

Measuring the Effect of Culture on Usage of Encrypted Communication in India

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Figure 1: Usability in Encrypted Communication

ABSTRACT

After quantifying culture as per the Hofstede's 5 dimensional framework[7], this paper measures the usage of encrypted communication by the Unified Theory of Acceptance and Use of Technology model proposed by Venkatesh et al.[18]. This paper is first of its kind to measure the impact of social influence on a very broad scale including the impact of friends, family, and gender. We used Cronbach's alpha to measure the reliability of responses and find that the responses perfectly fit the requirements and our study design has good satisfying performance. For measuring the overall impact, both quantitative and qualitative data has been gathered in terms of application preference and corresponding reasons for it. Based on our analysis, we analyze correlations between the variables of

these 2 models and cite limitations that we faced to help mitigate risks and provide directions for future research.

KEYWORDS

encrypted communication, culture, social influence, measurement

ACM Reference Format:

Ashish Gokarnkar and Nandini Bajaj. 2020. Measuring the Effect of Culture on Usage of Encrypted Communication in India. In *Usable Security and Privacy*, September 30, 2020, Department of Computer Science and Engineering, IIT Kharagpur. ACM, New York, NY, USA, 10 pages. <https://doi.org/CS60081>

1 INTRODUCTION

Cryptography was once the realm of academics, intelligence services, and a few cybersecurity enthusiasts who sought to break the monopoly on that science of secrecy. Today, the enthusiasts have won: Encryption is everywhere. It's easier to use than ever before. In fact, secure communications are now not only attainable but perhaps even the new default. Still, effective encryption doesn't always just happen, especially once one moves beyond basic messaging. Our study focuses on the topics of usage of encrypted communication, social influence, collection and analysis of data for measuring culture and the reliability and validity of culture measures. Through our analysis, we try to find the impact of culture on the usage of encrypted communication in society.

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CS60081, September 30, 2020, IIT Kharagpur

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ACM ISBN Term Project...\$15.00

<https://doi.org/CS60081>

The causality of data globalization and the need for the hour secure information systems have led encryption to become a part of every user connected to a network. The intention of this project is to measure the impact of cultural dimensions on the acceptance and usability of encryption in domains of communication. The study will be defined on the method of *Instant Messaging* in communication as it has been proposed to be the most prominent and equally susceptible in terms of privacy and security.[4] Unlike regular voice or video communication methods, instant messaging considers all aspects of the extended CIA model emphasizing accountability (non-repudiation factor).[13] This project considers existing work on different information technologies, which summarize that the effect of culture can be measured through the social influence variable on user acceptance.[2] It is the first of its kind to quantitatively measure the impact cultural variables on the usage of encrypted communication. It is also the first the attempt in the world to qualitatively correlate the influence of social factors on usage of encrypted communication.

1.1 Research Questions

To account for all the factors in our research, Our approach will be guided by 2 research questions:

- (1) What is the relative impact of social influence compared to others on the usage of encrypted communication systems?
- (2) Is the impact of social influence on the usage of encrypted communication systems correlated to the different variables of culture?

1.2 Hypotheses

As per the premonitions and general know of the authors over the usage of encrypted communication in India, the following hypotheses have been assumed.

- **Hypothesis 1:** Social influence has the highest impact on the usage of encrypted communication when compared to effort expectancy, performance expectancy, facilitating conditions' influence.
- **Hypothesis 2:** There exists a very high correlation between Social influence on the usage of encrypted communication and the cultural dimension of Individualism-Collectivism, where collectivistic people stipulate strong social influence.
- **Hypothesis 3:** Measure of Uncertainty avoidance is directly proportional to the usage of encrypted communication.

1.3 Formulated theories by authors

- (1) In general, social pressure for an individual to perform a behavior is partly influenced by cultural differences. In collectivist cultures like India, where the group tends to be more important than the individual, the person is more likely to be concerned about the thoughts and opinions of others and, thus, more likely to conform to behaviors deemed important to the group.[2] The social influence construct in this study represents social pressure felt by the individual to perform a specific behavior by assessing the influence other people may have on the respondent's behavior.
- (2) India is a collectivist culture that may be affected by different factors than the typical individualistic culture, such as the

United States, when it comes to IT acceptance.[7] Collectivism refers to societies in which the interests of the group prevail over the interest of the individual.[6] Ergo, encrypted communication usage shall be more accepted in people with higher ratings of this dimension.

- (3) Uncertainty avoidance includes the following measures: risk avoidance and ambiguity avoidance.[15] As risk is an integral part of threat modeling, usage of encryption to curb it can be considered to rise along with its scale.

2 METHODOLOGY

2.1 Models and Principles

To derive the impact of social influence on encryption, we focus on the

Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. [2003][18]. UTAUT was chosen as the basic model as it is a parsimonious and robust model of technology acceptance. It shall enable us to measure the relative impact of the social influence construct with respect to *effort expectancy*, *performance expectancy*, *facilitating conditions influence*.

As per the demographics of our target region - India, we follow cross-cultural research principles. Based on cross-cultural research literature, we choose Hofstede's 5-dimensional framework [1980[[7]], 1991[[6]]] incorporating *individualism-collectivism*, *masculinity-femininity*, *power acceptance*, *uncertainty avoidance*, and *time orientation* to explain the cultural aspects in results of the model testing. **Power distance** is the degree to which a culture accepts the unequal distribution of power; **uncertainty avoidance** is the degree to which a culture tolerates ambiguity and uncertainty; **individualism** is a cultural orientation in which people belong to loose social frameworks, and their primary concern is for themselves and their families; **masculinity** is the cultural orientation in which assertiveness and materialism are valued; **time orientation** is whether a culture's values are long-term or short-term oriented.[9] For authenticity in our research methodology, we assume the *etic* approach, which states that there is a set of universal cultural dimensions that are equally relevant to all cultures.[5] These cultural dimensions are considered to be the ones defined by Hofstede.

2.2 Survey Instrument Review

The objective of our study was to quantitatively measure the anthropological concepts like usage and culture. To equally account for the technological acceptance and the behavioral intention to use by the causality of culture, the study is divided into 2 parts for all measurements henceforth. The first part deals with gathering data regarding usage and acceptance of encrypted communication in instant messaging. The second part enables collecting responses for measuring the cultural dimensions. The data for our study will be collected by conducting surveys.

The survey will be split into 4 parts: overview and consent, UTAUT based questions, cultural background, demographics. Consent shall be placed first to maintain ethical performance and gather data from only willing respondents. Culture based questions shall be asked later to not cause any biases while answering the

Table 1: UTAUT constructs to measure acceptance

UTAUT constructs	Root Constructs	Model
Performance Expectancy	Perceived Usefulness	TAM ¹ [3]
Effort Expectancy	Perceived ease of use	TAM ² [3]
Social Influence	Subjective Norm	TRA ³ [1]
Facilitating Conditions	Behavioral Control	TPB ⁴ [1]

¹ Technology Acceptance Model ² Technology Acceptance Model

³ Theory of Reasoned Action ⁴ Theory of Planned Behavior

Table 2: Various measures for individual cultural variable

Cultural Variable	Measure
Individualism-Collectivism	Self v/s Group Interest
	Teamwork and loyalty
	Self-perception
	Personal independence
	Family integration
Masculinity-femininity	Conformity
	Social Responsibility
	Assertiveness
	Confrontation avoidance
	Competitiveness
Power Distance	Accepted inequality
	Hierarchical preference
Uncertainty avoidance	Risk avoidance
	Ambiguity avoidance
Time orientation	Tradition
	Decision-making approach

UTAUT questions. Demographics have been placed last as previous studies have shown that it causes high skewness in data.[16]

2.3 Questionnaire Overview

The project scenario was set as inclusive of two famous instant messaging apps. One of which was *Whatsapp* and the other being *Facebook Messenger*. Whatsapp is an app that is known to prioritize it's user's privacy based on the fact that all conversations on it are end-to-end encrypted. Facebook Messenger is a competitor of Whatsapp that focuses more on user satisfaction in terms of display appeal than user privacy.

Our survey was based on the 4 constructs of UTAUT as mentioned in Table 1, and 5 variables of Hofstede's model noted in Table 2, which helped us measure the impact of social influence and culture on the usage of encrypted systems. This data on analysis assisted us in drawing a correlation between different variables of culture and social impact.

2.3.1 Measurement Metric. For measuring dimensions of culture self-report questionnaires are perceived to be the best tool task.

Because alternative assessment methods, such as observation or experiment, are much more resource-demanding, the self-report questionnaire remains the most popular method of quantifying culture.[14] Hence, we deployed self-report questionnaires consisting of ratings for cultural measurement. Respondents rated the importance of each value on a Likert Scale consisting of 5 interval points[11] and for a few other questions, the respondent was asked to rate his consensus with a set of statements[17].

2.3.2 Risk Mitigation. Likert scales generally lead to two types of response biases[12]:

- Extreme response bias: Systematic tendency to over express agreement or disagreement by choosing anchors towards the ends
- Acquiescence bias: promptness to agreement[14]

We corrected acquiescence bias by combining positively and negatively worded items in a single instrument.[10], [8] For solving extreme response bias we applied within-subject standardization as suggested by Hofstede[7].

3 STUDY DESIGN

Use of convenience samples has been focused for vast majority of previous studies.[15][6][12] Moreover, over a half of the reviewed models were developed and validated using student samples.[15] However, every attempt has been made to focus on a very specific theoretically-justified target group.

Our study consisted of 3 variables namely Social Influence, Individualism-Collectivism, Uncertainty Avoidance. In addition to the detailed analysis metrics explained in the results section it will include the comparison of individuals from different cultural backgrounds (groups). By analysis of the data collected from the survey we aimed to find correlation between at least 2 of the above variables. We collected data by conducting surveys on student subjects at undergraduate universities in India that have a heterogeneous mix of different cultural backgrounds. Moreover, to solve age bias, we collected data from different generations by also gathering responses from parents of students of Indian universities. We floated the survey in college groups and institute notice-boards to target a larger audience.

3.1 Recruitment Process

While recruiting individuals for answering our surveys we aimed to focus on having representatives from multiple demographic and social backgrounds to ensure sufficient variance in the dimensions of culture. In India, *Indian Institutes of Technology* (IITs) are known to have a heterogeneous mix of individuals in terms of significantly different social and cultural backgrounds. Keeping these social and cultural differences, and previous study results in mind we recruited students from IITs and their parents for the survey, shortlisting a sample space of around 50 individuals who are willing to participate in the survey with sincerity in agreement with consent. For the initial pilot run to check the integrity of the survey, the pilot survey was tested on a convenience sample.

4 PILOT STUDY

Initial survey was piloted on 13 participants. These participants were chosen from the authors' network to form the convenience sample. The participants were chosen in such a way to maintain homogeneity in age distribution. Age distribution varied from 19 to 77 years; with 7 participants belonging to the age group of <24, 2 participants in the age group of 24 to 40, and 4 participants having ages >40.

4.1 Observations

As inputting the name for a participant was considered optional, 2 participants wished to keep their identity private. This also shows that research involving these responses may receive scrutiny and stigma from the audience. Other major observations are summarized as:

- WhatsApp is majorly the preferred messaging app in India in all sorts of situations for users from a variety of demographics.
- Participants with lack of knowledge in fields of encryption were forgetful of its definition explained in the beginning. Hence, questions related to encryption in the later parts received indifferent responses.
- It's extremely tough to gauge privacy concerns of users as their choices are heavily influenced by social impact. However, when presented with a threat model, their concerns came to light.
- For a few questions, answers constructed didn't cover all categories of the audience that were supposed to be analysed. These questions were modified accordingly for the final survey instrument and listed in Appendix B.

4.2 Improvements

As the survey included 39 questions, the main feedback received for participants was that the survey was too long. This created lot of fatigue for them while answering the ending questions and might have caused errors too. To counter this, some questions were sifted out from the pilot questions. The sifting procedure for each section involved selecting those questions with an unskewed distribution of responses. Finally, the selected questions were also cross-verified for measuring reliability. To cite an example, 4 questions in Masculinity - Femininity were culled to 2 questions by selecting the best 2 questions which showed good distribution in responses. The were also measured as per Cronbach's alpha to get an understanding of the reliability of the final selected questions. The logic behind selecting only those questions with good responses was that this eliminated those questions which might have led to acquiescence bias and extreme response bias that had been expected earlier. Few of the questions had overlapping responses too. The patterns for questions within the same section were similar. Hence, to remove the redundancy some questions were skipped in the culture section of the survey. The final survey instrument included only 29 questions out of the 39 questions as in the pilot survey. Other forms of improvements that were done to suit our needs are listed below:

- To solve the issue the issue of forgetfulness, definitions of encryption were incorporated in every question related to it

and a short and audience-catchy video (length of video = 2 minutes) explaining it was also introduced at the very start of the survey.

- Due to a human error caused by principal investigators, in the pilot survey the question to understand the region of living was skipped. It was added in the final survey.
- To understand user's preference when it comes to privacy and security 2 modifications were made:
 - (1) A qualitative question was added to our survey to analyse if the audience has had the same preferred app since the start or did they switch to a different app sometime in the course of their use. In case they switched to a different app, we wanted to gain insights on why this shift happened and what was the reason to chose the later app.
 - (2) Arrangements for conduction of online interviews to get qualitative data to gauge the choice made by users between usability and privacy & security. The reason to conduct interviews for this aspect was because measuring privacy concerns over quantitative survey questions was realized to be tough and ambiguous.
- Out of the questions gathered from Hofstede's previous works, one of them was found to be double-barrelled. It would have caused a deviation from the actual answers that were required. It was corrected accordingly by maintaining the core reasoning of the question intact.

5 DATA ANALYSIS

The final survey was conducted on a total of 82 participants.

These participants were recruited by circulating the survey among students of Indian Institute of Technology, Kharagpur and other universities. To gather participation from varied demographics we had contacted the parents of the student volunteers for participating in the survey. The improvements made in the survey based on our observations in the pilot survey proved to make a marked difference in the response from the participants and brought clarity to the study. We performed both quantitative and qualitative analyses.

5.1 Qualitative Analysis

To analyze the qualitative responses, we followed a standard **simultaneous coding** process. First, a researcher created a codebook based on the text responses. This codebook included labels for each of the responses with the explanation. Then both the researchers read through the same responses of the survey and independently assigned a code to each using the codebook. With a codebook that contained around four themes per question, Cohen's Kappa between the two coders was determined to have a threshold of 0.82 for the question regarding the reason for choosing the given app as participant's most preferred one. The initial Cohen's Kappa achieved was 0.9. Hence, revision was not considered necessary.

Another part where coding was involved is the data gathered regarding city of residence. Cities were coded into Tiers I, II, and III for getting categorical data out of given set of cities. Here initial coding was done by both the coders singularly. Cohen's Kappa obtained for the initial round was 0.78. For the second round, coding was done jointly where agreement wasn't achieved for categorizing the cities. This led to a final Cohen's Kappa of 1. Because of complete

agreement, researchers chose this to be very well categorized for hypotheses testing.

5.2 Quantitative Analysis

We had 9 questions to measure 5 constructs of culture. To finally get a single valued output for every variable of culture *within-subject standardization* was used. The entire procedure has been summarized in Table 9. A decimal value is obtained for each of the culture constructs due to the allocation of the above mentioned weights. Hence, for generalization the values have been rounded off to the nearest integer. This leads to the final values lying in the range from 1 to 5 which help in smooth hypothesis testing using *Chi square tests*. Later correlations have been found between UTAUT variables and Culture variables using *Spearman's Ranked Coefficient* and *Chi square tests*.

6 RESULTS

6.1 Relation between Effort Expectancy and Culture Variables

Here relations between 5 variables of culture and the 3 questions of effort expectancy [A]. The results of *Chi Square tests* and *Spearman's Coefficients* are listed in Tables 7 and 8.

Surprisingly, all p-values have a value greater than 0.05. This means that culture variables have no correlation with effort expectancy of encrypted communication. This is validated via Spearman's correlation coefficients as well, because for all the possibilities the coefficient value is found to be close to 0 showing no relation between the two variables. Thus **ease, security, privacy preferences of an application aren't correlated to the 5 variables of culture - power distance, uncertainty avoidance, individualism-collectivism, masculinity-femininity, and time orientation.**

6.2 Relation between Privacy Consciousness and their reaction to Facebook's spying

Here we attempted to analyse if privacy consciousness among users has any relation with the choice of application or privacy based decision they make when made aware that Facebook Messenger tracks all their chat messages. As expected, the p value came out to be <0.00001 for the contingency table presented in Table 3. The Chi square result for the given contingency Table 3 has a $\chi^2 = 56.94191914$ and $p < 0.00001$. This means that there exists a relationship between conscious users and the choices they make with regard to their messaging app. However, on independent observation of the choice made by users when informed that Facebook is constantly spying on their personal messages we got a response of 50 percent users as they will stop using messenger and another 37 percent users as they may change and 13 percent as they will not change. This came to our surprise as we had expected people to feel unsafe when informed that their data was being spied on, but we realised on analysis via interviews that they did believe that their identity and data was not of public interest and hence its leakage did not matter.

Table 3: Chi square test contingency table between Privacy consciousness and Facebook Spying

Question Construct	PS	F	Fam	A	N
Yes	0	0.64	0.16	1.52	0.68
No	0	4.05	1.013	9.63	4.307
Maybe	0	3.306	0.827	7.85	3.51

PS : I can share chats with my partner/ spouse. *F* : I may freely share chats with my friends. *Fam* : I may freely share chats with my family. *A* : I feel awkward to share chats generally but may share as per the scenario. *N* : I never share chats in any scenario.

Table 4: Chi square test contingency table between Awareness and Facebook Spying

Question Construct	Heard	News	Follow	Tech	Prof
Yes	0.107	0.714	1	0.678	0
No	0.707	4.71	6.6	4.478	0
Maybe	0.686	2.057	6.4	4.343	0

Heard : I have not heard of the term.

News : I have heard about it in the news. *Follow* : I follow tech and know how encryption works. *Tech* : I have technical understanding of encryption. *Prof* : I have undergone professional/ academic courses in IT and CS.

6.3 Relation between users that are aware of encryption and their reaction to Facebook's spying

As expected, the p value came out to be <0.05 . The Chi square result for the given contingency Table 4 has a $\chi^2 = 64.21436796$ and $p < 0.00001$. This means that there exists a relationship between the awareness of encryption among users and the choices they make with regard to their messaging app. It was observed that a large majority of the participants were aware of encrypted communication to an extent that they understood its use and basic technicalities and that had a strong relationship with the choice of app made by them when made aware of Facebook spying on their personal chats.

6.4 Relation between users that are aware of encryption and their privacy consciousness

As expected, the p value came out to be equal to <0.05 . The Chi square result for the given contingency Table 5 has a $\chi^2 = 38.92467918$ and $p = 0.001115$. This means that there exists a relation between the extent of awareness about encryption and the extent of consciousness with regard to privacy.

Table 5: Chi square test contingency table between Awareness and Privacy consciousness

Question Construct	PS	F	Fam	A	N
Heard	0	0	0	0	0
News	0.2	1.7	2.8	1.8	0
Follow	0.0307	0.2615	0.4307	0.277	0
Tech	0.523	4.446	7.323	4.708	0
Prof	0.246	2.092	3.446	2.215	0

PS : I can share chats with my partner/ spouse. *F* : I may freely share chats with my friends. *Fam* : I may freely share chats with my family. *A* : I feel awkward to share chats generally but may share as per the scenario. *N* : I never share chats in any scenario.

Heard : I have not heard of the term.

News : I have heard about it in the news. *Follow* : I follow tech and know how encryption works. *Tech* : I have technical understanding of encryption. *Prof* : I have undergone professional/ academic courses in IT and CS.

Table 6: Contingency table of City of Residence and Notional choices on usage of Facebook Messenger

<i>City – of – Residence</i> <i>Notion</i>	Tier 1	Tier 2	Tier 3
Yes	4	2	0
No	22	11	9
Maybe	14	11	9

6.5 Relation between City of Residence and the Notion to not use Facebook Messenger if the participants realize that Facebook Messenger eavesdrops conversations

All the variables are categorical in this segment. City of residence has been categorized into 3 tiers as per their infrastructure development and population density. And participant's options for their notion to use Facebook Messenger if the participants realize that Facebook Messenger eavesdrops conversations is taken in forms of *Yes*, *No*, and *Maybe*. The contingency table for this particular data is shown in Table 6. The Chi square result for the given contingency table has a $\chi^2 = 2.827$ and $p = 0.587$.

Thus region of residence and native place/ demographic doesn't have any correlation with privacy consciousness of participants as they are not bound to choose

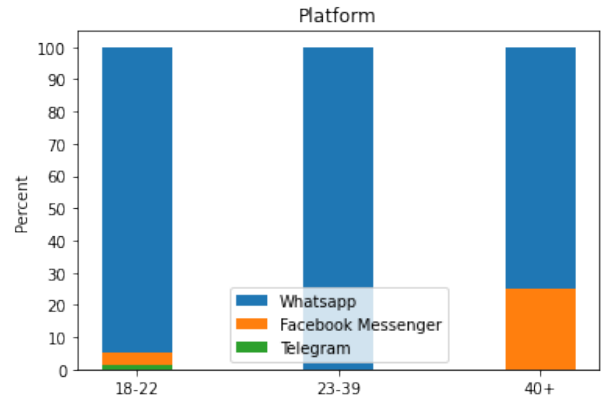
7 DISCUSSION

Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. A Cronbach's alpha of 0.501 is achieved for cultural questions without doing within-subject standardization. After doing within-subject standardization the value of Cronbach's alpha comes out to be 0.457. Test-retest reliability was reported only in twelve papers presenting the 121 reviewed instruments representing roughly 10% of the reviewed measures, averaging

0.58 and ranging from 0.35 to 0.76.[15]. Hence as our values for Cronbach's alpha lie within this region, we satisfy ourselves that the scores achieved are reliable and actually measure accurately the cultural variables as they are supposed to.

When Table 10 is analyzed, it is observed that 37.5% of responses are bound on the popularity of the app itself. 32.2% of responses are based on peer pressure from friends and academic circle. This pronounces the fact that the **social influence of the app has the highest leverage for making the app the first preference of any user**. Later the most important factor to consider is that of usability of the app which reverberates in 31.25% of the responses. Privacy comes last on this list with a presence of just 25% responses towards it. Shocking factor to consider is that, none of the participants implied substantial security reasons to the reason for preference of an app. Even when they saying end-to-end encryption, they were meaning protection from visual spying or third party eavesdropping. Hence, these security factors had to be clubbed in privacy itself.

7.0.1 Preference of app usage and Age Distribution. 3 categories of age has been considered for evaluation. They are 18 - 23, 24 - 39 and 40+. We found that for the age group 24 - 39, entire preference of app usage was WhatsApp. For the age group 18 - 23, WhatsApp dominated the list with very less percentage of usage allocated to Facebook Messenger and Telegram. Age group 40+ had very few participants (5 in total), hence, it seems that Facebook Messenger has a very huge dominance. But the authors feel that the similar trend shall follow in this age group too when the research is done in this age group on a large scale.



7.0.2 Preference of app usage and Age Distribution and Used from Start/ Shifted to it later data. It is found that nobody used Facebook Messenger from the start. Participants generally shifted to this platform considering various personal preferences. WhatsApp is the one with which people generally begin their journey of instant communication, but this factor needs to be comprehended well that participants' reason to choose WhatsApp wasn't that of security and end to end communication but was because of peer pressure, popularity of the app and social influence.

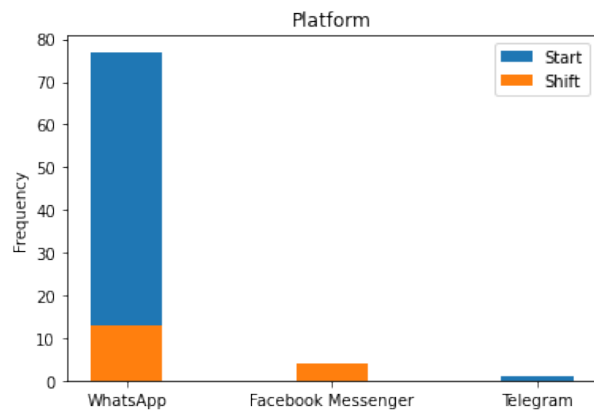
Table 7: Chi square test p-values between variables of culture and Effort Expectancy

Question construct	PD	UA	IC	MF	TO
Ease	0.2076	0.9984	1.0000	0.9997	0.9651
Security	0.4180	0.8915	0.9998	0.9586	0.7274
Privacy	0.3744	0.9924	0.9988	0.9805	0.9437

Table 8: Spearman's Correlation tests between variables of culture and Effort Expectancy

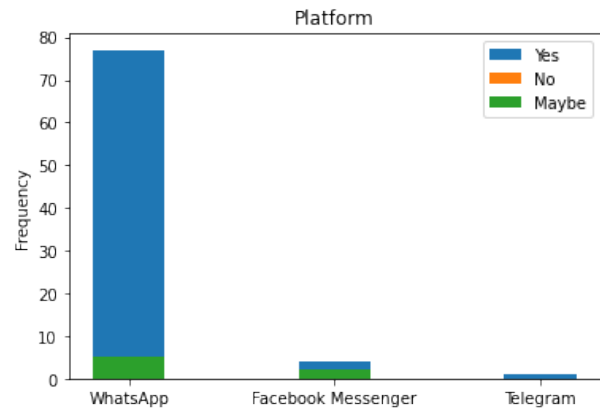
Question construct	PD	UA	IC	MF	TO
Ease	-0.0118	-0.0730	-0.0340	-0.1149	0.1261
Security	-0.1435	-0.0446	0.0454	-0.0275	-0.1417
Privacy	-0.0573	-0.1211	0.0976	0.0123	-0.0577

Culture Variable	Question	Construct	Value	Weight attached[14]	Final Score
Power Distance	PD1	Relationship Depth	x	3.26	$3.26x + 3.99y$
	PD2	Power Distance	y	3.99	$3.26 + 3.99$
Uncertainty Avoidance	UA1	Conservatism	x	3.49	$3.49x + 3.73y$
	UA2	Ambiguity avoidance	y	3.73	$3.49 + 3.73$
Individualism - Collectivism	IC1	Family Integration	x	4.17	$4.17x + 3.45y$
	IC2	Conformity	y	3.45	$4.17 + 3.45$
Masculinity - Femininity	MF1	Independent-interdependent self-perception	x	3.68	$3.68x + 2.7y$
	MF2	Risk avoidance	y	2.7	$3.68 + 2.7$
Time Orientation	TO1	Short- vs. long-term orientation	x	3.13	$3.13x$
					3.13

Table 9: Within Subject Standardisation for culture related questions

7.0.3 Preference of app usage and perception of the app used by majority of a participant's friends. A peculiar fact perceived here is that nobody chooses a messaging app which is not being used by their majority of friends. The percentage of people using an app which is not accepted socially is 0%. Almost entirely people are confirming that their friends use the same as them. Also the major reason behind starting to use any messaging app at all was their

peer group.

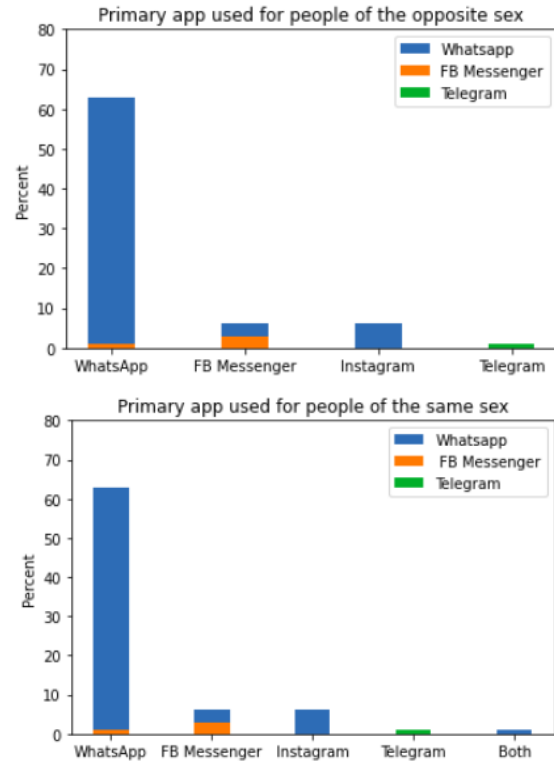


7.0.4 Usage based on communication with gender. From the bar graphs shown below the researchers understand the preference of messaging app for chatting with people of the same sex and opposite sex. Researchers observed that there was negligible difference in the app used for the purpose which means users did not choose different apps to communicate with people of different genders. WhatsApp was observed to be the most preferred app in

Table 10: The percentage of responses that fell into each category, and representative quotes. Percentages do not add up to totals because some responses received multiple codes.

Categories	Responses	Representative Quotes
Popularity	37.5	Popularity of the app Almost 90 percent of people use WhatsApp
Peer Pressure	32.2	All my friends used WhatsApp for instant messaging Actually I followed it because all are using it only It was in hype at the time I started using social media Most of the institute related communication was through FB
Passed Experiences	6.25	My FB was hacked in childhood and misused severely WhatsApp is way less distracting Little less random people texting us
Usability	31.25	User interface is very good Simplicity WhatsApp has a much better UI and feels more comfortable. WhatsApp feels like home. Multimedia sharing, Reference to previous messages and searching in previous chats are good features Faster and used lesser data on phone
Privacy and Security	25	With Whatsapp at least I can regulate who can access my account Privacy, ease of removing messages and limited audience Messages in WhatsApp are end to end encrypted It feels safe taking there due to end to end encryption

either case followed by Instagram and then Facebook Messenger.



8 LIMITATIONS

The user affiliation towards WhatsApp is found to be so strong that understanding user's preference towards encrypted communication based on privacy needs is very cumbersome. Our survey instrument was circulated only among the students of Indian Institute of Technology, Kharagpur. And university students from such top tier institute are known to have a higher awareness towards encryption. Although we tried to mitigate the bias by also including their parents into the research the total impact of this measure is invalidated. Another limitation which needs to be considered is the self-report questionnaires for measuring culture. These questionnaires actually may not be the most accurate way of quantifying culture. Infact as culture extends to psychological, anthropological, abstract concepts; it is very tough to quantify culture and procedure of doing it and its implications are highly debated. Even the 5 constructs used here after modelling after Hofstede's work may not be enough to get a good grasp of the human's consciousness and its actions. There are more than 30 constructs mentioned in Taras et al. [14] itself for measuring culture. Final thing that needs to be considered is that the study has been conducted solely on Indian participants, hence, its results are advised to be not generalised to fit the entire population of the world extending to western cultures like that of U.S.A. and U.K. and extreme eastern philosophies of Japan and South Korea.

9 CONCLUSION

In line with the Hypothesis 1 we observed from our study that Social Influence (peer pressure, popularity, and family) and Usability have the highest impact on the usage of encrypted communication when compared to the other factors like effort expectancy, performance expectancy, facilitating conditions' influence. To our surprise, and contrary to our second Hypothesis, we observed no or negligible correlation between Social Influence on the usage of encrypted communication and the cultural dimension of Individualism-Collectivism (where collectivist people stipulate strong social influence). Even uncertainty avoidance wasn't observed to be correlated to the usage of encrypted communication. **Therefore, neither is the usage of encrypted communication correlated to culture nor to location demographics. It only depends on the social background and peer group. This comes out to be a very interesting observation as it clearly throws light on the fact that technology has become widespread and socially accepted. Technology has seeped so deep in society that the effect of culture and gender on preference and usage of people towards encrypted communication has mitigated and the impact of Social Influence, Popularity and Peer pressure has taken over.**

ACKNOWLEDGMENTS

We thank *Prof. Mainack Mondal* for providing us the guidance and all the educational support required for commencement of the project. We hope to implement all his teachings successfully.

We also thank our friends and course-mates who were kind enough to volunteer for our pilot studies and help us gather valuable data and survey responses. It would not have been possible for us to complete the study and make observations without their time investment in helping us improve the study design.

REFERENCES

- [1] Icek Ajzen. 1991. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50, 2 (Dec 1991), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- [2] Kakoli Bandyopadhyay and Katherine A. Fraccastoro. 2007. The Effect of Culture on User Acceptance of Information Technology. *AIS Electronic Library (AISel)* 19, 1 (2007), 23. <https://doi.org/10.17705/1CAIS.01923>
- [3] Fred D. Davis. 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly* 13, 3 (Sep 1989), 319–340. <http://www.jstor.org/stable/249008>
- [4] Ivan Del Pozo and Mauricio Iturralde. 2015. CI: A New Encryption Mechanism for Instant Messaging in Mobile Devices. *Procedia Comput. Sci.* 63 (Jan 2015), 533–538. <https://doi.org/10.1016/j.procs.2015.08.381>
- [5] M. J. Gannon and R. K. Pillai. 2010. Understanding global cultures: Metaphorical journeys through 29 nations, clusters of nations, continents, and diversity. *ResearchGate* (Jan 2010), 1–634. <https://doi.org/10.4135/9781452224886>
- [6] Geert Hofstede, Gert Jan Hofstede, and Michael Minkov. [n.d.]. *Cultures and Organizations: Software of the Mind, Third Edition*. McGraw-Hill Education, New York, NY, USA. https://books.google.co.in/books/about/Cultures_and_Organizations_Software_of_t.html?id=o4OqTgV3V00C
- [7] Geert H. Hofstede. 2001. Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations Across Nations. *Behaviour Research and Therapy - BEHAV RES THER* 41, 7 (Jan 2001). [https://doi.org/10.1016/S0005-7967\(02\)00184-5](https://doi.org/10.1016/S0005-7967(02)00184-5)
- [8] Gerardo Marin, Raymond J. Gamba, and Barbara V. Marin. 1992. Extreme Response Style and Acquiescence among Hispanics: The Role of Acculturation and Education. *Journal of Cross-Cultural Psychology* 23, 4 (Dec 1992), 498–509. <https://doi.org/10.1177/0022022192234006>
- [9] Debra L. Nelson and J. Quick. 1994. Organizational Behavior: Foundations, Realities and Challenges. *undefined* (1994). <https://www.semanticscholar.org/paper/Organizational-Behavior%3A-Foundations-and-Nelson-Quick/c369494e5f362f9487b3345c13b94a69932811c3>
- [10] Ulrich Schimmack, Shigehiro Oishi, and Ed Diener. 2005. Individualism: A Valid and Important Dimension of Cultural Differences Between Nations. *Pers. Soc. Psychol. Rev.* 9, 1 (Feb 2005), 17–31. https://doi.org/10.1207/s15327957pspr0901_2
- [11] S. H. Schwartz. 1994. Beyond Individualism/Collectivism: New Cultural Dimensions of Values. *Cross-cultural research and methodology* 18 (Jan 1994), 85–119. https://www.researchgate.net/publication/234021883_Beyond_IndividualismCollectivism_New_Cultural_Dimensions_of_Values
- [12] Mark Srite. 2006. Culture as an Explanation of Technology Acceptance Differences: An Empirical Investigation of Chinese and US Users. *1. 14*, 1 (Nov 2006). <https://doi.org/10.3127/ajis.v14i1.4>
- [13] John Stone and Sarah Merriam. 2004. Instant Messaging or Instant Headache? IM has found a home within the enterprise, but it's far from secure. *Queue* 2, 2 (Apr 2004), 72–80. <https://doi.org/10.1145/988392.988410>
- [14] V. Taras. 2008. Culture Survey Catalogue: Original items, scoring keys and psychometric properties of 134 instruments for measuring cultural values and behaviors. *ucalgary.ca/~taras/_private/Culture_Survey_Catalogue.pdf* (2008).
- [15] Vas Taras, Julie Rowney, and Piers Steel. 2009. Half a century of measuring culture: Review of approaches, challenges, and limitations based on the analysis of 121 instruments for quantifying culture. *Journal of International Management* 15, 4 (Dec 2009), 357–373. <https://doi.org/10.1016/j.intman.2008.08.005>
- [16] Robert Teclaw, Mark C. Price, and Katherine Osatuke. 2012. Demographic Question Placement: Effect on Item Response Rates and Means of a Veterans Health Administration Survey. *J. Bus. Psychol.* 27, 3 (Sep 2012), 281–290. <https://doi.org/10.1007/s10869-011-9249-y>
- [17] Harry C. Triandis. 1982. Review of Culture's Consequences: International Differences in Work-Related Values. *Hum. Organ.* 41, 1 (1982), 86–90. <http://www.jstor.org/stable/44125611>
- [18] Viswanath Venkatesh, Michael G. Morris, Gordon B. Davis, and Fred D. Davis. 2003. User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly* 27, 3 (Sep 2003), 425–478. <http://www.jstor.org/stable/30036540>

A FINAL SURVEY INSTRUMENT

A.1 Facilitating Conditions

- (1) What do you use as your primary messaging app? (WhatsApp, Facebook Messenger, Other)
- (2) Have you been using the above chosen app as the primary messaging platform since the start or did you switch to it later?(Yes, No)
- (3) Please state a reason for the above answer.(Qualitative)
- (4) At what age did you start using the messaging app? (<18, 18 to 24, >24)
- (5) Do most of your close friends use the same messaging app as you? (Yes, No, Maybe)
- (6) Do most of your family members use the same messaging app as you? (Yes, No, Maybe)

A.2 Social Influence

- (1) Which app do you prefer to use for chatting with your family and other relatives? (WhatsApp, Facebook Messenger, Other)
- (2) Which app do you prefer to use for chatting with friends? (WhatsApp, Facebook Messenger, Other)
- (3) Which app would you prefer to use for chatting with a person of the same sex? (WhatsApp, Facebook Messenger, Other)
- (4) Which app would you prefer to use for chatting with a person of the opposite sex? (WhatsApp, Facebook Messenger, Other)

A.3 Effort Expectancy

- (1) How would you rate Facebook Messenger compared to WhatsApp on the basis of EASE?
- (2) How would you rate Facebook Messenger compared to WhatsApp on the basis of SECURITY?

A.4 Performance Expectancy

- (1) How scared are you about the privacy of your chat messages?
- (2) How privacy-conscious are you about your chat messages?
 - I can share chats with my partner/ spouse
 - I may freely share chats with my friends
 - I may freely share chats with my family
 - I feel awkward to share chats generally but may share as per the scenario
 - I never share chats in any scenario
- (3) How much awareness do you have about encryption in communication?
 - I have not heard of the term
 - I have heard about it in the news
 - I follow tech and know how encryption works
 - I have technical understanding of encryption
 - I have undergone professional/ academic courses in IT and CS
- (4) If we tell you that Facebook Messenger is constantly reading your personal chats on messenger, would you still use it as much? (Yes, No, Maybe)

A.5 Power Distance (PD)

- (1) Employees should not talk to their bosses about personal matters.
- (2) Power and wealth are evil.

A.6 Uncertainty Avoidance (UA)

- (1) Change in my life is important to me.

- (2) A manager must be an expert in the field in which he or she manages.

A.7 Individualism - Collectivism (IC)

- (1) When a girl/ boy becomes 21 years of age, they should be encouraged to move away from home.
- (2) It is important that people conform to the group's norms to reach their goals.

A.8 Masculinity - Femininity (MF)

- (1) The most important thing in my life is a career with a good salary and satisfaction.
- (2) It is important to finish one interaction before rushing off to another.

A.9 Time Orientation (TO)

- (1) Short Term goals collectively align your interests and careers more effectively than long term goals.

A.10 Demographics Part

- (1) Your Name
- (2) Your Gender (Male, Female, Other, Prefer not to say)
- (3) Your Age
- (4) City of residence
- (5) Have you lived out of your home for >1 year? (Yes, No)
- (6) Guardian's email id