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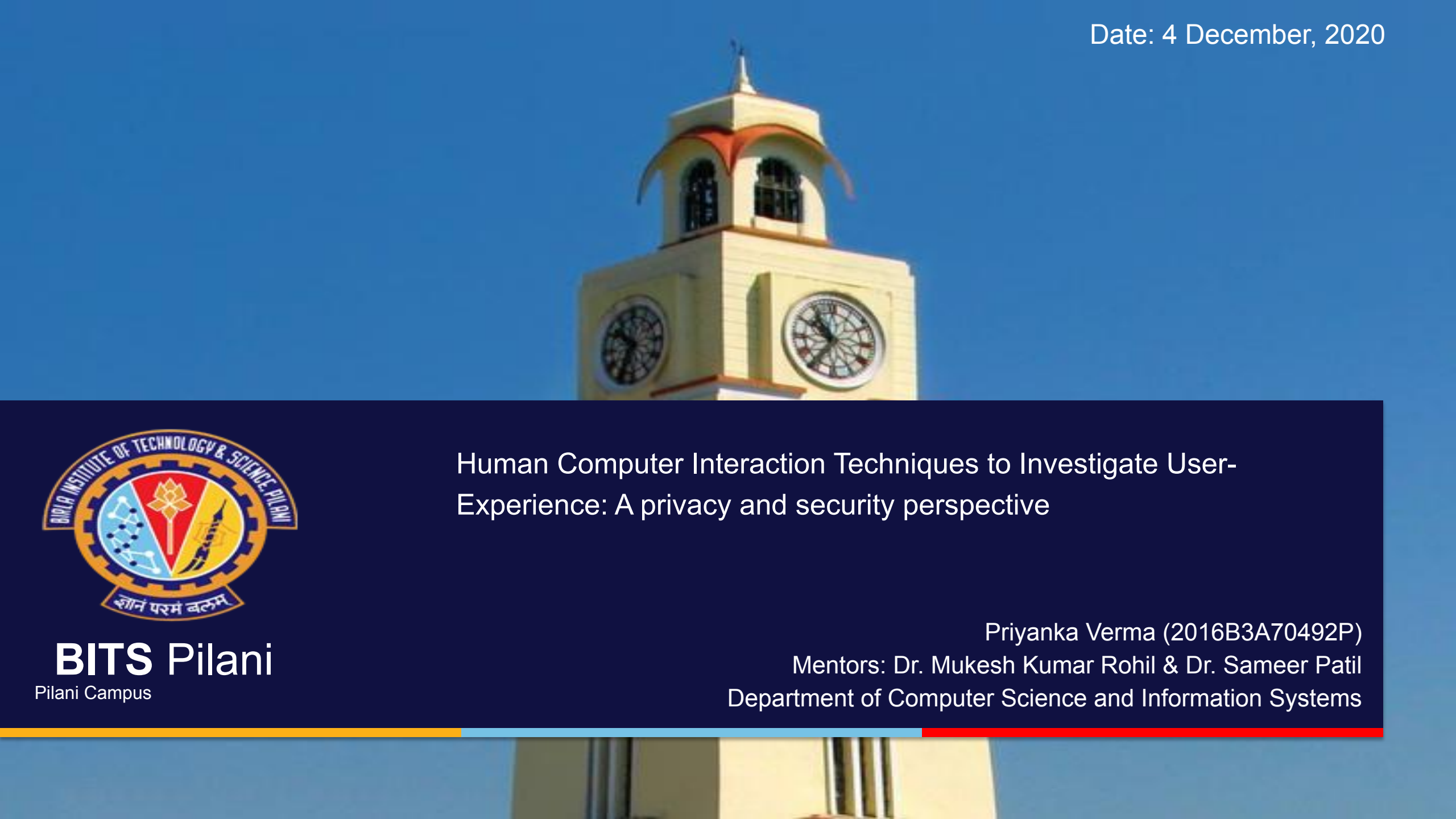

Human Computer Interaction Techniques to Investigate User-Experience: A privacy and security perspective

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Introduction

Notification has been defined as a visual cue, auditory signal, or haptic alert generated by an application or service that relays information to a user outside of the current focus of attention.[1]

Notifications form an integral part of smartphones

- dozens or hundreds of notifications per day
- key role in delivering information about updates, warnings, reminders and various events

Costs

- During device sharing uncomfortable situations could arise
- Also, notifications may be visible to a large crowd when a personal device is casted to a projection screen during a presentation
- Costs associated:
  - Anxiety and increased stress
  - Interrupt important tasks and workflow
  - Privacy costs

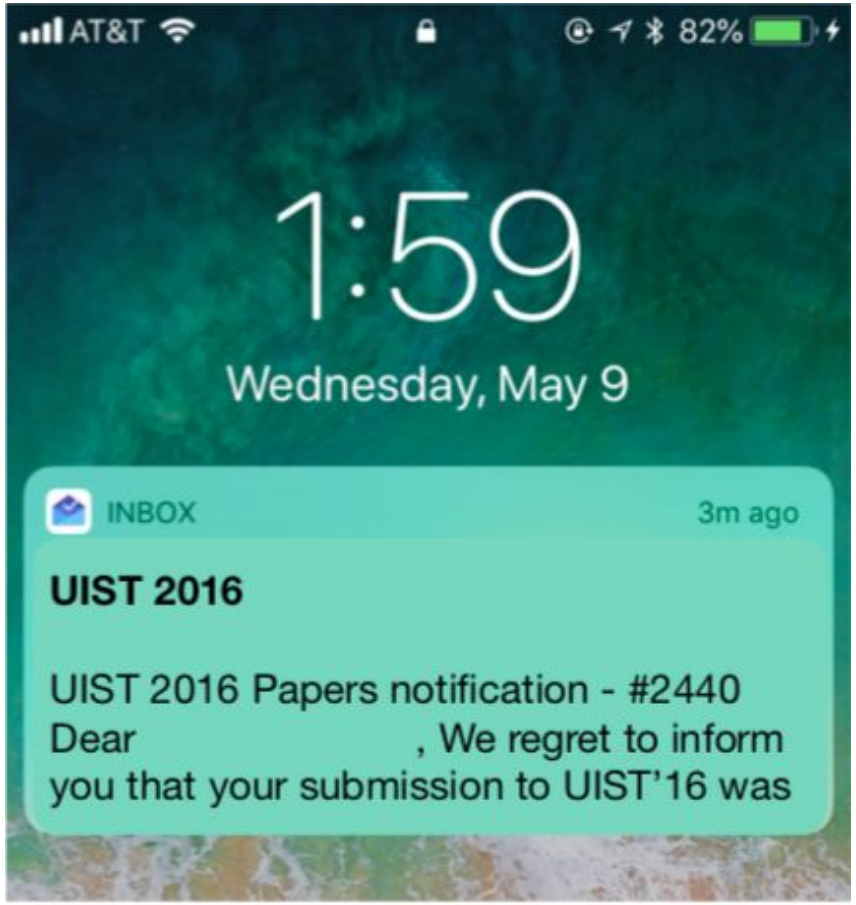


Figure 1
Source: Yongsung Kim, Adam Fourney, and Ece Kamar. 2019.

[1] [Iqbal, S. T., and Horvitz, E. Notifications and awareness: a field study of alert usage and preferences. In *Proc. CSCW* (2010).]

Privacy Definition

- is of highly contextual and nuanced nature.
- Altman[1] states different aspects of Individual privacy concerns are connected to the ``interplay of people, their social world, the physical environment, and the temporal nature of social phenomena".
- Westin[2] describes four states of privacy: Solitude, Intimacy, Anonymity, and Reserve. As summarized by Margulis[3]:
  - Solitude is being free from observation by others.
  - Intimacy refers to small group seclusion to achieve a close, relaxed, frank relationship among group members.
  - Anonymity provides freedom from identification and from surveillance in public places and for public acts.
  - Reserve is based on the desire to limit disclosures to others.
- Solove[4] has described how everyday activities are connected conceptual characterizations of privacy such as:
  - `intrusion' of solitude: ``intrusion involves invasions or incursions into one's life. It disturbs the victim's daily activities, alters her routines, destroys her solitude, and often makes her feel uncomfortable and uneasy" (p.549).
  - Digital intrusions, such as spam, telemarketing, unwanted or inopportune notifications, etc., violate privacy by disrupting solitude, interrupting ongoing activities, and creating discomfort much the same as intrusions experienced in physical spaces.

[1] Irwin Altman. 1975. The environment and social behavior: privacy, personal space, territory, and crowding. (1975).

[2] Alan F Westin. 1968. Privacy and freedom. Washington and Lee Law Review 25, 1 (1968), 166.

[3] Stephen T Margulis. 2011. Three theories of privacy: An overview. Privacy online (2011), 9–17.

[4] Daniel J Solove. 2006. A Taxonomy of Privacy. University of Pennsylvania Law Review 154, 3 (2006), 477.

Do notifications become a concern for users in the context of privacy? If so, how often do users face negative experiences due to notifications users?

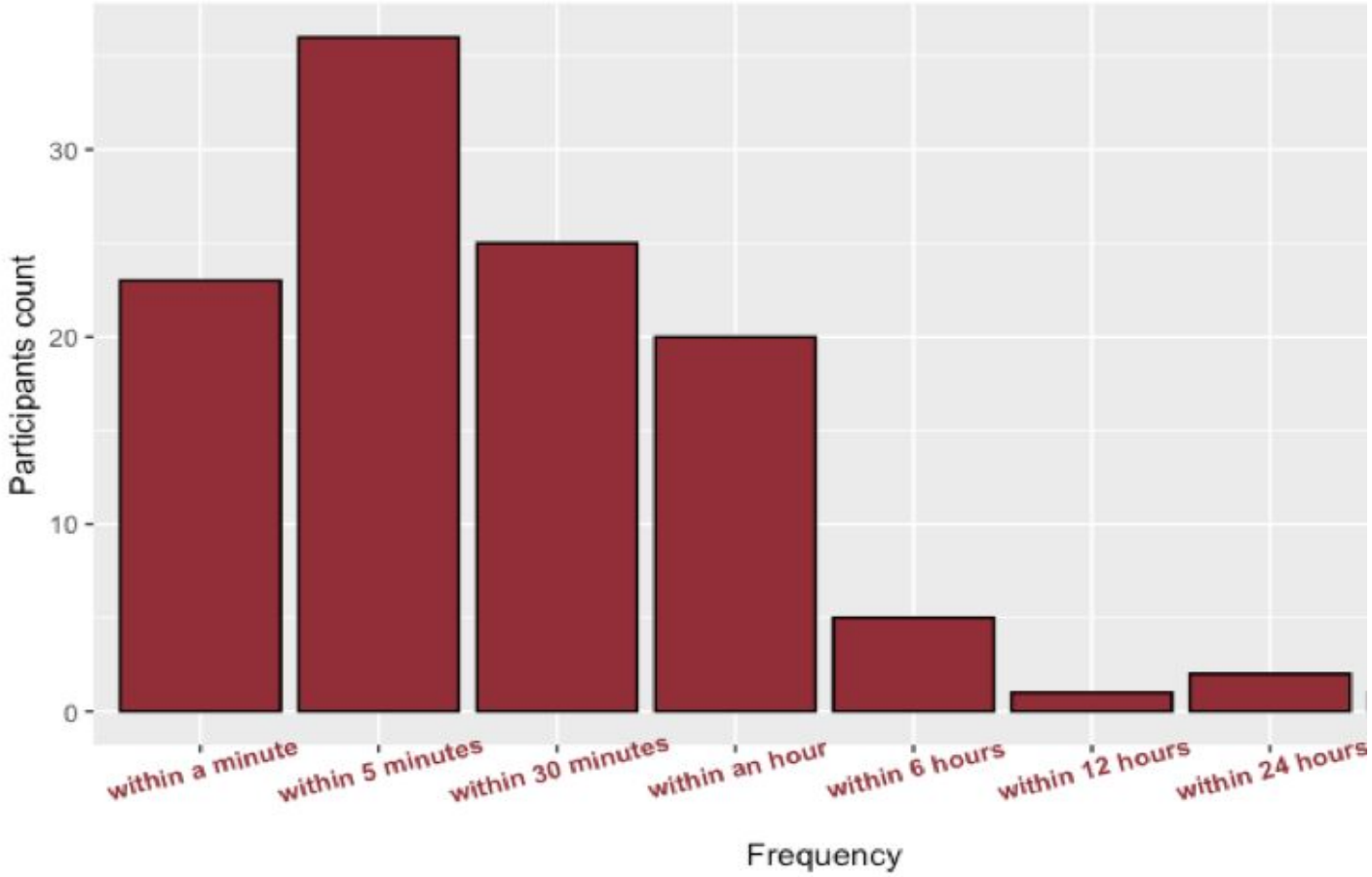
User Interactions with Notifications

95.78\% (N = 175) of the users mentioned that they received at least one notification in the last one hour of taking the survey.

Q1 "How quickly did you address the notification after you first saw it?"

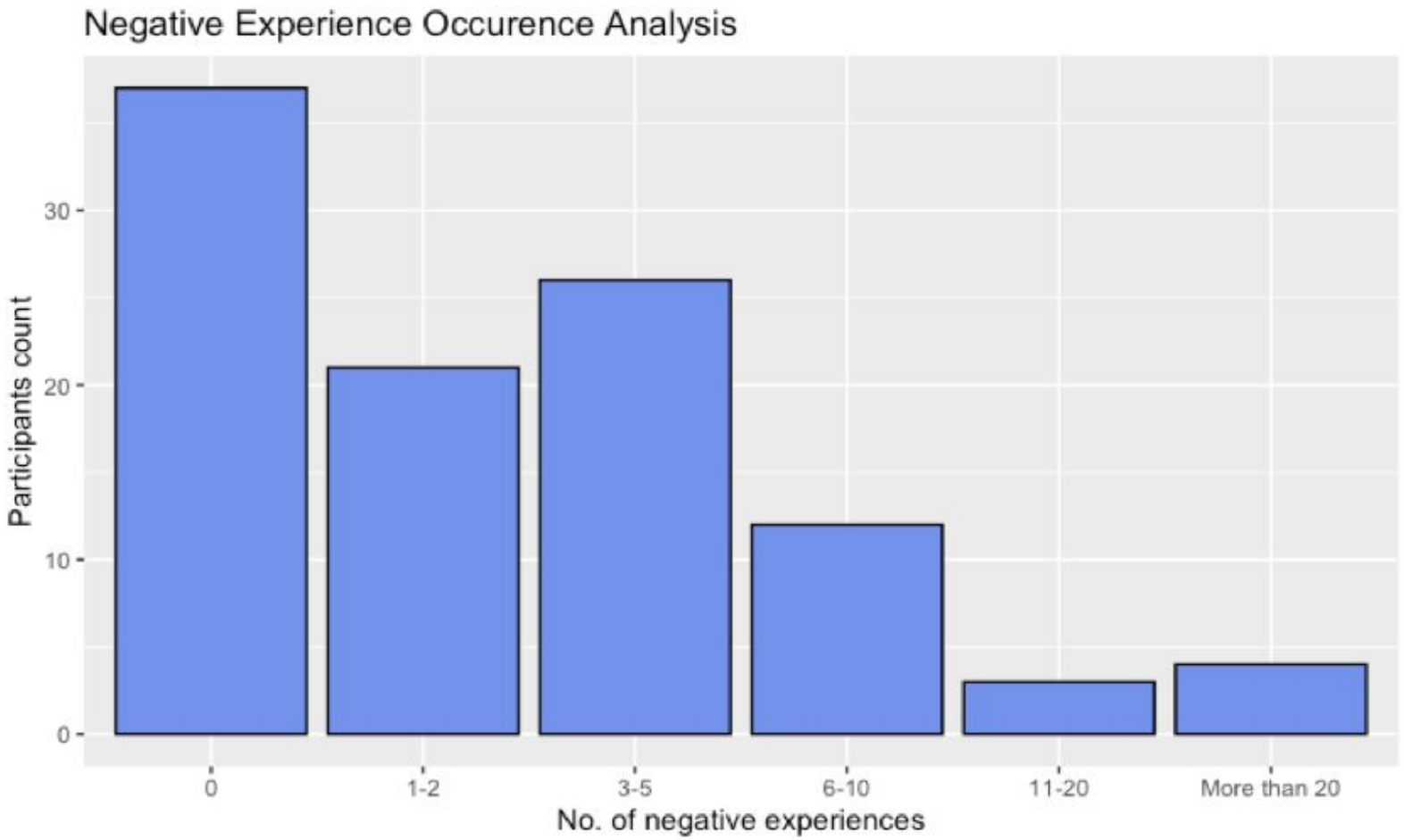
Q2 : Which App sent the notification?

- Diverse apps like social media, instant messaging, Productivity Apps (Trello, Zoom), Financial Apps, Entertainment Apps, Personal Care Apps (Bed Bath and Beyond), News and others like Famisafe,notification bubbles, Learning Genie, Mixpanel, Nugapp



60.0 \% (N = 111) of the users picked up their phone at least once in 30 minutes to check, clear, or address notifications

RQ1: Do notifications become a concern for users in the context of privacy? If so, how much and how often can notifications be a cause of negative experience for users?



64.08\% (N = 67) of the respondents reported facing at least one negative experience in their life due to their smartphone notifications.

User Concerns

Intrusion:

- “One time i clicked the link on the notification received without studying in details resulted phone **affected with virus**”.
- “Group chats are always **annoying** and they send a lot of notifications. It is **distracting** and **irritating** especially when you’re busy. Also, some of the apps frequently send notifications and it’s frustrating that I can not customize them”.
- “My notification for Blink, Amazon’s camera security service, kept going off due to movement and it was **distracting**”.
- "Negative experiences mostly had to do with **notifications waking me up in the middle of the night** with a ping and screen".

Unintended information disclosures:

- I was texting something personal with my hubby, suddenly when i was with my colleague it popped up and the person read out, it was a negative experience”.
- "It was a **private message** on Instagram and I did not want my partner to see it".
- "I forgot to clear the notification and my spouse saw some secret messages."
- "One of my friends read a message that was about her, and it made her upset".
- “Business Information watched by stranger”

Concerns for shared use:

- "When I was working on something for work where i had to **cast my device screen** for others to see. The notification was highly personal".
- "I had **given my phone** to my friend when the notification arrived. in that time, I left the phone screen unlocked and also I forgot to take the appropriate actions to silence the notifications."
- “I was **watching a video with a younger cousin and the notification popped** up.”

Concern for content from different types of apps

How does app category determine content sensitivity?

Que1: "How concerned would you be if a **family member reads the content of a notification** from each of the app categories listed below?"

Que2: "How concerned would you be if a **colleague reads the content of a notification** from each of the app categories listed below?"

App categories:
Instant Messaging
Social Media
Calendar
E-mail
Banking and Payments
Health and fitness
Dating.

Concern for notification content

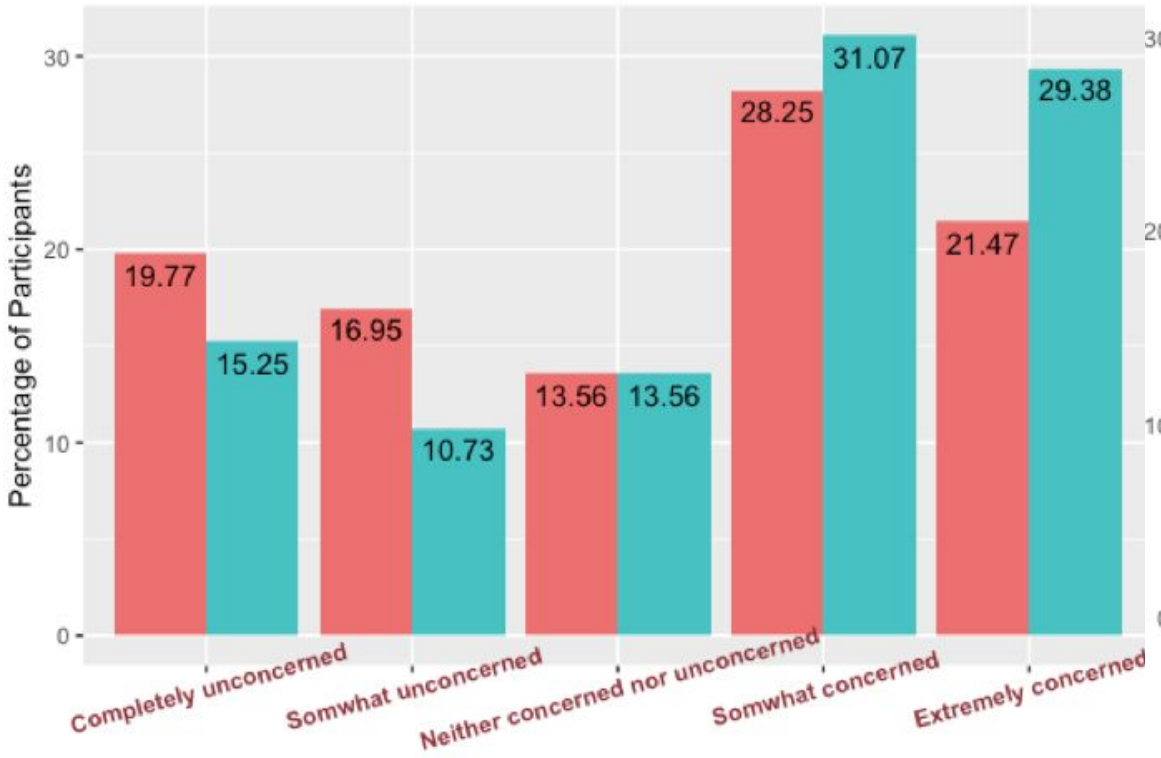


Figure 1: Instant Messaging Apps
seen somewhat sensitive or extremely sensitive by 49.72% and 60.45% of the respondents in context of family members and colleagues.

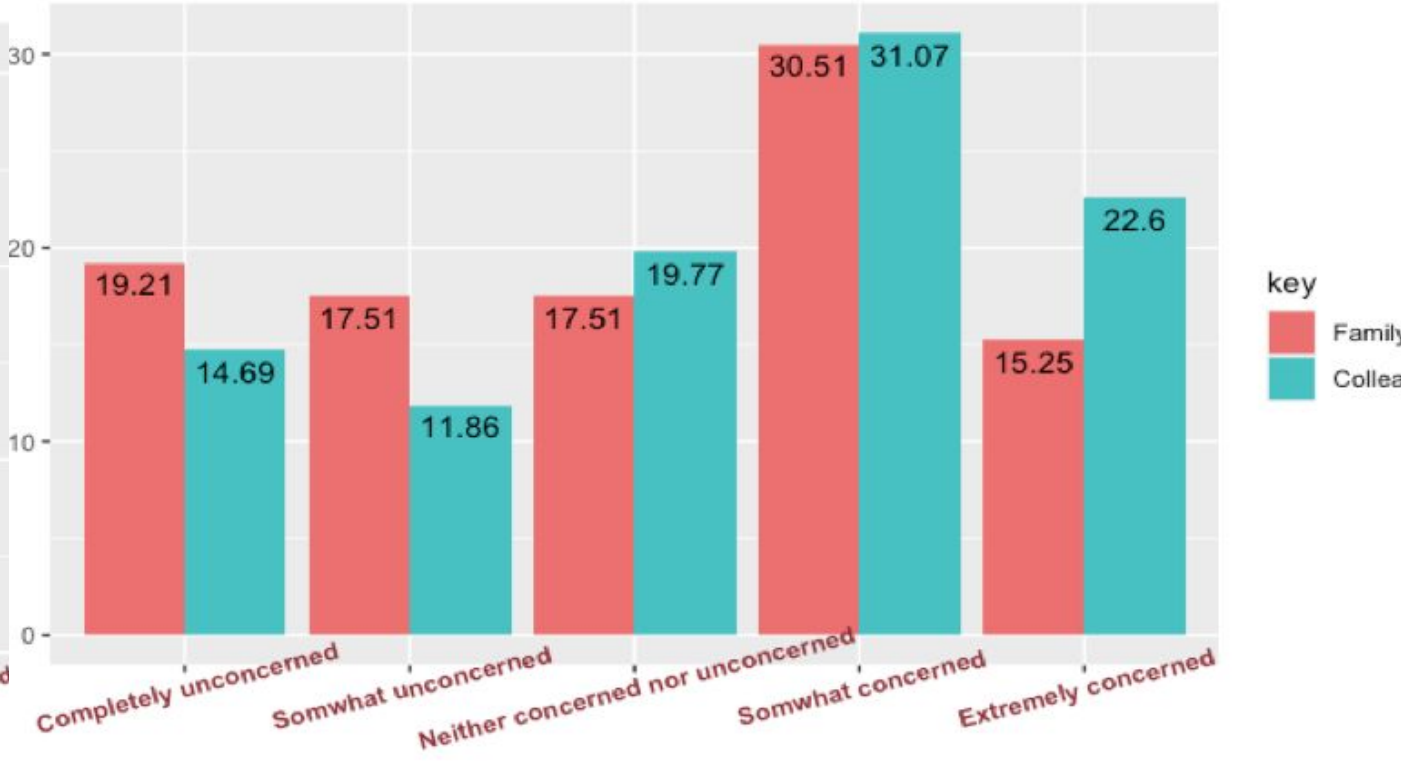


Figure 2: Social Media Apps
seen somewhat sensitive or extremely sensitive by 45.75% and 53.67% of the respondents in context of family members and colleagues.

Concern for notification content

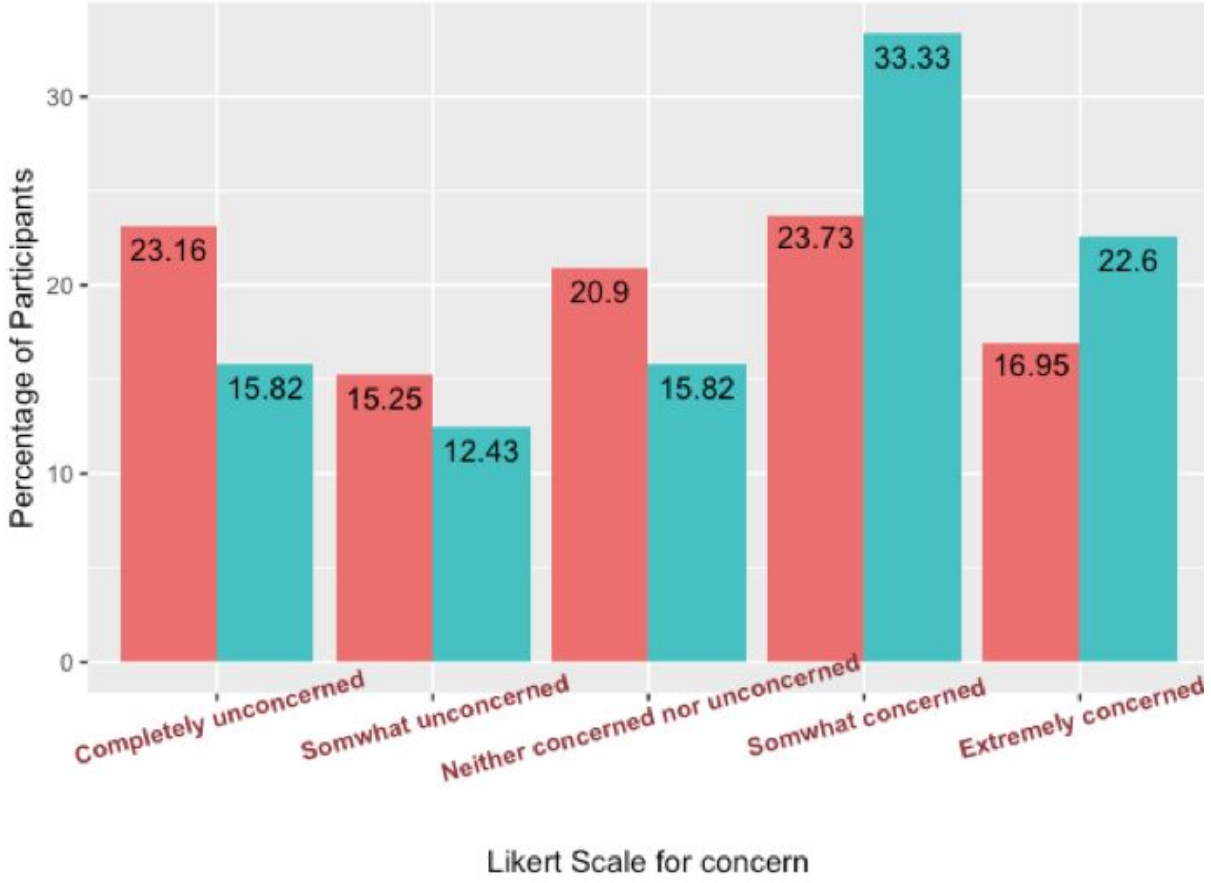


Figure 3: Email apps
seen somewhat sensitive or extremely sensitive by ~40% and ~55% of the respondents in context of family members and colleagues.

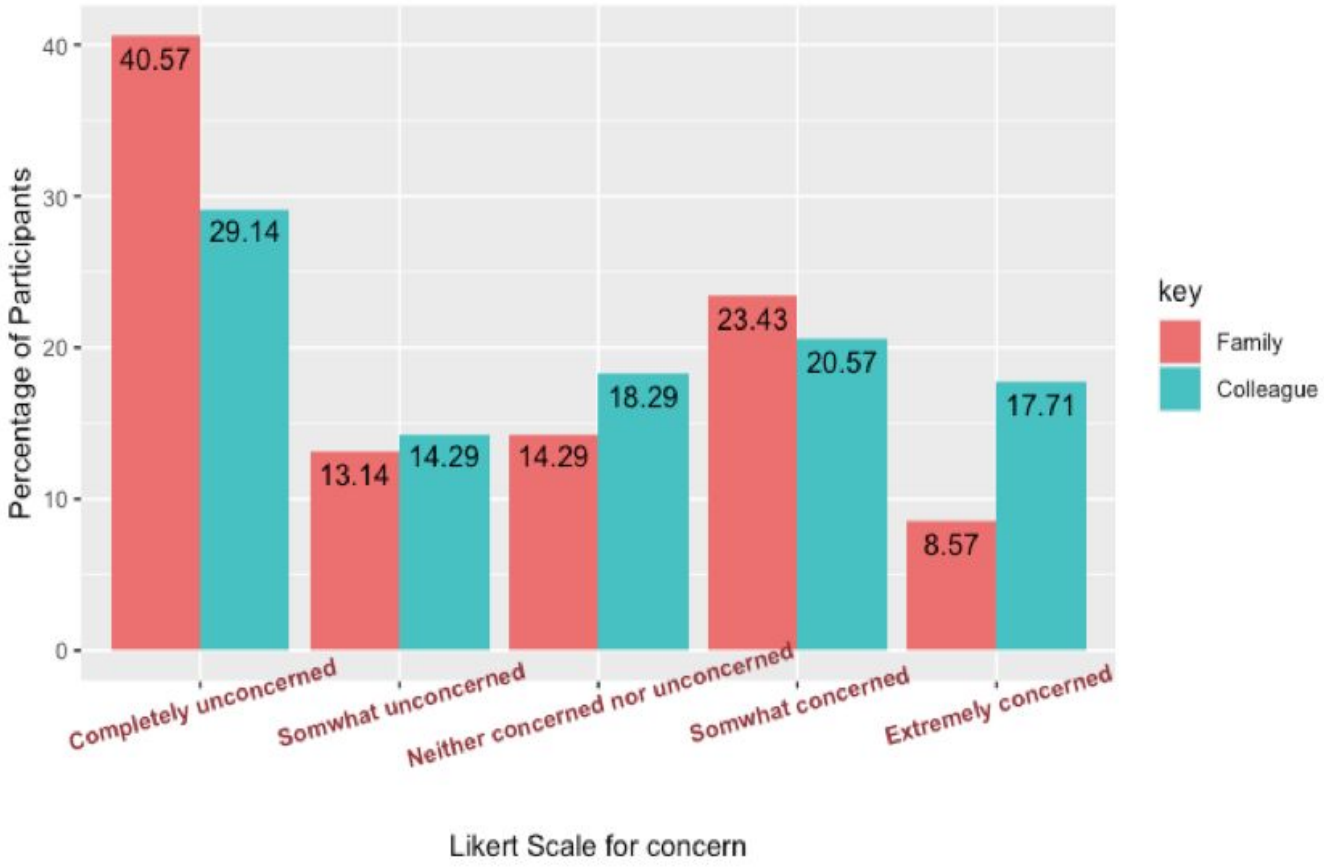


Figure 4: Calendar apps
seen somewhat sensitive or extremely sensitive by ~31% and ~37% of the respondents in context of family members and colleagues.

Concern for notification content

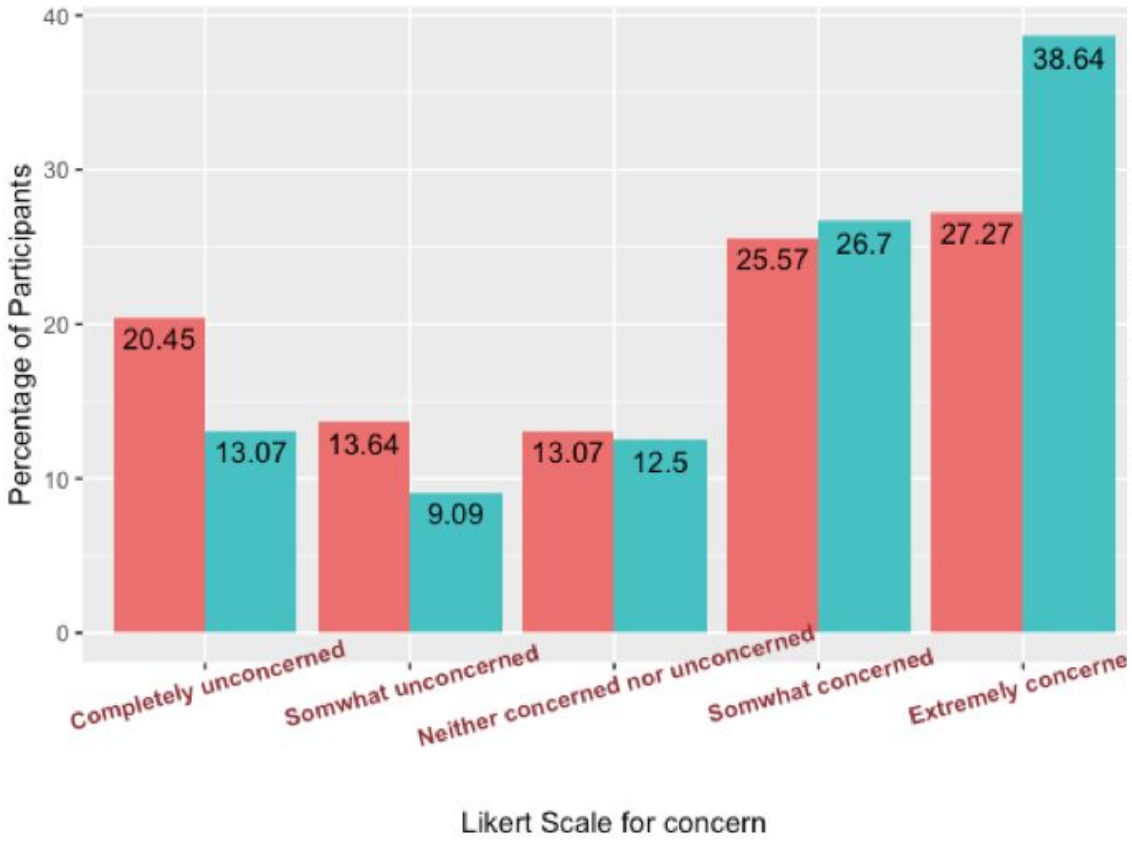


Figure 5: Banking Apps
seen somewhat sensitive or extremely sensitive by ~52% and ~65% of the respondents in context of family members and colleagues.

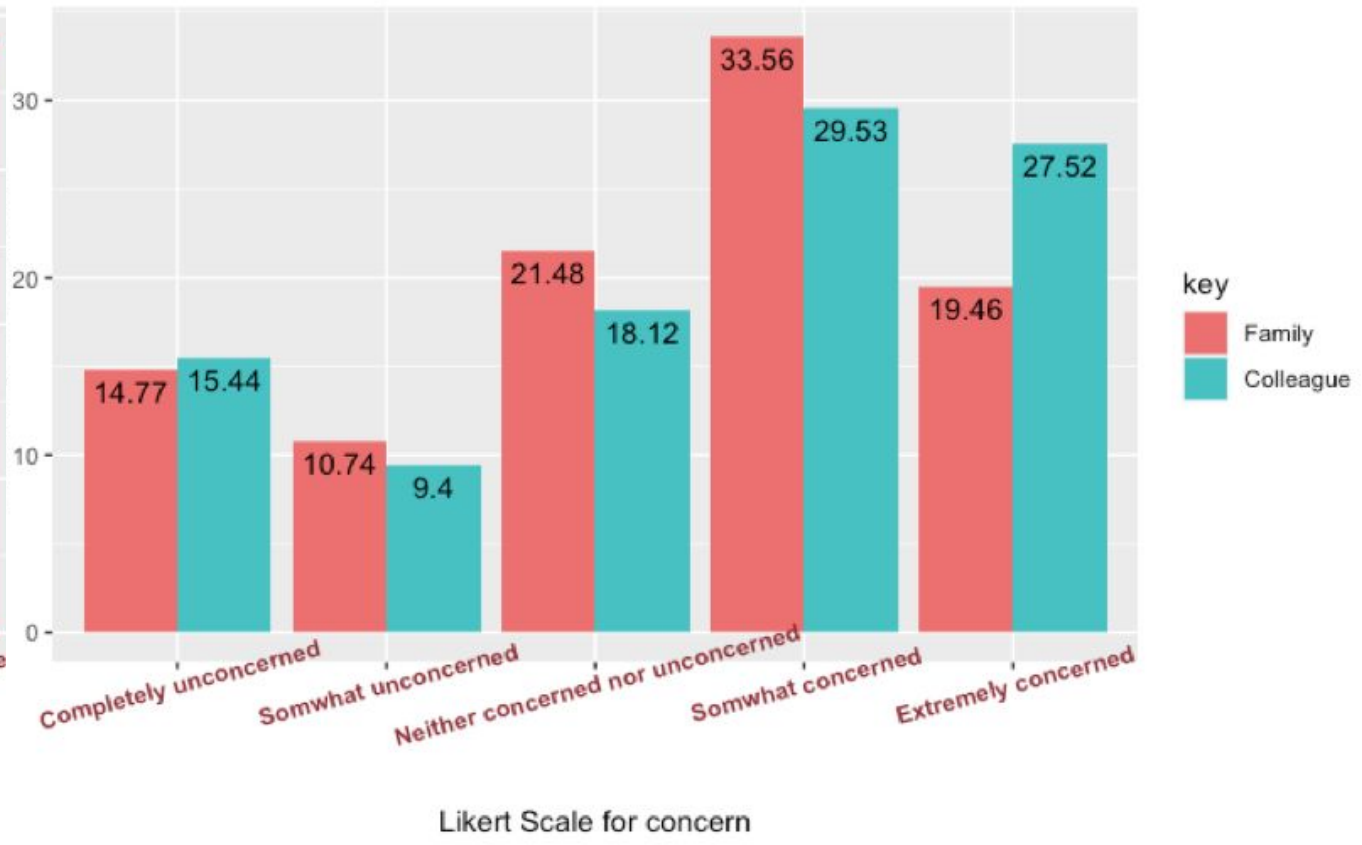


Figure 6: Dating Apps
seen somewhat sensitive or extremely sensitive by ~53% and ~57% of the respondents in context of family members and colleagues.

Table 5: User concern mean score if notification content from different app categories is read by a family member or colleague.

App Categories	Family Member	Colleague
Instant messaging	3.37	3.56
Social media	3.31	3.43
Calendar	2.63	2.96
E-mail	3.23	3.50
Banking and payments	3.48	3.68
Health and fitness	2.87	3.16
Dating	3.37	3.45

Findings

The sensitivity of content from different notifications depends upon:

1. Notifications delivered in presence of colleagues is more private than notification received in presence of family members for all types of apps.

2. Content from Banking and Payment Apps is seen as most sensitive by smartphone users (based on mean scores). Content from Calendar apps is seen as least sensitive.

3. In the context of surroundings of family members, the type of apps whose content is marked as somewhat sensitive or extremely sensitive most times is for Dating Apps (~53% respondents). This is followed by no. of respondents for Banking & Payments apps (~52%) and Instant Messaging (~49%).

4. In the context of surroundings of colleagues, the type of apps whose content is marked as somewhat sensitive or extremely sensitive most times is for Banking and Payment Apps (~65% respondents). This is followed by no. of respondents for Instant Messaging apps (~64%) and Dating Apps (~57%).

How do user preferences and smartphone settings like mode of notification delivery affect instances of information disclosures?

Control over smartphone state

56.07% (N = 97) of the users reported the use of Do Not Disturb Mode, 79.77% (N = 138) of Silent Mode, 44.5% (N = 77) turn off, 42.77% (N = 74) airplane mode and 61.85% (N = 107) notification management apps in their smartphones for at least one hour in a typical day.

Reasons to control smartphone state:-

- To limit distractions
  - don’t like alerts or noises. So I keep my phone in silent mode at all times. find this works best for me and limits distractions”.
  - "I don't like alerts or noises. So I keep my phone in silent mode at all times. I find this works best for me and limits distractions"
- Prevent Interruptions
  - "Usually I mostly use silent mode when working or hanging out with family or friends" and "Silent mode is the best with a 'shake' alert. In this case I'm notified 'minimally' without the dreaded sound going off interrupting any important task at work or with friends and family"
- Ease of addressing notifications
  - "i do use a notification manager from samsung to group notifications"

Negative Experiences and smartphone control

Table 3: Negative Experiences and Mean use of features (in hours)

Negative Experiences Occurrences	DND Mode	Silent Mode	Turn Off	Airplane Mode	Notification Apps
0	1.60	5.63	1.49	1.37	2.11
1-2	2.38	7.38	1.00	1.43	3.62
3-5	2.42	4.62	2.92	2.92	5.46
6-10	8.50	11.00	7.08	9.25	12.00
11-20	6.50	5.75	5.25	5.75	4.25
More than 20	0.5	3.00	0.50	0.25	0.25

Frequent occurrences of Negative Experiences (More than 20) with smartphone notifications are associated with less control over smartphone state

Negative Experiences and smartphone control

Table 4: Correlation of use of smartphone features and occurrences of negative experiences due to notifications.

Smartphone Mode	Correlation values	Adjusted p-values
Use **Do Not Disturb (DND)** Mode	0.29	0.014
Use **Silent** Mode	0.033	1.00
Turn the device **off**	0.27	0.028
Use **Airplane** mode	0.28	0.024
Use notification management apps	0.26	0.036

Findings:
Users who experience frequent negative experiences with notifications need to take more active engagement in managing the state of their device.

Mobile Users Information Privacy Concerns (MUIPC)

MUIPC

- Developed by Xu et al. 2008 and Xu, Heng, et al. 2012)
-
- Perceived Surveillance:
  - Practice of data collection, whether legitimate or illegitimate, “is the starting point of various information privacy concerns

- Perceived Intrusion:
  - The notion of intrusion has often been connected to the concept of personal space (Solove 2006). The notion of personal space, in today’s computing environment, has expanded to incorporate realms of both physical and informational space, due to the powerful technological advancements.

MUIPC

Table 6: Perceived Surveillance

Occurrences of negative Experiences	Mean Score	Median Score
0	14.73	15.0
1-2	15.51	16.0
3-5	16.20	16.0
6-10	16.73	18.0
11-20	17.00	18.0
More than 20	17.60	18.0

ANOVA Test results
F = 2.97 (p= 0.0877)

Table 7: Perceived Intrusion

Occurrences of negative Experiences	Mean Score	Median Score
0	14.72	15.0
1-2	15.51	16
3-5	16.20	16.0
6-10	16.73	18.0
11-20	17.00	18.0
More than 20	17.60	18.0

F = 5.958 (p = 0.0164)

Technical Efficacy Score

Technical Efficacy Score

- Due to unequal access to and adoption of smartphones, a significant amount of individuals are at a disadvantage due to experiencing difficulties in
- Anrijs S et al (2020): We have chosen 5-items of 'General Digital Difficulties (GDD)' from the original scale.

Table 9: Digital Difficulties Score

Scale Items	Mean score	SD
In general, I often have difficulty when using my smartphone, apps, websites, or computer programs.	2.64	1.54
In general, I am not able to solve questions or problems on my own when using my smartphone, apps, websites, or computer programs.	2.69	1.51
In general, I need support when trying out something new on my smartphone or computer.	2.74	1.61
In general, I find it hard to adjust settings of my smartphone, apps, websites, or computer programs (for example, privacy or safety settings).	2.72	1.58
In general, I often have questions or problems when using my smartphone, apps, websites or computer programs after an update has been done.	2.66	1.49

Table 10: Digital difficulties and association with Negative Experiences due to smartphone notifications.

Occurrences of negative experiences	Mean score	Median Score
0	9.89	6.00
1-2	13.24	14.00
3-5	16.92	18.00
6-10	17.92	19.00
11-20	14.75	15.50
More than 20	10.00	6.50

one-way ANOVA Analysis: F value = 9.24 (p-value = 0.00301)

Conclusion

- Our findings show that privacy concerns related to smartphone notifications are influenced by information content and additional audience beyond the receiver.
- At the same time, our findings extend the literature by adding notification-specific nuance and surface additional privacy-affecting aspects connected to notifications.
- The findings of our study highlight the need for greater attention ensuring that notification delivery avoid privacy violations for the user as well as the other parties whose information is contained in the notification content.
- One-size fit all strategy not appropriate and there is a need to personalize notification content and delivery frequency.

Users of mobile devices receive dozens of notifications every day. Inopportune notifications can result in undesirable privacy violations.