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

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Figure 1: Usability in Encrypted Communication

ABSTRACT

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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encrypted communication, culture, social influence, measurement

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1 RESEARCH OBJECTIVES

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).[12] This research shall consider 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]

1.1 Research Questions

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 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][16]. 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 lose 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 HYPOTHESES

- **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.

3 STUDY METHODOLOGY

The objective of our research is 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. Survey instruments have been designed to gather data regarding these concepts.

Table 1: UTAUT constructs to measure acceptance

UTAUT constructs	Root Contructs	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

The survey was split into 4 parts: `overview and consent`, `UTAUT based questions`, `cultural background`, `demographics`. Consent was placed first to maintain ethical performance and gather data from only willing respondents. Culture based questions were asked later to not cause any biases while answering the UTAUT questions. Demographics had been placed last as previous studies have shown that it causes high skewness in data.[15]

4 DRAFT RELATED WORK SECTION

The designed survey instrument contained 39 questions. 18 questions were a part of the culture section to gather data on 5 dimensions of Hoftstede's framework. 6 questions were considered for gauging demographics. 15 questions in total collaborated for the 4 parameters of UTAUT model.

UTAUT model is set inclusive of the scenario where 2 famous instant messaging apps were taken for consideration. To depict encrypted communication, *WhatsApp* was considered rhetorical to it. 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. For unencrypted communication *Facebook Messenger* was chosen for representation. Facebook Messenger is a competitor of Whatsapp that focuses more on user satisfaction in terms of display appeal than user privacy, however it does have a hidden feature called secret messaging that employs end to end encryption which has low accessibility. To not confuse our participants which technical jargons and to base our study on usage of the apps rather than their knowledge we chose to directly name these apps and not use aliases. This enabled to avoid assignable causes in the data thereby reducing non-conformities. We fetched data from our participants about their preference towards these instant messaging apps based on their social and cultural backgrounds.

4.1 Questionnaire Overview

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 will help us measure the impact of social influence and culture on the usage of encrypted systems. This data on analysis will assist us in drawing a correlation between different variables of culture and social impact.

4.1.1 Measurement Metric. For measuring dimensions of culture self-report questionnaires were perceived to be the best tool task. Because alternative assessment methods, such as observation or

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 Conformity Social Responsibility
Masculinity-femininity	Assertiveness Confrontation avoidance Competitiveness
Power Distance	Accepted inequality Hierarchical preference
Uncertainty avoidance	Risk avoidance Ambiguity avoidance
Time orientation	Tradition Decision-making approach

experiment, are much more resource-demanding, the self-report questionnaire remains the most popular method of quantifying culture.[13] We deployed self-report questionnaires consisting of ratings for cultural measurement. Respondents rated their consensus with a set of statements on a Likert Scale consisting of 5 interval points[11].

4.1.2 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[13]

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

5 OBSERVATIONS AND RESULTS

Initial survey was piloted on 13 participants. These participants were chosen from the author's 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`. 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 all a variety of demographics.
- 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.
- 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 come to light.
- For a few questions, answers constructed didn't cover all the categories of the audience that were supposed to be interacted. These questions have been modified accordingly for the final survey instrument and listed in Appendix B.

6 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, final questions have been sifted out from the pilot questions. The sifting procedure for each section involved selecting those questions with an unskewed distribution of responses. 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 logic behind selecting only those questions with good responses is that this eliminated those questions which might have led to acquiescence bias and extreme response bias which have been explained 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. The final survey instrument includes only 29 questions out of the 39 questions.

To solve the issue the issue of forgetfulness, definitions of encryption were incorporated in every question related to it. A short and audience-catchy video (length of video = 2 minutes) explaining it was also introduced at the very start of the video. Due to a human error caused by principal investigators, in the pilot survey the question to understand the region of living was skipped. It has been added in the final survey. To understand user's preference when it comes to privacy and security 2 modifications have been made:

- A qualitative question has been 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, to gain insights on why this shift happened and what was the reason to chose the later app have been proposed.
- 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 is because measuring privacy concerns

over quantitative survey questions was realized to be tough and ambiguous.

7 FUTURE WORK

Since people from all demographics were found to majorly use WhatsApp the surveys need to modified to understand if they always used WhatsApp or did they switch to it at some point later and also understand the reason for it in both cases. For the 5 cultural constructs, a total of 9 questions have been curated. For cultural constructs with multiple questions, weights shall be applied to the values of the responses as per the values mentioned by Taras et. al[14]. After scores have been gathered for every individual cultural construct of Hofstede[6], they shall be correlated with constructs mentioned in the UTAUT model by Venkatesh et. al[16].

The questions proposed in UTAUT model under individual construct are very varied in the survey presented by this research. To cite an example, under the effort expectancy construct of UTAUT we have formulated questions on factors of ease and security. To club these questions in such a way that they result in a single output would be unjustifiable. The sole reason being, the responses they collect are based on two entirely different domains itself. Hence, the authors suggest to keep the questions modelled on UTAUT different and unbundled.

Cronbach's alpha shall be used as the coefficient of reliability. This shall help us define whether the questions we have designed is accurately measuring the variable of interest. This shall be done on likert questions which measure culture as they involve answers to be ranged in between two anchors. **Confirmatory factor analysis** will result for the final scales. For deriving inferences, **PLS correlation** would be used to find serial auto correlation between data variables. The variables for this data analysis model shall be the 5 constructs of culture and relevant questions from the UTAUT part. Also internal composite correlations shall be drawn amongst relevant questions from the UTAUT questions. This shall help us analyze whether questions formulated under UTAUT are correlated internally in some way. For conclusion the following schema shall be followed on the **correlation matrix**:

- if correlation between 2 variables is greater than 0.5, then these 2 variables shall be considered to be positively correlated
- if correlation between 2 variables is lesser than -0.5, then these 2 variables shall be considered to be negatively correlated
- if correlation between 2 variables lies in between -0.5 and 0.5 then their response will be considered in different

The authors wish to validate their hypotheses and derive additional inferences from the results achieved via analysis of this correlation matrix.

8 RESOURCES

For conducting the surveys, we had considered two important segments: a) `Likert Scales` and b) `Scenario based questions`. We chose Google Forms as our carrier for survey instrument due to its ease of use and data collection.

For conducting statistical analysis, regression tools shall be utilized. *Microsoft Excel* will be used to handle the data and maintain records. Correlations shall be found using statistical softwares like *R Studio* and *Minitab*.

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A PILOT SURVEY

A.1 Facilitating Conditions

(1) At what age did you start using the messaging app? (<18, 18 to 24, >24)
(2) Which app do you use as your primary messaging app? (WhatsApp, Facebook Messenger, Other)

(3) Do most of your close friends use the same messaging app as you? (Yes, No, Maybe)
(4) 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 chat with family and other relatives? (WhatsApp, Facebook Messenger)
(2) Which app do you use as your primary messaging app? (WhatsApp, Facebook Messenger)
(3) Which app would you prefer to use for professional conversations? (WhatsApp, Facebook Messenger, Other)
(4) Which app would you prefer to chat 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?
(3) How would you rate Facebook Messenger compared to WhatsApp on the basis of TRUST?

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 news
- I fairly know how encryption works and I have heard about cryptography
- I follow tech and am know the jargon
- 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

(1) Employees should not talk to their bosses about personal matters.
(2) Power and wealth are evil.
(3) It is all right for employees to disagree openly with their bosses.
(4) It is important for me to be able to work independently.

A.6 Uncertainty Avoidance

(1) Rules and regulations are important and it's customary to abide by them.
(2) Change in my life is important to me.
(3) It is important to be flexible during negotiations.
(4) A manager must be an expert in the field in which he or she manages.

A.7 Uncertainty Avoidance

(1) Rules and regulations are important and it's customary to abide by them.
(2) Change in my life is important to me.
(3) It is important to be flexible during negotiations.
(4) A manager must be an expert in the field in which he or she manages.

A.8 Individualism - Collectivism

(1) When a girl/ boy becomes 21 years of age, they should be encouraged to move away from home.
(2) If an individual thinks of a different way to perform a task, that person should be encouraged to do it that way, even if there is a chance of failure visible in that way.
(3) It is important that people conform to the group's norms to reach their goals.
(4) I would always cooperate to keep group harmony.

A.9 Masculinity - Femininity

(1) It is very important for me to receive recognition for my work.
(2) The most important things to my career are a good salary and a job that I do well and like.
(3) My job is only one of many parts of my life.
(4) It is important to finish one interaction before rushing off to another.

A.10 Masculinity - Femininity

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(2) The most important things to my career are a good salary and a job that I do well and like.
(3) My job is only one of many parts of my life.
(4) It is important to finish one interaction before rushing off to another.

A.11 Time Orientation

(1) I have the approach of "Taking one step at a time."
(2) Short Term goals collectively align your interests and careers more effectively than long term goals.

A.12 Demographics

(1) Your Name
(2) Your Gender (Male, Female, Other, Prefer not to say)
(3) Your Age
(4) Number of languages you are comfortable with...
(5) Have you lived out of your home for >1 year? (Yes, No, Maybe)
(6) Guardian's email id

B FINAL SURVEY INSTRUMENT

B.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)

B.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)

B.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?

B.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
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    - 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)

B.5 Power Distance

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

B.6 Uncertainty Avoidance

(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.

B.7 Individualism - Collectivism

(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.

B.8 Masculinity - Femininity

(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.

B.9 Time Orientation

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

B.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