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Analytical study of the COVID apps users' perception about data security and privacy

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Analytical Study regarding Users' Perception of COVID Apps

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ABSTRACT

COVID-19 pandemic has impacted many across the globe. Mobile tracing and exposure apps have been used to mitigate the problem and curb the spread of the virus. Wide exposure of the apps is in need for them to be effective. However, concerns about factors like data privacy and security affect users' perception and participation in them. In this study, our goal is to investigate how information privacy and security may impact users' ratings of COVID-19 apps. In addition, we explore how political typology also influences the ratings. We considered 31 apps related to COVID-19 exposure and tracing in the United States. From these apps, we managed to scrape data related to 29 from Google play digital store and extracted 1,832 reviews. After analyzing the user reviews our preliminary findings show that the polarity and subjectivity of the review are significantly associated with the reviewers' apps ratings. Interestingly, we find this relationship intensifies when security and privacy issues are addressed in the reviews. In addition, we find that political ideology plays a significant role in how users rate COVID apps. The findings of this research have implications for both theory and practice.

Keywords: COVID-19 Apps, COVID-19 Tracking, COVID-19 Exposure, Apps Privacy, Apps Security, Political typology, Apps reviews.

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INTRODUCTION

Mobile technologies have been increasingly adopted across different fields (e.g., healthcare, marketing, finance). These technologies contributed to rapid development in the mobile apps market that raises opportunities for apps developers, platform providers, healthcare institutions, and related government agencies. In the COVID-19 era, mobile apps can help healthcare authorities and governments gather data to monitor and curb the spread of the pandemic (Wen et al. 2020). However, there are some concerns related to the privacy and security of sharing personal information that may result in cybersecurity incidents (Juma'h and Alnsour 2021). Such suggests the need for further empirical research to address the issues of information privacy and security (Gangaiamaran and Pasupathi 2017). These concerns are relevant to healthcare apps, in particular, the COVID-19 exposure and tracing apps. In this research in progress, we aim to study the relation between COVID-19 apps data privacy and security and users' ratings.

To our knowledge and based on our review of the current literature, until now, a very limited number of empirical studies have addressed the relationship between the use of COVID-19 apps and information privacy and security from the user's perspective. Our study addresses this gap. Also, we extend the study by examining the relationship between the state political typology and the users' perceptions of COVID-19 apps. This paper is organized as follows: the next section presents the theoretical background and hypothesis development, followed by data collection and methodology, results, and finally, the main conclusions, limitations, and suggestions for further research.

THEORETICAL BACKGROUND & HYPOTHESIS DEVELOPMENT

Westin (1967) defined information privacy as the ability of individuals to determine and control the level of information that is revealed or communicated to others. Healthcare authorities and agencies are using contact tracing to identify people who may have contacted an exposed other individual. COVID-19 exposure detection apps can provide authorities with data that can be used to control the spread of disease (Wen et al. 2020). Luna et al. (2014) state that wider acceptance of mobile service apps will require a renovation of the current service IT structure, which in turn will require investments in both public and private sectors geared towards increased integration of internal and external hardware and software systems without compromising user privacy. Thus, successful development and deployment of mobile apps require continued investment and development through a necessary consideration of the effects of perceived security and privacy levels of provided services on users.

Apps can improve the efficiency of healthcare services. To enhance capabilities and the usage of the apps, developers often include new functionalities before they are fully being developed or tested, which are risking the security and privacy of the users of apps. Such practices often concern the users and may potentially lead them to gain negative impressions about the apps and lower the potential for continual use (Tuch et al. 2012; Wu et al. 2011). The lack of secure integration and interoperability with other related information systems are posing significant barriers to widespread mobile apps' usage and adoption (Dehzad et al. 2014). Concerns about personal data are among the most common reasons why some mobile device users avoid downloading mobile apps requiring access to personal data. In the case of healthcare apps, there is a degree of lack of interest on the part of both patients and healthcare providers to embrace apps because of concerns over security and privacy issues (Cho et al. 2020). Utz et al.

(2021) conducted a survey in Germany, China, and the US to study user acceptance of corona apps. They found that Chinese participants prefer the collection of personalized data, while German and US participants favor anonymity.

There have been several studies that examined user reviews in areas like movies (Joshi et al. 2010), food and beverage (Chahuneau et al. 2012), retail (Archak et al. 2011), and healthcare that is focused on the apps content rather than user reviews and feedback (Fu et al., 2013). Analyzing users' reviews and feedback help us to understand better how users perceive apps. For example, Finkelstein et al. (2014) used data mining to investigate the effects of the reviews on apps downloads and found a positive relationship between the number of positive reviews and downloads. The researchers also found a correlation between positive reviews and apps ratings. The performance of apps is reflected in the user ratings (Irick 2008). Rating and reviews affect the subsequent adoption and success of an application in the digital marketplace (Pagano and Maalej 2013). Apps that are low in ratings will not survive in the marketplace, while apps that have high ratings and good reviews will be in a better position to attract new users and gain a larger share of the market (Fu et al. 2013; Pagano and Maalej 2013). For example, Li et al. (2020) state that contact tracing apps have potential benefits in helping health authorities to control the spread of COVID-19, but the effectiveness of the apps is related to their installation rate that can be influenced by people's perceptions regarding the usefulness of the apps in the presence of privacy concerns. Understanding how the perceived level of security and privacy affects the rating of apps remains relevant to both practice and research. Thus, we hypothesize:

H1: The perception of information security and privacy influences user's app rating

H2: Political typology influence user's app rating

DATA COLLECTION AND METHODOLOGY

We found 31 apps related to COVID-19 tracing and exposure in the United States. Two of the apps at the point of this study didn't have any reviews, thus we scraped the data for 29 apps from the Google Play Digital Store. The total number of reviews was 1,832. We filtered the comments that were in the English language, longer than 3 words, and mentioned keywords related to data privacy or security. The final sample consists of 537 reviews. In the Appendix, we provide examples of COVID-19 apps used in this study. Figure 1 displays a word cloud that shows the most repeated keywords. Negative and positive sentences count for 56.3% and 15.6%, respectively as shown in Figure 2. These results are consistent with reviewers' concerns regarding COVID-19 apps.

Figure 1. Comments word cloud after excluding stop words

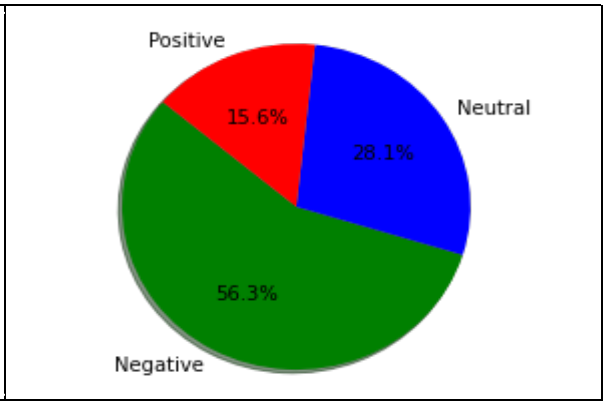

Figure 2. Sentiment distribution in comments related to security and privacy

Table 1 presents the definitions of the key variables that we used to analyze reviewers' perceptions of using COVID-19 apps. Also, as noted in Table 2, the comment rating is slightly above the average; this result indicates that users are still not comfortable in using COVID-19 apps.

Table 1. Description of key variables

Variables	Description
Comment App Rating	The rating of the app posted by the app user on the digital market ranges from one to five stars
Comment Polarity	A continuous variable that represents the comment polarity; ranges from a sentiment of negative one to a sentiment of the positive one
Comment Subjectivity	A continuous variable that represents the comment subjectivity ranges

Variables	Description
	from zero to a positive one
Comment length	The total number of characters in each comment
Comment punctuation	The use of marks and signs to separate words and clarify the meaning
Blue state	If the state that is providing the app has voted democrat in the last election the value is 0 otherwise it is 1
App Rating	The average of all ratings of the app in the digital market (app store)
Number of ratings	Total number of app ratings in the app store
App size (MB)	The current app size in megabytes
App installs	Total number of app downloads in the app store
Current App version	The current app version (1, 2, 3, …)
Required Android Version	The minimum required Android version

Table 2. Descriptive statistics of key variables

Variable	Observation	Mean	Std. Dev.	Min	Max
User Rating	1,832	2.630	1.680	1	5
Comment Sentiment	1,832	0.085	0.271	-1	1
Comment Subjectivity	1,832	0.448	0.256	0	1
Comment length	1,832	273.56	240.764	12	1,384
Comment Punctuation	1,832	3.806	3.568	0	100
Blue state	1,832	0.218	0.413	0	1
App Rating (over all)	1,832	3.663	0.281	3	4.5
Number of ratings	1,832	681.86	565.539	54	2042
App size (MB)	1,832	37.23	37.167	3.1	106
App installs	1,832	172,658.4	228892.7	100	1,000,000
Current App version	1,832	1.29	0.745	1	4
Required Android Version	1,832	5.763	0.739	5	8

PRELIMINARY RESULTS

Table 3 presents the regression results. The user rating has a significant and positive relationship with the user comment's sentiment and subjectivity across the different samples (See Model 1, 2, and 3). Yet we notice that the polarity effect increases from 2.220 in Model 1 to 3.686 in Model 3 (1.466 stars out of 5 total stars per rating). Such results indicate that information security and privacy measures augment the comment polarity effect on the user app rating.

Table 3. Regression results for key variables.

	(1)	(2)	(3)
VARIABLES	User Individual Rating[1]	User Individual Rating[2]	User Individual Rating[3]
Comment Polarity	2.220***	2.329***	3.686***
	(0.134)	(0.283)	(0.655)
Comment Subjectivity	0.637***	1.194***	1.862**
	(0.144)	(0.292)	(0.777)
Blue State	0.225**	0.714***	1.110***
	(0.089)	(0.167)	(0.361)

VARIABLES	(1) User Individual Rating[1]	(2) User Individual Rating[2]	(3) User Individual Rating[3]
Control Variables	Included	Included	Included
Observations	1,806	534	140
R-squared	0.203	0.239	0.351

1: The rating for all comments, 2: The rating for comments that mentioned location sharing or enabling Bluetooth, 3: The rating for comments that allude to the app's information privacy or security aspects.
Standard errors in parentheses; * p<0.01, ** p<0.05, * p<0.1

An interesting finding is related to the political typology of the app providing state has a significant impact on the user rating. We find that across the different models in table 4, users from blue states have app ratings higher than other states. The effect seems to be clearer when the comment discusses a matter related to information security and privacy (Model 1, Beta = 0.225 vs. Model 3, Beta = 1.110).

FINAL REMARKS

The primary results show the importance of privacy and security concerns of apps users. Therefore, we anticipate more research to be realized to address this issue. Also, we suggest future research to address the government and cultural effects of using COVID-19 Apps.

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APPENDIX: Related tables

Table A1. Correlation among key variables

Variable	1	2	3	4	5	6	7	8	9	10
Comment rating	1.000									
Sentiment	0.420	1.000								
Subjectivity	0.161	0.192	1.000							
Comment length	-0.075	-0.052	0.145	1.000						
Punctuation percentage	-0.039	-0.040	-0.064	-0.019	1.000					
App Rating	0.229	0.105	0.004	-0.230	-0.005	1.000				
Number of ratings	-0.063	-0.063	0.069	0.384	-0.027	-0.127	1.000			
App size (MB)	0.078	0.033	0.036	-0.039	0.012	0.250	0.244	1.000		
App installs	0.001	-0.030	0.012	0.207	-0.017	0.167	0.781	0.133	1.000	
App installs	-0.119	-0.039	-0.013	-0.025	-0.004	-0.376	-0.139	-0.157	-0.127	1.000
Android version	-0.103	-0.041	0.009	0.040	0.012	-0.379	0.022	0.269	-0.141	0.605

Table A2. Regression results.

VARIABLES	Model 1 User Rating[1]	Model 2 User Rating[2]	Model 3 User Rating[3]
Comment Polarity	2.220***	2.329***	3.686***
	(0.134)	(0.283)	(0.655)
Comment Subjectivity	0.637***	1.194***	1.862**
	(0.144)	(0.292)	(0.777)
Blue State	0.225**	0.714***	1.110***
	(0.089)	(0.167)	(0.361)
Comment length	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)
Comment Punctuation	-0.011	-0.071	-0.088
	(0.010)	(0.039)	(0.088)
App Rating	0.838*	-0.131	-0.425
	(0.188)	(0.317)	(0.719)
Number of ratings	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
App size (MB)	0.001	-0.001	-0.003
	(0.001)	(0.002)	(0.004)
App installs	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Current App version	-0.084	0.018	0.012
	(0.068)	(0.109)	(0.345)
Required Android Version	-0.043	-0.319**	-0.403
	(0.076)	(0.126)	(0.341)
Constant	-0.401	4.338***	5.984*
	(0.901)	(1.459)	(3.604)
Observations	1,806	534	140
R-squared	0.203	0.239	0.351

1: The rating for all comments, 2: The rating for comments that mentioned location sharing or enabling Bluetooth, 3: The rating for comments that allude to the app's information privacy or security aspects.
Standard errors in parentheses; * p<0.01, ** p<0.05, * p<0.1

Table A3. List of scraped COVID-19 apps.

App Name	Category	Provider	State
AlohaSafe Alert	Health & Fitness	Hawaii Department of Health	Hawaii
CA Notify	Medical	CA Dept of Technology	California

App Name	Category	Provider	State
Care19 Diary	Medical	ProudCrowd, LLC	North Dakota
Care19 Diary	Medical	ProudCrowd, LLC	South Dakota
Care19 Diary	Medical	ProudCrowd, LLC	Wyoming
CO Exposure Notifications	Medical	Colorado Department of Public Health & Environment	Colorado
CombatCOVID PBC	Health & Fitness	Palm Beach County BoCC	Palm Beach
COVID Alert CT	Medical	CT Department of Public Health	Connecticut
Covid Alert DE	Medical	Delaware Department of Health and Social Services	Delaware
COVID Alert NJ	Health & Fitness	State of New Jersey Applications	New Jersey
COVID Alert NY	Health & Fitness	New York State Department of Health	New York
COVID Alert PA	Medical	Commonwealth of Pennsylvania	Pennsylvania
COVID Defense	Health & Fitness	State of Louisiana	Louisiana
Covid Trace Nevada	Medical	Nevada Division of Public and Behavioral Health	Nevada
Covid Watch Arizona	Medical	ADHS-Arizona Department of Health Services	Arizona
COVIDaware MN	Tools	State of Minnesota	Minnesota
COVIDWISE	Health & Fitness	VDH	Virginia
Crush Covid RI	Health & Fitness	State of Rhode Island	Rhode Island
DC CAN	Medical	DC Exposure Notifications	D.C.
Guam Covid Alert	Health & Fitness	Otech Developer	Guam
GuideSafe	Medical	Alabama Department of Public Health	Alabama
MD COVID Alert	Medical	Maryland Department of Health	Maryland
MI COVID Alert	Health & Fitness	State of Michigan	Michigan
NM Notify	Medical	NM DOH	New Mexico
Rastrea el Virus	Health & Fitness	Puerto Rico Science, Technology & Research Trust	Puerto Rico
SlowCovidNC	Health & Fitness	NC Department of Health and Human Services	North Carolina
UT Exposure Notifications	Medical	Utah Department of Health	Utah
WA Notify	Washington	Washington State Department of Health	Washington
WI Exposure Notification	Medical	State of Wisconsin - Department of Health Services	Wisconsin