Aligning AI with Security and Democracy Perceptions to Improve QoE and QoL

Anonymous Author(s)
Affiliation
Address
email

Abstract

Rapid advancements in artificial intelligence (AI) along with the deployments of more data-driven pervasive technologies are currently offering incredible possibilities and solving problems in innovative ways. The pace of AI's development is so fast that it is hard to follow in details all the ethical and social implications. Therefore, it is legitimate to assess the effect of AI-based technologies on day to day quality of life. This paper analyzes the effect of the user's Quality of Experience (QoE) when using these new AI-based services on the Quality of Life (QoL). In particular, this paper focuses on two aspects: security and democratization. The security threats of any new technology defines the QoE especially nowadays after revealing warning signs regarding privacy threats and lack of public trust. Furthermore, democratization perception in terms of technology used is also a crucial feature that governs steering AI development towards ethically serving the interests of the society; and therefore improving the QoE and QoL. Hence, we propose a framework to provide comprehensive analysis of the current status in the existing literature while focusing on the anticipated tools for democratization. In addition, we highlight some research gaps and suggest future opportunities to be addressed.

1 Introduction

Nowadays, Artificial Intelligence (AI) is considered a key technology that is driving our world and forming the basis of all learning and future complex decision making. AI is currently deployed in several industries such as healthcare, transportation and the production chain [1]. Researchers anticipate that AI will impact every corner of our lives and transform our societies both positively and negatively [2]. The versatility of AI technologies address challenges in a broad range of fields such as biomedical, financial and autonomous machines. AI algorithms are impacting our lives through guiding several decision making processes and stakeholders.

However, not all the AI innovations are societally beneficial. One central concern about the improvements that come along with AI advancements is the security. Several AI environments rely on collecting and sharing information which pose major privacy issues. In general, AI performs better when more data is collected. Most of the users are aware of the threat to privacy that comes from social media algorithms. However, the usage of this data poses an issue when users are unaware of how their private data will be used.

Recently, another dimension emerged that may affect the acceptance of the AI services which is the need for democratic control. Users are requesting more tools for democratization in the field of AI. Such tools take several forms such as governance mechanisms and proposed regulations. These tools are nowadays crucial especially that few big tech companies concentrate power in their hands which impacts negatively the democratic process. These companies appreciate the significance of

Submitted to 35th Conference on Neural Information Processing Systems (NeurIPS 2021). Do not distribute.

collected data; and hence will always be data thirsty and may override any legal or ethical rules in order to collect more data. These companies are so profitable that they can shape the economy of some countries and support opinions that they deem beneficial. These corporations are ubiquitous technically and societally. Hence, there are several efforts to frame the relationship between AI-based technologies and democracy.

The role of the AI-based technologies is key in all areas of our lives such as health and social care. Most of these technologies are in general extremely helpful and aid in improving the Quality of Life (QoL). The QoL is a multidimensional concept that has several definitions in the literature. The World Heath Organization (WHO) defines QoL as 'individuals' perception of their position in life in multiple contexts and over four domains, i.e., physical health, psychological, social relations, and environment. Technology today is leading these domains and the bond is expected to be even stronger in the upcoming eras. Therefore, the AI-based services have a great impact on our everyday life. AI can then improve the quality of life but may create potential risks that should be seriously considered and solved.

Along the same direction, AI-based technologies and applications aim at satisfying the user's expectations which is measured using the Quality of Experience (QoE). QoE is defined as the end-user's acceptability of an application or service [3, 4]. It measures the degree of delight or annoyance of the user which is affected by the impact of several QoE factors, defined as "any characteristic of a user, system, service, application, or context whose actual state or setting may have influence on the QoE for the user" [4].

In this paper, we highlight some of the debates around AI-based technologies especially those that cause users to question whether their privacy is being violated. In addition, some users request having tools for democratization to be sure that AI will not damage them. Ultimately, to fully adopt AI with all its improvements, users should have good perceptions of AI security and AI democratization. Only then can the full deployment of AI improve the user's quality of experience and quality of life.

2 Related work

The literature has developed a number of studies that can help understand the dependencies between QoL, QoE, security perception and democratization perception. In this section, we present and analyze relevant works in the literature to provide a details understanding of the difference concepts and their dependencies.

When implementing any service that aims at supporting the community, the QoL of the community that will access the service is studied in order to estimate their willingness to accept new tech services and to approximate the QoE [5]. Even in non-technical aspects, the perceptions of home care experience of elderly for example are associated with quality of life outcomes [6]. There are some studies that link the QoE to QoL in particular one application such as television viewing where researchers study the relationship between how people actually experience television (QoE) and how television viewing affects QoL [7]. In addition, the amount of energy consumed by commercially available sensors and mobile devices affects the QoE which directly affects the QoL due to the burden of recharging the devices frequently [8].

Even though the AI-based services and technologies pose major security issues and threats, the studies in the literature addressing the impact of security perception on QoE are still limited. The user should trust the AI-based activities so that the user can perceive these services as positive experience. This trust relationship is affected by many factors such as risk, web security, privacy and design [9]. Customers tend to have bad experience when they face poor security features [10]. For example, in the e-health domain, mobile health systems are being proposed to be used by nurses to help in decision making; however, these systems should pass the perceived security check before being deployed [11].

The e-health services are also heading towards democratization for better QoE. Physicians should be able to examine patients remotely and use AI-based services that aid in decision making. These services require acceptable web connection services which is poor in certain areas of the world; therefore, users are requesting democratizing the e-health [12]. The experience of users with digital technologies like AI is being shaped by the lawless environment; therefore, some challenges of AI need rules which encompass the legitimacy of democratic process [13].

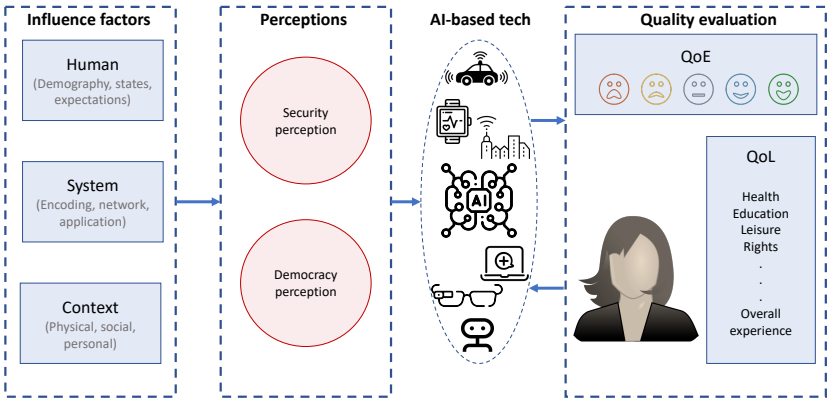

Figure 1: Framework showing dependencies and impact of influence factors, perceptual dimensions, the use of AI, QoE and QoL.

To cope with all these challenges accompanying the invasion of AI-based technologies, several studies are looking at different aspects of the problem. However, to our knowledge, there is no one framework that provides a holistic view conveying all the dependencies. In this direction, we provide a comprehensive approach that aligns the sphere of AI advancements with QoE and QoL while taking into consideration the user's perception of security and democratization.

3 Research methodology

The main goal of the paper is to help understand the relationship between AI and QoL and propose a holistic framework that contributes in improving the QoL by highlighting the current and future security and democracy-challenged AI environment. In order to reach this goal, we propose the framework in Figure 1 where we capture the different components that integrate together in the AI domain. As shown in the figure, there are several factors that affect each component; therefore, we aim at capturing these factors and study their relationship with the QoE and QoL metrics. In addition, we aim at studying the link between security perception, democracy perception, the use of AI-based technologies, QoE and QoL. Therefore, we collected and synthesized some papers from the literature that study the impacts of these components and the mutual interplay between them. We then compare these studies and highlight the research gaps and suggest different opportunities to be addressed in the future AI democracy-challenged environment.

The main objectives of this research are:

- to further understand the relationship between QoL, QoE, security perception and democracy perception;
- to study and analyze existing works in the field;
- to highlight gaps and propose novel directions to solve current and future anticipated challenges.

4 Impacts and dependencies

In the previous section, we generally present the framework in Figure 1 and briefly state the dependencies between the different terms, i.e. influence factors, security perception, democracy perception, QoE and QoL. This section analyzes these dependencies further and reports some existing studies to identify the research gaps and highlight the need for further studies.

4.1 Impact of QoE on QoL

There is a high impact of QoE on QoL and this is presented in several works in the literature. However, not all of these works consider the AI-based technologies as their field of study. In addition, QoL has

several dimensions. For instance, the user's health is one dimension; in this sense, QoE will affect QoL in terms of user's health when using recent advances in e-health systems. In general, higher QoE reflects better quality of life.

The recent integration of AI in advanced technologies such as machine-to-machine communications has led to involving novel metrics to measure the performance of the machines (accuracy), the satisfaction of the user (QoE) and the effect of the machine on user's life (QoL) [14]. In addition, some works model the relationship between QoE and QoL in terms of service delay. Lower service delay leads to a better QoE, and hence, a higher QoL which is an inextricable part of our day-to-day life [15]. In [16], the authors present a suite of mobile and e-health service to improve the QoL. The proposed work implements AI algorithms to automatically detect anomalous behaviour of elderly. This work uses the data collection and survey approach to be able to discuss the impact of QoE on QoL. They conducted surveys on the user acceptance where they used 5-point Likert Scale to get feedback from users about items related to QoE and QoL. The interesting aspect in this work is that QoE has been quantified using the System Usability Scale (SUS).

AI algorithms have also to develop an automated readability assessment estimator over German text. In order to assess the whole system, some researchers use a QoE approach to assess the performance of the proposed algorithms and the time-saving effect on everyday life [17]. Moreover, autonomous electric vehicles are an important example of advanced AI-based technologies. There are several features in autonomous vehicles; however, most of the important features are related to quality of experience aspects. They can directly affect everyday life through saving lives by connecting the autonomous vehicles [18]. Furthermore, time is becoming more and more important to people nowadays that even a visit to the museum can be optimized. In [19], the authors study the behavior of museum's visitors who try to maximize their quality of experience by time management. A Reinforcement Learning (RL) approach was proposed which learns from the visitor's behavior to make instantaneous time suggestions in order to maximize the QoE and QoL. Smart cities is also a hot topic in AI that directly affects the daily life of occupants. For instance, crowd management systems are important to improve the QoL of citizens. One selected work in this aspect used deep RL perspective [20].

Even though several studies addressed the impact of QoE and QoL, there is still a need for researches to study the impact of QoE on QoL in AI-based technologies in particular. In addition, the different dimensions of QoL should be studied together to see how AI affects several aspects of our lives (e.g.: health, education, economy, governance, etc...).

4.2 Impact of security perception on QoE

Limited works in the literature addressed the impact of security on QoE in AI environment. In general, most of the studies tackle the security issue in one specific domain. For example, there are several works that use AI for cognitive wireless communications which are known to extensively improve the users' technical QoE; however, they are not adequate to meet some security checks. To satisfy the QoE in terms of security concerns, wireless communications use complicated decision making, network management and resource optimization. Although these advanced techniques have high costs of deployment, they improve the security of cognitive wireless communications; and thus, increase the QoE [21].

Some works study the impact of security perception on QoE in terms of energy metric. Building adaptive and secure management computer systems that offer good Quality of Service (QoS) and Quality of Experience (QoE) consume high levels of energy consumption. Therefore, some approaches incorporate self-awareness so that computer systems react rapidly to any change in the network while meeting QoE and security requirements [22]. The quality of experience in the education domain has also been impacted by the security perceptions of users. Educational platforms are using AI-based solutions to become smarter especially after the COVID-19 pandemic which showed the need for remote learning. However, the rapid growth in technology field has been faster than the education practices. Hence, users might find new AI-based technologies insecure and challenging which impacts their overall QoE [23].

In terms of communication networks, one key challenge is the management of the security of the network. AI is helping to solve associated security issues for 5G. AI provides easy migration to verticals-industries so that the QoE of users is maintained. The scalability needs also further

improvement in terms of connectivity and computation offloading to improve QoE in edge applications [24, 25].

After checking the available literature that studies the impact of security on QoE in AI domain, we can state that the number of studies is still limited. In addition, the impact and the relationship between QoE and security is still not quantified.

4.3 Impact of democracy perception on QoE

Finally, we move to discuss the impact of democracy perception on QoE in AI environments. Some approaches use surveys to collect data regarding the experiences and insights of democratic experts to acquire their thoughts about the effect of AI on democracy which impacts the QoE. The answers in the surveys showed that experts expect that there is no turning back at this point in AI which is currently enmeshed into our everyday life. However, the current use of AI is incongruent with fundamental democratic principles. In [26], the authors differentiate between direct and indirect democracy to study its effect on QoE. They capture all the principles of democracy including human rights, justice and freedom. Other works provided models that consider the social and ethical dimensions to help in assessing the democratization tools. They base their models on a conceptual understanding and the experience of users in similar cases [27].

Richard Sclove, the writer of *Democracy and Technology*, an award-winning book, stated 26 years ago that with the advancements in AI, we should pay greater attention to the regulation of the new technologies to guarantee acceptable quality of experience of users [28]. Recently, there are contradicting studies when it comes to the effect of AI on democracy and its impact on the experience of the citizens in particular. On one hand, the authors in [29] discuss that AI-based technologies' principal function is to gather personal information to create behavioral profiles which can be used to distort democracy and individual rights. They expect that AI will be weaponized to corrupt elections. On the other hand, the authors in [30] look into AI as a potential solution to increase governmental efficiency and to improve citizens' experience and their interaction with their government; and hence, improve citizens' experience. Furthermore, researchers are investigating the role of certain fields of AI such as blockchain in realizing the potential of AI-based technologies and democratization [31].

5 Discussions of key findings

In the previous section, we presented the basis for a set of research directions towards finding the relationship between security perception, democracy perception, QoE and QoL. The most important finding is that there are very limited papers that discuss these relationships in the field of AI. However, there are several papers that tackle each of these aspects alone in the field of AI. Another important finding is that these relationships are not modelled or quantified. Therefore, we propose several future interdisciplinary research directions.

The basis of the relationship between QoE and QoL depends on simple IF-THEN rule as follows: if the AI service provided gives the user higher QoE, then the quality of life will improve. This rule is based on the fact that QoL nowadays depends on technology and in particular AI-based technologies that are automating several human tasks. Therefore, a research opportunity is to quantify this effect of QoE on QoL in AI context. This research direction is important to allow all stakeholders to estimate and expect the change in QoL influenced by QoE; hence, predict the future demand of their provided service.

Furthermore, QoE is impacted by several influence factors that are related to human, system and context. Hence, QoE is multidimensional. We focus in this paper on two dimensions: security and democracy. However, there are several other dimensions that can be further investigated and quantified. For instance, The influence of security perception and democracy perception can be modelled and quantified using regression models.

This recommendation for future research direction can be further investigated using Natural Language Processing (NLP) algorithms to collect more articles, comments, posts and tweets that link QoE to security and democracy perceptions in the field of AI. Accordingly, the impact of these perceptions on QoE can be then collected and analyzed from real users' experience. In addition, real surveys can also be conducted to capture the thoughts of people on the relationship between their perceptions

of both security and democracy and the QoE of any AI service. This full quantified framework will provide more accurate modeling and evaluation of QoE and QoL metrics.

6 Conclusion

AI is greatly impacting our lives in both positive and negative manners. With the rapid advancements in AI, the challenges accompanying this technology will increase, which draws our attention towards taking actions to resolve its arising challenges. These challenges are mainly related to security and democracy perceptions. It is crucial to address these challenges when designing future AI-based solutions.

The full positive potential of AI can only be reached when users; all users; have good perceptions of AI security and positive effect on democracy. Therefore, this paper aims at understanding the relationship between AI-based technologies and the user's security and democracy perceptions as well as their effect on the quality of experience (QoE) and the quality of life (QoL). This paper proposes a novel framework that puts all these concepts into a layered perspective which clearly represents the impacts and the interplay dependence starting from general influence factors to reach the major performance metric which is QoL. The findings in this work shall ensure that any future developments in the field of AI will take real people as reference points to gain their trust in terms of security and democracy. Future work will explore further the link between AI science and societal consequences. In addition, future directions will dissect this field further to decide which sub categories should be promoted and which should be restricted.

References

[1] Stead, W. W. (2018). Clinical implications and challenges of artificial intelligence and deep learning. Jama, 320(11), 1107-1108.

[2] Zou, J., & Schiebinger, L. (2018). AI can be sexist and racist—it's time to make it fair.

[3] Abbas, N., Hajj, H., Dawy, Z., Jahed, K., & Sharafeddine, S. (2017). An optimized approach to video traffic splitting in heterogeneous wireless networks with energy and QoE considerations. Journal of Network and Computer Applications, 83, 72-88.

[4] Brunnström, K., Beker, S. A., De Moor, K., Dooms, A., Egger, S., Garcia, M. N., ... & Zgank, A. (2013). Qualinet white paper on definitions of quality of experience.

[5] Rojas-Mendizabal, V. A., Serrano-Santoyo, A., Conte-Galvan, R., & Gomez-Gonzalez, A. (2013). Toward a Model for Quality of Experience and Quality of Service in e-health Ecosystems. Procedia Technology, 9, 968-974.

[6] Malley, J., D'Amico, F., & Fernandez, J. L. (2019). What is the relationship between the quality of care experience and quality of life outcomes? Some evidence from long-term home care in England. Social Science & Medicine, 243, 112635

[7] Kubey, R., & Csikszentmihalyi, M. (2013). Television and the quality of life: How viewing shapes everyday experience. Routledge.

[8] Taleb, S., Hajj, H., & Dawy, Z. (2018). EGO: Optimized Sensor Selection for Multi-Context Aware Applications with an Ontology for Recognition Models. IEEE Transactions on Mobile Computing, 18(11), 2518-2535.

[9] Baraković, S., Baraković Husić, J., Maraj, D., Maraj, A., Krejcar, O., Maresova, P., & Melero, F. J. (2020). Quality of life, quality of experience, and security perception in web of things: An overview of research opportunities. Electronics, 9(4), 700.

[10] Shin, D. H. (2017). Conceptualizing and measuring quality of experience of the internet of things: Exploring how quality is perceived by users. Information & Management, 54(8), 998-1011.

[11] Jaradat, M. I. R. M. (2021). Exploring the influence of security/privacy, trialability, output quality and anxiety on the adoption of mobile decision support systems among nurses: a developing country context. International Journal of Mobile Learning and Organisation, 15(3), 251-281.

[12] Bhattacharyya, A., Agrawal, S., Rath, H. K., & Pal, A. (2019, June). Towards Democratizing E-health Under Constrained ICT Infrastructure Through 'A-REaLiST'Solution. In 2019 European Conference on Networks and Communications (EuCNC) (pp. 533-538). IEEE.

[13] Nemitz, P. (2018). Constitutional democracy and technology in the age of artificial intelligence. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376(2133), 20180089.

[14] Minovski, D., Åhlund, C., Mitra, K., & Zhohov, R. (2020). Defining Quality of Experience for the Internet of Things. IT Professional, 22(5), 62-70.

[15] Roy, P., Tahsin, A., Sarker, S., Adhikary, T., Razzaque, M. A., & Hassan, M. M. (2020). User mobility and quality-of-experience aware placement of virtual network functions in 5g. Computer Communications, 150, 367-377.

[16] Delmastro, F., Dolciotti, C., Palumbo, F., Magrini, M., Di Martino, F., La Rosa, D., & Barcaro, U. (2018, October). Long-term care: how to improve the quality of life with mobile and e-health services. In 2018 14th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob) (pp. 12-19). IEEE.

[17] Naderi, B., Mohtaj, S., Karan, K., & Möller, S. (2019, June). Automated Text Readability Assessment for German Language: A Quality of Experience Approach. In 2019 Eleventh International Conference on Quality of Multimedia Experience (QoMEX) (pp. 1-3). IEEE.

[18] Damaj, I. W., Serhal, D. K., Hamandi, L. A., Zantout, R. N., & Mouftah, H. T. (2021). Connected and Autonomous Electric Vehicles: Quality of Experience survey and taxonomy. Vehicular Communications, 28, 100312.

[19] Tsiropoulou, E. E., Kousis, G., Thanou, A., Lykourentzou, I., & Papavassiliou, S. (2018). Quality of experience in cyber-physical social systems based on reinforcement learning and game theory. Future Internet, 10(11), 108.

[20] Zhao, L., Wang, J., Liu, J., & Kato, N. (2019). Routing for crowd management in smart cities: A deep reinforcement learning perspective. IEEE Communications Magazine, 57(4), 88-93.

[21] Hwang, K., Chen, M., Gharavi, H., & Leung, V. C. (2019). Artificial intelligence for cognitive wireless communications. IEEE Wireless Communications, 26(3), 10-11.

[22] Gelenbe, E., Domanska, J., Fröhlich, P., Nowak, M. P., & Nowak, S. (2020). Self-aware networks that optimize security, QoS, and energy. Proceedings of the IEEE, 108(7), 1150-1167.

[23] Antoniou, J. (2021). Quality of Experience and Emerging Technologies: Considering Features of 5G, IoT, Cloud and AI. In Quality of Experience and Learning in Information Systems (pp. 1-8). Springer, Cham.

[24] Lovén, L., Leppänen, T., Peltonen, E., Partala, J., Harjula, E., Porambage, P., ... & Riekki, J. (2019). EdgeAI: A vision for distributed, edge-native artificial intelligence in future 6G networks. The 1st 6G Wireless Summit, 1-2.

[25] Suárez, L., Espes, D., Le Parc, P., Cuppens, F., Bertin, P., & Phan, C. T. (2018, November). Enhancing network slice security via Artificial Intelligence: challenges and solutions. In Conférence C&ESAR 2018.

[26] Christodoulou, E., & Iordanou, K. (2021). Democracy under attack: Challenges of addressing ethical issues of AI and Big Data for more democratic digital media and societies. Frontiers in Political Science, 71.

[27] Mantelero, A. (2018). AI and Big Data: A blueprint for a human rights, social and ethical impact assessment. Computer Law & Security Review, 34(4), 754-772.

[28] Sclove, R. (2020). Democracy and technology: an interview with Richard Sclove from Beth Simone Noveck. Digital Government: Research and Practice, 1(1), 1-6.

[29] Manheim, K. M., & Kaplan, L. (2018). Artificial intelligence: risks to privacy and democracy.

[30] Mehr, H., Ash, H., & Fellow, D. (2017). Artificial intelligence for citizen services and government. Ash Cent. Democr. Gov. Innov. Harvard Kennedy Sch., no. August, 1-12.

[31] Yánez, W., Mahmud, R., Bahsoon, R., Zhang, Y., & Buyya, R. (2020). Data allocation mechanism for Internet-of-Things systems with blockchain. IEEE Internet of Things Journal, 7(4), 3509-3522.