Trust in Technology: A Survey Tool to assess users' trust experiences

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Abstract

This work reports a survey mechanism to empower non-experts to measure technology trustworthiness. It uses a validated Human-Computer Trust Scale (HCTS) with nine items and aims to answer if (RQ1) Can this survey system build from the HCTS be a valuable tool for mapping user's Trust in a system? (RQ2) Can the HCTS be used to support trustworthy design practices? Overall results indicate that the system can be a helpful tool and can be an effective tool to map trust behaviours towards technology. The majority of the inquired (designers) considered simple, valuable and easy to use the tool. However, it was challenging to understand and interpret the results. Highlighted points are the fact of being not technical, practical, and simple to apply. Results also indicate that it can be an effective tool to map trust behaviours across cultures when analyzed with complementary indicators, like differences, privacy perception.

Keywords: Trust in technology, User research, design methods, User Experience

1. Introduction

As Zuboff [25] remarked technology changed our economic system's and transformed our society into a "surveillance capitalism" system. Such intertwine between technology our daily activities, and the inability to predict their behaviours led to the need for trusting technology and debating for trustworthy design systems. This forced the need for novel social and cultural regulations on trust related topics like: privacy, security, and ethical approaches in design [3]. As well as forced the current need to build more human-centric tools that foster privacy & trust awareness. Even so, detrimentally of the default mainstream attention given to ethics, privacy and security, we continue to feel threatened and not know how our data is being used or misused [18], [13], [22]. More, as literature acknowledges, one of the major issues in trust research in technology is the failure to recognise the construct's subjective and multi-dimensional nature, as trusting can be interpreted from different lenses [15] [17]. For instance, for some authors people don't develop Trust with technological artefacts, people trust people, not technology because it lacks volition and moral agency [4], [24], [20]. For others, trust is technology-centric in nature detrimentally to Human-centric nature. Other focus on studying the effects of trust in the human-artefact relationship [1],[2], [16], [21], [23]. Consequently, it makes it difficult for practitioners to fully grasp these concepts and applications or even recognise their role to facilitate human-computer interactions (HCI), eventually leading to breaches of Trust, both behavioural and perceived.

2. Background

Trust is "a willingness (belive) of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" [25]. Current strategies for advancing technological innovations should support that understanding. As pointed by Zuboff [25] much still needs to be done further to understand the effects on users' trust behaviours or prevent breaches of trust in technology. Mechanisms that can eventually help to avoid a possible decline in a crisis of trust in technology that, besides leading to possible harmful effects on society, can affect individuals' relationship with technology.

2.1. Models to Measure trust in Technology

The literature provides an oversupply of models and frameworks on how to trust in technology can be measured and conceptualized in the Human Computer Interaction field. Since the study of Muir & Moray [17] - considered the first study about the measure of trust in automation - many studies have been created with the same purpose. However, they showed some problems. Empirically derived (ED) [10], Human-Computer Trust (HCT) [14], SHAPE Automation Trust Index (SATI) [5] [11], are examples of that. All these scales have benefited from empirical study and systematic development, yet each has its flaws. The ED instrument, for instance, addresses trust in automation in the abstract without reference to an actual system and, as a consequence, appears to be more a measure of propensity to trust than trust in a specific system. The HCT was developed from a trust model and demonstrated agreement between items and target dimensions but stopped short of confirmatory factor analysis. SATI development neglected psychometric tests of construct validity. The Human-Computer Trust Model Scale (HCTM) [8] developed recently and demonstrated to be reliable as it went through a rigorous empirical testing process. Assessing the scale validity in four specific technological applications - E-Voting, Siri and two futuristic scenarios home for life and futures schools [6], [7]. It is also a simple and easy to use a scale that portrays perceived trust in technology through 3 main attributes: risk perception, Competence, and Benevolence.

3. The methodology

The goal was to build a mechanism to assess Trust in technology simple and easy to use by designers and other stakeholders. This study procedure adopted a Design Science Research [9] approach and included four design stages — (1) discover, (2) define, (3) develop, and (4) deliver. [19]. Two main research focuses were considered here: (1) design and develop a survey instrument to measure Trust in technology for non-trust experts and (2) measuring the usefulness of the HCTS to support trustworthy design practices. **First** step focused on understanding the context - mapping users needs and exploring similar instruments in use. **Second**, define the personas, user requirements and low and high fidelity prototypes. **Third** and **fourth** steps focus on the system development and evaluation. During these two processes, the goal was to understand to what extent the designed system (built from the HCTS) could empower non-experts (e.g. interaction designers, developers) to design more trustworthy systems. As well as assess the extent to which the system can be efficient and easy to use. This study research questions: RQ1: Can this survey system build from the Human-Computer Trust Sale (HCTS) be a valuable tool for mapping user's Trust in a system? RQ2: Can the Human-Computer Trust scale (HCTS) be used to support trustworthy design practices?

3.1. System Design

This system (TrustedUX[1]) was build during October 2020 and March 2021, funded by the European Union Horizon 2020 research and innovation program under the NGI-TRUST (grant 825618). The design procedure followed a user-centred design approach, [19]. Highlighted aspects include: (1) **the main page area** provide guidelines to understand better how the trust assessment tool works as well as the research behind it with videos and written information. (2) **The survey setting area**, enables users to create a survey study intuitively. (3) **The data visualization/report area** is automatically generated and contains information about respondents demographic; the trust assessment results. also additional information that relates each answers, the scale trust attributes and the final results. The overall trust perception is calculated using a set of 9 statements where answers from participants are collected on a 5-point Likert scale according to the Gulati, e.t al. (2019) HCTS [8].

Phase 1 - discover. Focus on the system requirements analysis, specification and ideation. Here similar instruments in the market were examined, like the AttractDiff[2] and SUS [12]. As well as focused on understanding the context and needs of users, including the reasoning for their evaluation choices (techniques used include interview and participatory design sessions). Results lead us to define three system requirements main areas — A Main page or 'the information module that include information about the service, how it works, the research validity, resources available, the authors, etc. The survey and data collection area and the data analysis results visualization/report module.

Phase 2 - define. This phase build from previous information including the interviews with stakeholders (trust expert, UX researcher and a interaction designer) to defined four Personas. Those helped to illustrate potential users goals and motivations, consequently those personas were validated with users (a UX designer and a teacher, a student). This process was followed by the Information Wire-flow to identify the functional and non-functional requirements, and UML- entity-relationship diagrams, both complemented the user requirements descriptions, see figure below. We also created a mood board using the Miro tool that informed mainly the designed aesthetics. This provided a more seamless collaboration between the team involved in the project, the designer, UX researcher, trust expert and Developers. This phase was complemented by interactive feedback evaluation studies reported in the next design phase. This helped to understand the potential user and their usage journey needs.

Phase 3 - Develop. In this phase, started with prototyping the different components of the system informed by both wireframes and the Card sorting procedures performed in previous phases. Those prototypes went through three different interaction cycles - prototype, evaluation and re-design. The final results presents three distinctive information screens (1) main page' or 'the information area. Mainly provides information about 'why using the service', 'how it works'; 'the research'; 'resources available?'; 'the authors' and 'try it now'; (2) the survey component included the validated Human-Computer Trust Scale (HCTS) with nine items and complementary demographic questions (Age, Gender, Education and Nationality). The data analysis and visualization module provided the data analysis and the interpretation of the results. Tools used for prototyping: Miro[3] and Figma[4].

3.2. Results and Discussion

In this final phase of the system design deliver the authors performed two main usability assessment studies.

[1] www.trustux.org
[2] http://www.attrakdiff.de/index-en.html
[3] https://miro.com/
[4] https://www.figma.com/

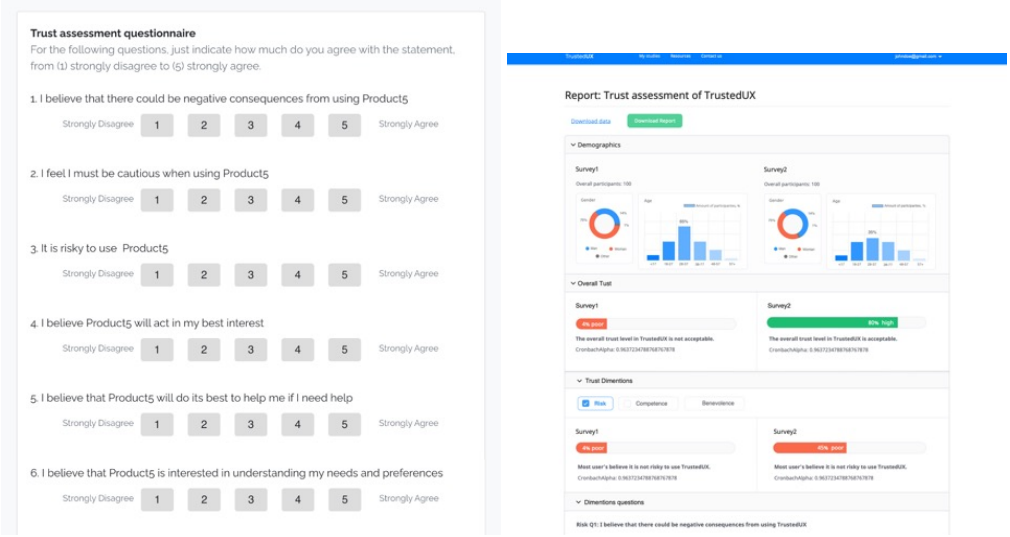

Fig. 1. Survey & results visualization/report

UX evaluation - Lab study. The goal of this study was focus on asking participants to use the system (task script protocol) to assess it efficiency and effectiveness using metrics like: Time to task, Effort, Errors. Six participants were invited to perform three main tasks 1) creating an account; 2) Create a new survey to measure trust in Alexa 3) Interpret the results reports. This study was performed during December 2020. Findings on the usability performance of the system indicated good usability standards with minimal errors and effort. However, the Findings on the usability performance of the system stated good usability standards with minimal errors and effort. However, the login process can be improved and simplified. Participant 1 choose the Google sign up option, which takes fewer clicks and considerably less time. Participant 2 enter a user name and password before creating an account, and three was confused with the password criteria - not alphanumeric. Additionally, results indicated that some terms need to be further clarified and used consistently. As well as results indicated that some spelling typos and code errors persist and need to be fixed as well. For instance, participant 4 reported that when he wants to sign-up, the first option which he sees is 'Try now', but on the front page, it says, 'Try it now'.

UX evaluation - longitudinal field study. The second study aimed to invite three participants to apply the instrument and reflect on the usefulness and practicability of the survey system to measure trust user's Trust in a system. This study was performed during March 2021. Participant 1, UX designer evaluated users trust in Google home, Participant 2, Business Development, assessed users' trust in Hoia.me COVID-19 Tracing app and three a student evaluated users trust in WhatApp. Findings will be reported below. All participants in the longitudinal field study were able to apply the scale and report valuable insights on users perceived trustworthiness. Also were able to understand the influence of each individual construct of the model (risk perception, Competency and Benevolence) in the user's perceived Trust. Participant 1, for instance, observed and reported that google home is perceived as low in Trust (score 60.8%, M=3.0), with the most critical dimension associated with risk perception and concluded that the google home system still needs to provide more visual cues on how trustworthy it is. Participant 2 collected data from 78 respondents and found out that half have either a poor or very low level of Trust in HOIA, and the causes for mistrust, include aspects like not believing that HOIA is competent to decrease the spread of the virus. This participant was able also to use the results to redesign a proof of concept with a set of guidelines for supporting Trust in HOIA's competence, with the help of a group of design experts. Participant three found out that the system can be an

effective tool for mapping trust behaviours across cultures when analyzed with complementary indicators, like gender differences and privacy perception.

In sum, results indicate that in fact this (**RQ1**) survey system build from the HCTS can be a valuable tool for mapping user's Trust in a system. When asked all participants considered the system to be a valuable tool for mapping a user's Trust in a system by its users. the AttrakDiff Semantic Differential Scale used in the study also indicated that particiapnts consider the system to be human, not technical, simple and not complicated, practical, bold, innovative but challenging when asked to rate the system using. As remarked by a participant, "The mode of calculating the user scale is unclear to me. I believe a standard and easy way to calculate user response will help improve the method more." Therefore, despite being. More, the system also has proven to be able to support trustworthy design practices (**RQ2**). However, complementary work needs to be done for the system to support designers fully. For example, more information is needed with guidelines/visual cues and hints on designing or supporting trustworthy systems (e.g. indicating how to create visual cues that can leverage positive risk perceptions of the system). As a participant remarked: "I think it's more for academics/researchers. However, there are many business analysts or UX designers who don't have so much academic or research experiences, maybe it could be somehow more for them as well? For example, at my workplace, we have UX initiatives, and not many of them are actually UXers, but people coming from different areas trying to get UX into their work/products, and for them, I guess they need more guidance about what it is about."

4. CONCLUSION

This research project builds from the rationale that we need to provide more instruments to assess users' predispositions to trust a technological artefact. Overall results indicate that the system (TrustedUX survey system[5]) build from the HCTS [8] has proven to be a valuable instrument to serve as lenses to explore and map trust behaviors towards technology. Highlighted points are the fact of being not technical in nature, practical, and simple to apply. Results also revealed that the HCTS could be used to map trust behaviours across cultures if analysed with complementary indicators. Future impact: this instrument is just an indicator of how users' perceive Trust in technology. It does not provide additional insight on the reasons for the mistrust or trust. However, participants still struggle to understand how to interpret into providing design recommendations.

References

1. Ajenaghughrure, I.B., Sousa, S.C., Kosunen, I.J., Lamas, D.: Predictive model to assess user trust: a psycho-physiological approach. In: Proceedings of the 10th Indian conference on human-computer interaction. pp. 1–10 (2019)
2. Benbasat, I., Wang, W.: Trust in and adoption of online recommendation agents. Journal of the association for information systems **6**(3), 4 (2005)
3. Eike, E.: Digitalisation and democracy: fake News, disinformation and the EU. Master's thesis, Norwegian University of Life Sciences, Ås (2020)
4. Friedman, B., Khan Jr, P.H., Howe, D.C.: Trust online. Communications of the ACM **43**(12), 34–40 (2000)
5. Goillau, P., Kelly, C., Boardman, M., Jeannot, E.: Guidelines for trust in future atm systems-measures (2003)
6. Gulati, S., Sousa, S., Lamas, D.: Modelling trust: An empirical assessment. In: 16th IFIP TC 13 International Conference on Human-Computer Interaction — INTERACT

[5] https://www.trustux.org/

2017 - Volume 10516. pp. 40–61. Springer-Verlag, Berlin, Heidelberg (2017)
7. Gulati, S., Sousa, S., Lamas, D.: Modelling trust in human-like technologies. In: Proceedings of the 9th Indian Conference on Human Computer Interaction. pp. 1–10 (2018)
8. Gulati, S., Sousa, S., Lamas, D.: Design, development and evaluation of a human-computer trust scale. Behaviour & Information Technology **38**(10), 1004–1015 (2019)
9. Hevner, A., Chatterjee, S.: Design science research in information systems. In: Design research in information systems, pp. 9–22. Springer (2010)
10. Jian, J.Y., Bisantz, A.M., Drury, C.G.: Foundations for an empirically determined scale of trust in automated systems. International journal of cognitive ergonomics **4**(1), 53–71 (2000)
11. Kelly, C., Boardman, M., Goillau, P., Jeannot, E.: Guidelines for trust in future atm systems: A literature review (2003)
12. Lewis, J.R.: The system usability scale: past, present, and future. International Journal of Human–Computer Interaction **34**(7), 577–590 (2018)
13. Lorenz, Birgy; Sousa, S., Tomberg, V.: Privacy awareness of students and its impact on online learning participation - a case study. In: Open and Social Technologies for Networked Learning: IFIP WG 3.4 International Conference, OST 2012. pp. 189 – 192. Springer Verlag (2013)
14. Madsen, M., Gregor, S.: Measuring human-computer trust. In: 11th australasian conference on information systems. vol. 53, pp. 6–8. Citeseer (2000)
15. Mayer, R.C., Davis, J.H., Schoorman, F.D.: An integrative model of organizational trust. Academy of management review **20**(3), 709–734 (1995)
16. Mcknight, D.H., Carter, M., Thatcher, J.B., Clay, P.F.: Trust in a specific technology: An investigation of its components and measures. ACM Trans. Manage. Inf. Syst. **2**(2), 12:1–12:25 (Jul 2011). https://doi.org/10.1145/1985347.1985353, http://doi.acm.org/10.1145/1985347.1985353
17. Muir, B.M., Moray, N.: Trust in automation. part ii. experimental studies of trust and human intervention in a process control simulation. Ergonomics **39**(3), 429–460 (1996)
18. Oper, T., Sousa, S.: User attitudes towards facebook: Perception and reassurance of trust (estonian case study). In: International Conference on Human-Computer Interaction. pp. 224–230. Springer (2020)
19. Rugman, A.M., D'cruz, J.R.: The" double diamond" model of international competitiveness: The canadian experience. MIR: Management International Review pp. 17–39 (1993)
20. Shneiderman, B.: Designing trust into online experiences. Communication of the ACM **43**(12), 57–59 (2000)
21. Söllner, M., Leimeister, J.M.: What we really know about antecedents of trust: A critical review of the empirical information systems literature on trust. Psychology of Trust: New Research, D. Gefen, Verlag/Publisher: Nova Science Publishers (2013)
22. Sousa, S., Bates, N.: Factors influencing content credibility in facebook?s news feed. Human-Intelligent Systems Integration pp. 1–10 (2021)
23. Sousa, S., Lamas, D., Dias, P.: Value creation through trust in technological-mediated social participation. Technol Innov Educ. Springer Berlin Heidelberg (2014)
24. Zheng, J., Veinott, E., Bos, N., Olson, J.S., Olson, G.M.: Trust without touch: jumpstarting long-distance trust with initial social activities. In: Proceedings of the SIGCHI conference on human factors in computing systems. pp. 141–146 (2002)
25. Zuboff, S.: Big other: surveillance capitalism and the prospects of an information civilization. Journal of Information Technology **30**(1), 75–89 (2015)