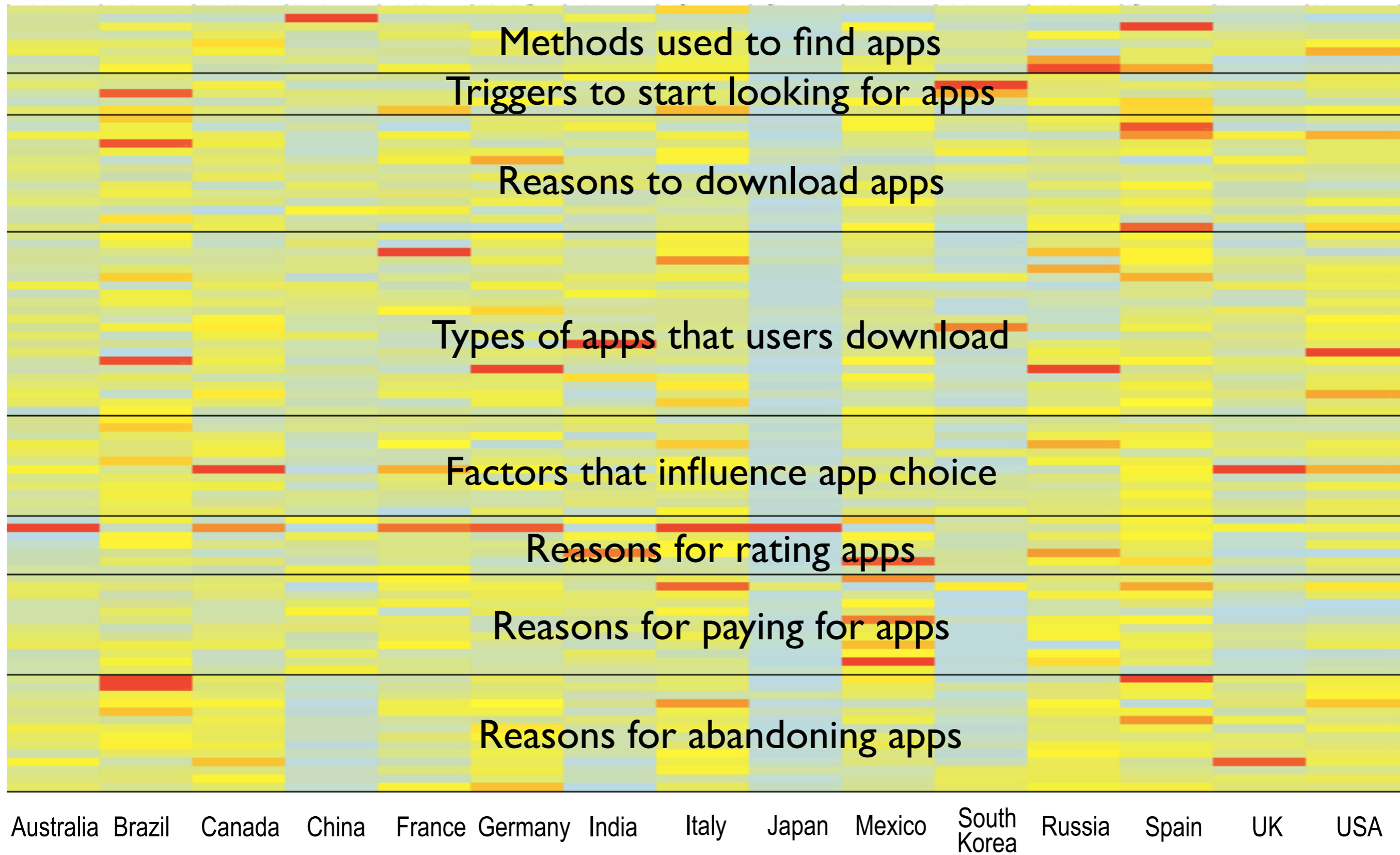
RQ3.4 Abandonment



RQ4 Country Differences

- Pearson's chi-squared test (χ^2)
 - Analyse whether there were significant differences across countries for all categorical variables
 - $p < 0.001 \Rightarrow$ significant difference
- Odds ratio
 - Measure the magnitude of the difference between each country and the other countries
 - Country C has an odds ratio of R for behaviour B \Rightarrow users from country C are R times more likely to exhibit behaviour B compared to users from the other countries

Heat Map of Odds Ratio per Variable



RQ4 Country Differences

<u>UK</u>	<p style="text-align: center;">UK</p> <p>App users are 3 times more likely than other countries to be influenced by price when choosing apps ($\chi^2 (1) = 54.12, p = .000$)</p> <p>App users are 3 times more likely than other countries to abandon an app because they had forgotten about it ($\chi^2 (1) = 52.65, p = .000$)</p> <p>App users are 3 times more likely than other countries not to rate apps ($\chi^2 (1) = 20.74, p = .000$)</p>
<u>Australia</u>	
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<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Australia</h2> <p>App users are 3 times more likely than other countries not to rate apps ($\chi^2 (1) = 47.47, p = .000$)</p> <p>App users are 2 times more likely than other countries to be influenced by price when choosing apps ($\chi^2 (1) = 14.24, p = .000$)</p> <p>App users are 2 times more likely than other countries to abandon an app because they had forgotten about it ($\chi^2 (1) = 9.95, p = .002$)</p>
<u>Australia</u>	
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<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Brazil</h2> <p>App users are 2 times more likely to stop using an app because it crashes ($\chi^2 (1) = 76.64$ $p = .000$)</p> <p>App users are 2 times more likely to stop using an app because it is slow ($\chi^2 (1) = 73.06$, $p = .000$)</p> <p>App users are 2 times more likely to download social networking apps ($\chi^2 (1) = 57.02$, $p = .000$)</p>
<u>Australia</u>	
<u>Brazil</u>	
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<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Canada</h2> <p>App users are 2 times more likely to be influenced by price when choosing apps ($\chi^2 (1) = 74.19, p = .000$)</p> <p>App users are 2 times more likely not to rate apps ($\chi^2 (1) = 53.18, p = .000$)</p> <p>App users are 2 times more likely to stop using an app because they had forgotten about it ($\chi^2 (1) = 29.8, p = .000$)</p>
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RQ4 Country Differences

<u>UK</u>	<h2>China</h2> <p>Users are 9 times more likely than other countries to select the first app on the list presented to them ($\chi^2 (1) = 541.92, p = .000$)</p> <p>Users are 6 times more likely than other countries to rate apps ($\chi^2 (1) = 278.4, p = .000$)</p> <p>Users are 6 times more likely than other countries to download apps that feature their favourite brands or celebrities ($\chi^2 (1) = 264.32, p = .000$)</p>
<u>Australia</u>	
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<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>France</h2> <p>App users are 2 times more likely to download catalogue apps ($\chi^2 (1) = 6.9, p = .009$)</p> <p>App users are 1.5 times more likely not to rate apps ($\chi^2 (1) = 7.93, p = .005$)</p> <p>App users are 1.3 times more likely to be influenced by price when choosing apps ($\chi^2 (1) = 3.89, p = .049$)</p>
<u>Australia</u>	
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<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Germany</h2> <p>App users are 2 times more likely than other countries to download reference apps ($\chi^2 (1) = 27.4, p = .000$)</p> <p>App users are 2 times more likely than other countries not to rate apps ($\chi^2 (1) = 30.4, p = .000$)</p> <p>App users are 2 times more likely than other countries to download apps out of impulse ($\chi^2 (1) = 9.82, p = .002$)</p>
<u>Australia</u>	
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RQ4 Country Differences

<u>UK</u>	<h2>India</h2> <p>App users are 3 times more likely than other countries to download education apps ($\chi^2 (1) = 119.46, p = .000$)</p> <p>App users are 3 times more likely than other countries to rate apps because someone asked them to do so ($\chi^2 (1) = 40.35, p = .000$)</p> <p>App users are 2 times more likely than other countries to download sports apps ($\chi^2 (1) = 56.11, p = .000$)</p>
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<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Italy</h2> <p>App users are 1.43 times more likely not to rate apps ($\chi^2 (1) = 7.6, p = .006$)</p> <p>App users are 1.30 times more likely not to pay for apps ($\chi^2 (1) = 3.94, p = .047$)</p> <p>App users are 1.21 times more likely to download travel apps ($\chi^2 (1) = 1.67, p = .196$)</p>
<u>Australia</u>	
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<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Japan</h2> <p>App users are 6 times more likely than other countries not to rate apps ($\chi^2 (1) = 100.78, p = .000$).</p> <p>App users are 2 times more likely than other countries not to pay for apps ($\chi^2 (1) = 26.34, p = .000$)</p> <p>App users are 1.4 times more likely to look for apps when they need to know something ($\chi^2 (1) = 4.7, p = .03$)</p>
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<u>Mexico</u>	
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<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Mexico</h2> <p>App users are 3 times more likely to pay for apps because they believe that paid apps have more features in general ($\chi^2 (1) = 45.15, p = .000$)</p> <p>App users are 2 times more likely to rate an app because they were asked by the app to do so ($\chi^2 (1) = 39.22, p = .000$)</p> <p>App users are 2 times more likely to pay for an app to get additional features for free apps ($\chi^2 (1) = 33.17, p = .000$)</p>
<u>Australia</u>	
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<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>South Korea</h2> <p>App users are 4 times more likely than other countries to look for apps when feeling bored ($\chi^2 (1) = 103.8, p = .000$)</p> <p>App users are 4 times more likely than other countries to download game apps ($\chi^2 (1) = 59.91, p = .000$)</p> <p>App users are 3 times more likely than other countries to look for apps when they want to be entertained ($\chi^2 (1) = 61.78, p = .000$)</p>
<u>Australia</u>	
<u>Brazil</u>	
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<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Russia</h2> <p>App users are 2.5 times more likely to download reference apps ($\chi^2 (1) = 35.6, p = .000$)</p> <p>App users are 2 times more likely to find apps using search engines ($\chi^2 (1) = 51.3, p = .000$)</p> <p>App users are 2 times more likely to rate apps because someone asked them to do so ($\chi^2 (1) = 11.62, p = .000$)</p>
<u>Australia</u>	
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<u>Russia</u>	
<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>Spain</h2> <p>App users are 1.6 times more likely to find apps by looking at the featured apps section of the app store ($\chi^2 (1) = 13.16, p = .000$)</p> <p>App users are 1.6 times more likely to stop using an app because it crashes ($\chi^2 (1) = 13.52, p = .000$)</p> <p>App users are 1.5 times more likely to download apps to interact with people they don't know ($\chi^2 (1) = 4.45, p = .035$)</p>
<u>Australia</u>	
<u>Brazil</u>	
<u>Canada</u>	
<u>China</u>	
<u>France</u>	
<u>Germany</u>	
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<u>Spain</u>	
<u>USA</u>	

RQ4 Country Differences

<u>UK</u>	<h2>USA</h2> <p>App users are 2 times more likely than other countries to download medical apps ($\chi^2 (1) = 21.51, p = .000$)</p> <p>App users are 2 times more likely than other countries to download weather apps ($\chi^2 (1) = 19.31, p = .000$)</p> <p>App users are 2 times more likely than other countries to be influenced by price when choosing apps ($\chi^2 (1) = 16.08, p = .000$)</p>
<u>Australia</u>	
<u>Brazil</u>	
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New Market-driven SE Challenges

- **App store dependency [RE]**

Traditional software can be sold via multiple channels. Apps can only be sold via the app store of the platform they are developed for. App store guidelines are frequently updated and vary across app stores (some are strict, e.g., App Gratis). App store guidelines are country specific (e.g., FDA). Developers need to consider app stores as important stakeholders.

- **Packaging requirements [RE]**

App description, screenshots, name, and icon have a large influence on the visibility & number of downloads. Traditionally met by marketing teams. Country specific (e.g., cuteness).

- **Vast feature spaces [RE]**

Traditional market-driven software offer large feature sets to meet all of the users' anticipated needs, add new features for new releases. Apps tend to have fewer features but with very frequent updates. Trends change fast. What are the optimal set of features, what to omit/include. Creative RE. Requirements prioritisation.

- **High quality expectations [NFR]**

App users have high expectations on usability and performance - unforgiving when an app fails to meet their expectations. Different countries have different level of tolerance.

- **Price sensitivity [SEE]**

Price influence app selection (57% do not pay for apps). Willingness to pay for apps depend on country (WhatsApp). Traditional software cost estimation techniques limited by lack of pricing data.

- **Ecosystem effect [SE]**

Traditionally, software vendors function as independent units, where performances are largely dependent on product features, reputation & marketing efforts (e.g., Microsoft, Norton). App stores have created a software ecosystem where developers are networked and their success/failure highly dependent on one another and on app users who can influence the sale of their apps.

Investigating Country Differences in Mobile App User Behavior and Challenges for Software Engineering

Soo Ling Lim, Peter J. Bentley, Natalie Kanakam, Fuyuki Ishikawa, and Shinichi Honiden

Abstract—Mobile applications (apps) are software developed for use on mobile devices and made available through app stores. App stores are highly competitive markets where developers need to cater to a large number of users spanning multiple countries. This work hypothesizes that there exist country differences in mobile app user behavior and conducts one of the largest surveys to date of app users across the world, in order to identify the precise nature of those differences. The survey investigated user adoption of the app store concept, app needs, and rationale for selecting or abandoning an app. We collected data from more than 15 countries, including USA, China, Japan, Germany, France, Brazil, UK, Italy, Russia, India, Canada, Spain, Australia, Mexico, and South Korea. Analysis of data provided by 4,824 participants showed significant differences in app user behaviors across countries, for example users from USA are more likely to download medical apps, users from UK and Canada are more likely to be influenced by price, users from Japan and Australia are less likely to rate apps. Analysis of the results revealed new challenges to market-driven software engineering related to packaging requirements, feature space, quality expectations, app store dependency, price sensitivity, and ecosystem effect.

Index Terms— Requirements/specifications, market-driven software engineering, mobile application development, user requirements, survey research, app user behavior, software product lines, software ecosystems.

1 INTRODUCTION

MOBILE apps are software applications developed for use on mobile devices such as smartphones and tablets. Once developed, an app is sold via an application distribution platform, commonly known as an app store. App development is market-driven. Similar to traditional market-driven software [1, 2], the requirements for an app are usually derived from strategic business goals or from market opportunities. During the development of an app, developers have limited contact with potential users. Success is measured by the number of downloads and revenues generated from the app. The app store concept has democratized the software industry – almost anyone can build and sell apps to a worldwide population of users via app stores.

The benefits of app stores come with significant challenges. App developers face a crowded and highly competitive app market, and as a result, an app can fail (receive little or no downloads) due to features unrelated to its functionality and usability, such as app name, app icon or level of exposure. As the profit margins from app sales

are small (Section 1.2), an app should ideally appeal to a large number of users worldwide in order to be successful. However, many developers are unaware that users from different countries have different behavior and needs, and that these factors affect app downloads¹. There is also a lack of awareness about the importance of features such as app description, screenshots, pricing, and user feedback. These challenges have caused many apps to fail. Studies have found that 400,000 out of 600,000 apps in the iOS App Store have no downloads², and 80% of paid Android apps received less than 100 downloads [3].

Despite these failures, app development continues to accelerate worldwide. Market-driven software engineering has been studied in the past [4-6], but today researchers are increasingly focusing on the new opportunities and challenges of app development. Recent studies have made advances in our understanding of app user behaviors through mining app store data, gathering user activity logs and surveys (e.g., [7-9]). These provide useful data relating to specific smartphones, app stores, apps, app categories (e.g., medical apps), countries, or age groups. However to date there has been little research that studies global user behaviors in different app stores and mobile devices, comparing across countries. In this work we

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¹ <http://www.guardian.co.uk/technology/appsblog/2012/dec/04/ios-android-revenues-downloads-country>
² <http://www.pcmag.com/news/mobile-phone/3373458/400000-ios-app-store-apps-have-no-downloads/>

SL Lim, P Bentley, N Kanakam, F Ishikawa, and S Honiden (2014). Investigating Country Differences in Mobile App User Behaviour and Challenges for Software Engineering. *IEEE Transactions on Software Engineering*, in press.

http://www.cs.ucl.ac.uk/research/app_user_survey/



Secrets of App Store revealed by artificial life forms

Modelling Apple's App Store marketplace as an ecosystem reveals what makes it thrive and which apps are likely to sell

IT IS easy to get rich as a developer on Apple's App Store - just build an app that mimics a bestseller. So why doesn't everyone get in on the act? Because the ploy ends up killing interest in the store entirely, according to researchers who built a simulation of the store to see what makes it tick.

[Apple's thriving marketplace](#) of well over 500,000 apps for the iPad, iPhone and iPod touch is a self-regulating ecosystem that doesn't tolerate copycats, say [Soo Ling Lim](#) and [Peter Bentley](#) at University College London, who modelled activity on the App Store.

Since Apple releases very little data associated with App Store interactions, Lim and Bentley built the next best thing - an "artificial life" simulation of the store. Named AppEco, it uses bits of software that obey unique behavioural rules to mimic apps, developers and consumers.

The simulation mimics four types of developer the team labelled innovators, optimisers, milkers and copycats. The copycats found it easy to make money -



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