

Article

The societal and technological impact of Quantum Computers

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Abstract

This research focuses on quantum computing. These are rapidly developing technologies that can significantly advance areas such as cybersecurity, artificial intelligence, and data processing. The study examines both the advantages and limitations of quantum systems. The main goal of this research was to understand whether the world is ready for a quantum computer era and its future consequences. The investigation showed that quantum computing has certain limitations, including potential harms to cybersecurity. However, many studies suggest the development of new encryption methods to prevent quantum cyberattacks. The results of the work show that NISQ is highly noise-prone and error-prone. And many researchers expect a gradual transition to hybrid systems that combine classical and quantum computing. The study concludes that, while quantum computing has great potential, it still faces significant challenges, including stability, error correction, and ethical issues. The technology is still too immature for full-scale implementation. Still, a future can be envisioned in which quantum and classical systems coexist in a hybrid model, gradually shaping a new era of computing.

Keywords: Quantum computing, cybersecurity, adaptation, ethics, impact, cryptography.

I. INTRODUCTION

Quantum computing is a technology of the future that will give a massive boost to the development of computers and data processing. Many people are familiar with regular computers and know they use binary code (0 and 1), whereas quantum computers use qubits. They can be in different states at the same time [1]. This allows quantum computers to solve problems much faster.

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Quantum computers could be the beginning of a rapid development in technologies such as quantum mechanisms, networks, cryptography, and gaming [2]. But there are also significant risks that people may not be prepared for. For example, the problems that quantum computers can create in the field of cybersecurity, as they can make all encrypted data accessible to attackers [3]. It means that quantum computers are unstable and require detailed research. This is why this work focuses on studying whether humans can adapt to the power of quantum computers. [4]. This work will aim on identifying opportunities and challenges that bring quantum computers. Quantum computers and their power can be a threat. They give opportunities for solving complex problems, creating new models and advancing other fields in technology area. But they also make risks. Quantum computers can be used to solve complex scientific problems, for example creating more accurate computational models and improving data security. But in other side their advantages can also pose a threats like cracking existing encryption systems. In addition, quantum devices are still imperfect: they are prone to errors, require a lot of energy, and expensive equipment. There are also no clear laws and regulations governing their use. Therefore, the main challenge of this research is to determine whether it is possible to prepare for the emergence of quantum technologies in order to take advantage of their benefits while avoiding potential risks. Despite numerous studies devoted to the technical development, security implications, and potential applications of quantum computing, they still fail to answer the central question of this research: "Are people ready for a quantum computer?". Many gaps were addressed, including energy efficiency [5], cybersecurity [6], encryption methods [7], and quantum-powered artificial intelligence [8]. However, none of the articles demonstrated people's readiness for quantum computing, touching on ethics, the shift in the generally accepted concept of "computer," and the potential for a complete transformation of human life, just as it did with the creation of the first telephone and the internet. It would be useful to conduct a survey among ordinary people to gather their opinions on quantum computing, outlining all the pros and cons, as well as the potential risks of the transition from standard computing to quantum computing. Therefore, a clear scientific gap exists on this topic. Further research is needed, to understand how people will accept and adapt to a world with quantum computers. It is important to fill this gap to eliminate potential risks and assess humanity's readiness for quantum computing. In order to solve the problems that are associated with quantum computers, it is important to find a balance between their potential and the risks associated with them. In this work there are a couple suggestions that are brought in order for society to better prepare itself with the integration of quantum systems. On one hand it is important to support research and development related to quantum and quantum adjacent technologies, otherwise limiting progress in that field. On the other hand the international standards and regulations associated with them must be developed before it's wide adoption to the public mass, otherwise risking the situation similar to generative artificial intelligence models, which at the time of writing, include abuse and misuse of the technologies. Although already present, educational organizations should develop existing programs and consider opening new ones related to quantum technologies. However, basic programs added to the general curriculum should also be added to raise awareness. Despite all that, it's practically impossible for quantum technologies to gain immediate acceptance, however it's a necessary period, before it's wide adoption can be expected, which is crucial for future progress of the field.

Quantum technologies are not a thing of fiction today. And quantum computing will be introduced into people's lives in the near future. When the application of quantum computing will be used in practical tasks, and the more questions may arise, how much are humanity ready for this change? The purpose of this study is to find out what impact quantum technologies can have and how it will affect society, macroeconomics, science and the political arena. Despite the fact that quantum computing opens up a vast horizon of possibilities, it can not be forgotten that there are huge risks in areas ranging from cybersecurity to increasing tension in the global arms race. Each participant in this study studied this issue from different angles: Some studied the impact on cybersecurity; The second studied the technical barriers; Still others studied the economic and political consequences of the introduction of quantum technologies; And combining all these studies has provided complete picture on the topic of readiness for the quantum era. The purpose of the research. The goal is to understand and find out whether the world is ready for a quantum computer era and its future progress consequences. The Objectives of the research. In the studies of this dissertation, three main objectives are set: To analyze the current state of quantum computing technologies and assess their potential benefits and risks for science, industry, and society. Identify strategies for a safe and effective way to integrate quantum technologies, including the development of any international standards, educational programs, and collaboration between research institutions and governments. To understand and assess society's readiness for the quantum era by defining how humanity can take advantage of quantum computing, minimizing possible problems, and ensuring sustainable technological progress.

In this research work, multiple approaches were taken regarding investigating the topic of Quantum computing, including, but not limited to. quantum algorithms, quantum hardware, quantum software, and practical uses. and limitations. Particular emphasis was given to the study of the technology's current and future state, illustrating the current limitations imposed by the system's complexity, and its practical applications once those issues are overcome, particularly in quantum chemistry, optimization, cryptography, machine learning [9] and AI models [10]. The research also revealed the possibility and practicality of the hybrid systems, derived using two

separate architectures - semiconductor and quantum - in a single system, utilizing the advantages of both in workloads that they are each optimized towards [11].

TABLE I
CASE STUDIES ON CYBERSECURITY AND FUNDAMENTALS

Case Study	Key Contributions	Rationale
[6]	<i>Supercomputers and quantum computing on the axis of cyber security. (2024)</i> RSA/AES algorithms are ineffective against quantum systems; need for quantum-resistant encryption algorithms	Illustrates the need of new encryption algorithms for cybersecurity to stay relevant
[12]	<i>Quantum Computing and Ethical Hacking: Redefining Vulnerability Assessment in Cyber Security. (2023)</i> New encryption and legal frameworks are needed.	Covers not only technical, but also ethical and legal implications of quantum hacking
[7]	<i>Quantum cryptography with coherent states. (1995)</i> Physical phenomena unique to quantum systems are capable to be used for hack detections	Provides potentially very strong security measures to prevent hacking
[13]	<i>Certified random number generation using quantum computers. (2025)</i> Random number generator is truly random, unlike classical one with pseudo-randomness.	Shows the impossibility to predict quantum randomness
[14].	<i>A Survey of Important Issues in Quantum Computing and Communications. (2023)</i> Difficulties of manufacturing stable quantum computers, possibility of quantum network	Covers the quantum computing broadly

The table above presents articles related more to technological issues of quantum computers, such as cybersecurity, encryption methods, and key exchange for secure communication.

Compared to the table above, which focused more on security, the table below is more focused on the future and the artificial intelligence that will be created using quantum computers. Many studies suggest that it would be far better to transition to a hybrid use of quantum computers, that is, to use quantum computers alongside the conventional computers that are used in everyday life. Several articles in the table below also discuss the benefits and risks of quantum computers in the future. This helps us understand the ethical norms for using quantum computers and further analyze how society will adapt to this new method of using computers.

TABLE II
CASE STUDIES ON FUTURE QUANTUM POWER AND MACHINE LEARNING

Case Study	Key Contributions	Rationale
[1]	<i>The future of quantum computing with superconducting qubits. (2022)</i> Quantum systems are not purely theoretical, but practical. Possibility of hybrid quantum/classical systems.	Shows the possibility of emerging hybrid systems, having advantages of both.
[15]	<i>On the impact of quantum computing technology on future developments in high-performance scientific computing. (2017)</i> Quantum systems are not universally good against all problem fields.	Show the both the negative and positive aspects of quantum computing
[16]	<i>Our future with quantum computers. (2023)</i> There are 3 developments paths, with high probability of multiple approaches combined	Discusses not only technological, but also ethical and practical side of quantum computers
[17]	<i>Quantum machine learning for image classification. (2024)</i> Quantum integration to classical systems decreases parameters needed	Demonstrates quantum system capability in hybrid context
[8]	<i>Challenges and opportunities in quantum machine learning. (2022)</i> Quantum system and machine learning connection. Quantum computing already used in present	It uses real-world studies to come to the conclusions

Compared to the first table, which focused more on security, the table above is more focused on the future and the artificial intelligence that will be created using quantum computers. Many studies suggest that it would be far better to transition to a hybrid use of quantum computers, that is, to use quantum computers alongside the conventional computers that are used in everyday life. Several articles in the table below also discuss the benefits and risks of quantum computers in the future. This helps us understand the ethical norms for using quantum computers, and further analyze how society will adapt to this new method of using computers.

TABLE III
CASE STUDIES ON HARDWARE, INDUSTRY DEVELOPMENT, AND SOCIETAL RISKS

Case Study	Key Contributions	Rationale
[11]	<i>Quantum Computer Architecture Toward Full-Stack Quantum Accelerators. (2020)</i> Qubit behavior, hardware complexity, hybrid systems.	Shows where quantum advantage appears.
[18]	<i>Advances in Quantum Computation and Quantum Technologies: A Design Automation Perspective. (2022)</i> Physical limits of classical transistor chips; quantum systems having quantum advantage	Motivates necessity of quantum computing.
[9]	<i>IBM quantum computers: evolution, performance, and future directions. (2025)</i> Large qubit processors already developed, existence of Qiskit software tools, possibility for cloud access to quantum technologies	Shows actual industry progress from one of the notable technological companies
[19]	<i>A Battle for the Future: Quantum Computing Chips Markets analysis in the light of Game Theory. (2018)</i> There is a possibility of further inequality driven by the access of quantum technology	Covers quantum computing from economical standpoint
[20]	<i>The Impact of Quantum Computing on Present Cryptography. (2018)</i> Current encryption potential to become ineffective with quantum systems	Approaches cybersecurity problems from critical standpoint
[3]	<i>Early Fault-Tolerant Quantum Computing. (2024)</i> Necessity of Error correction algorithms and scalability issues introduced after 1000+ qubits.	Explains why quantum systems can't grow too big currently

The table above lists articles that address aspects of quantum computer installation, including where and how they will be located, cooling methods, and so on. It also discusses the economics of the transition to quantum computers, how affordable they will be for people with an average standard of living, which regions will use quantum computers more often, and methods which will help society adapt to this new computing method.

TABLE IV
CASE STUDIES ON ADDITIONAL ARTICLES (PART 1)

Case Study	Key Contributions	Rationale
[2]	<i>A Review on Quantum Computing Trends & Future Perspectives. (2022)</i> Identifies history, current approaches, and unresolved challenges; outlines potential applications	Provides wide background context and defines open problems in quantum research.
[4]	<i>Review of Distributed Quantum Computing: From single QPU to High Performance Quantum Computing. (2025)</i> Describes DQC models, inter-QPU communication, and scaling issues that appear with high performance quantum systems	Relevant to understanding to models and of scalability quantum systems.
[5].	<i>Energy-Consumption Advantage of Quantum Computation. (2025)</i> Shows where quantum reduces energy usage and where overheads eliminate benefits.	It assesses the environmental and practical aspects of quantum computing and its adoption
[10]	<i>Quantum Computing and AI: Impacts & Possibilities. (2022)</i> Improvements in machine learning tasks involving large, complex datasets from quantum integration	Show the role of quantum systems in AI models and software related to it
[21]	<i>Next Steps in Quantum Computing: Computer Science's Role. (2019)</i> Identifies software, compiler, and algorithmic needs for practical quantum systems.	Explains the necessity of hybrid and cross-disciplinary approaches.

The additional studies cited in the table above highlight the challenges inherent in the transition to quantum computers. Furthermore, these studies reveal several new opportunities as humanity transitions to quantum computers. Specifically, new communication methods without network latency, powerful new machine learning models, and new software and their capabilities. Each scientific paper presents a problem, possible solutions, and a series of steps to adapt to new types of computing machines with minimal or no consequences.

At the same time, it's not hard to see that the transition from conventional computer systems, which use binary arithmetic for calculations, to quantum computers, which use qubits for mathematical operations, is a labor-intensive and time-consuming process. Researchers emphasize that this process is still in its early stages and requires not only technological breakthroughs in this area but also human adaptation to these changes. People must still rely on academic and industrial norms to navigate this labor-intensive transformation.

TABLE V
CASE STUDIES ON ADDITIONAL ARTICLES (PART 2)

Case Study	Key Contributions	Application
[22]	<i>Machine learning methods in quantum computing theory. (2019)</i> Describes that ML helps analyze quantum systems and develop algorithms.	Improve connection between ML and quantum computing.
[23]	<i>Prediction by Linear Regression on a Quantum Computer. (2016)</i> Quantum computers help make quick predictions	Provides an example of quantum speedup in ML tasks.
[24]	<i>Machine Learning Applications of Quantum Computing: A Review. (2024)</i> Discusses real applications, limitations and opportunities of QML.	Supplements theoretical reviews with practical context.
[25]	<i>Strengths and Weaknesses of Quantum Computing. (1997)</i> Defines problem classes with quantum speedup and problem classes without advantage.	Provides a theoretical basis and refutes highly optimistic claims about quantum computers.

The second section of case studies on additional articles explores the application of all the above-mentioned methods for using quantum computers, not only in theory but also in practice. Researchers conducted experiments and tests to determine how each technique can improve the performance of quantum computers. Attention is also focused on the connection between quantum computers and machine learning. Researchers see enormous potential in machine learning and AI with quantum computers, and this is practically their only area of application. O studies in this table, however, present less optimistic arguments regarding quantum computers.

II. THE SOCIETAL AND TECHNOLOGICAL IMPACT OF QUANTUM COMPUTERS

In this case, various articles served as input, providing a more detailed understanding of quantum computers and a deeper understanding of topics related to security, AI, machine learning, the future of quantum computing, and other similar subjects. In addition to the articles, a survey was conducted that provided a clear picture of how people view quantum computers and their potential implications. However, a limited amount of testing was done through the statistical analysis, with only the basic pool being performed, which was done on the Telegram social platform, with samples being represented via the groups functionality. The poll contained only descriptive analysis, using broad questions to identify the overall public opinion on quantum computing; it was not a focus of the research and instead focused mostly on qualitative analysis of articles covered in the paper.

Considering the lack of experts relating to the field of quantum engineering and its related fields, it's assumed and to a point proven that all the data, graphs, diagrams, visuals, etc. that were present in the articles do not contain any major inconsistencies or inaccuracies of any relevant information from which conclusions were drawn. Similarly, it is assumed that the information present is self-sufficient for competency in the topics that the articles provide for the writing of the paper.

The study conducted was centered around the basics of quantum computing, namely its hardware and software at a conceptual level, the disadvantages and advantages of the technology related to it, and practical applications that come with the adaptation in the future. The scope of the article excludes topics without relevance to quantum and semiconductor computing, engineering, and architecture, with the writing being limited to the subjects within the scope of the paper, with outside topics only briefly mentioned. A survey was conducted among 51 people who are studying or have studied at SDU University. The results of the survey are presented below.

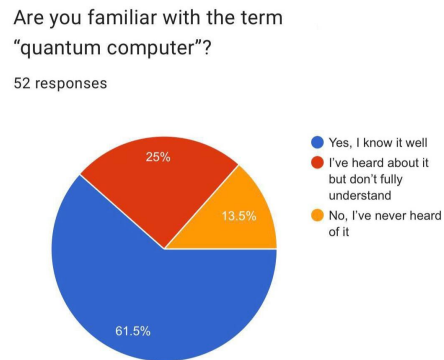


Fig. 1.

During the survey, most respondents understood what quantum computers are (61.5% were familiar with the term, 25% had heard of it but not fully understood it, and 13.5% had never heard of it). While it shows most of the population knows about quantum computers, that being 86.5%, there is only small supermajority of people who actually have acceptable understanding of it, implying limited awareness of the term. It appears there is higher proportion of people understanding the term well in younger groups compared to older groups.

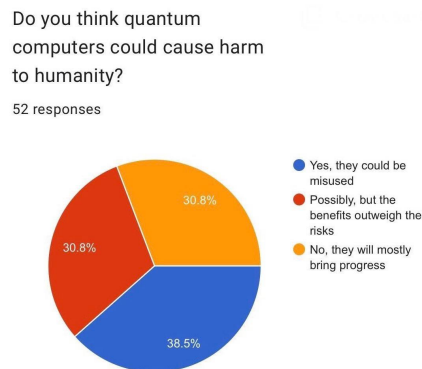


Fig. 2.

However, opinions were divided on the potential harm to humanity. 38.5% believed they could be used for harm, 30.8% believed the benefits outweigh the risks, and 30.8% believed they would primarily bring progress. This demonstrates that people are still cautious and uncertain about the impact quantum computers will have, which in turn points to the need for research in this area. However, there is still a significant number of respondents who responded that the potential of misuse is significant, mostly from younger groups.

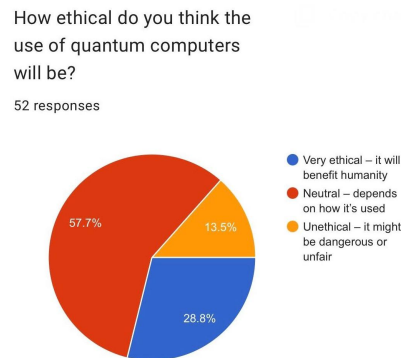


Fig. 3.

In terms of ethics, people recognize the benefits quantum computers could bring but are also wary of the risks. A supermajority appears to hold the neutral opinion regarding the ethicality of quantum computer use at 57.7%, followed by respondents' positive responses about the ethics at 28.8%, followed by a minority that holds the opposite opinion at 13.5%. It appears that the population at large is not against quantum computers in terms of ethics.

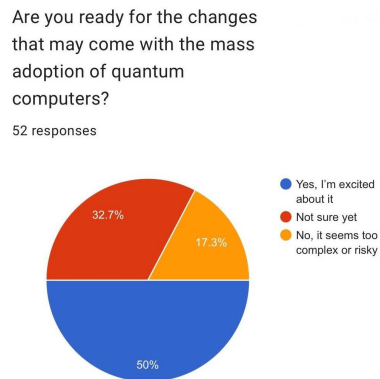


Fig. 4.

From the responses, It is pretty clear that most people are not against about the changes that may be required in order to adapt to the quantum era, with 50% being confident, 32.7% being unsure, and 17.3% in disagreement. It shows that the vast majority of respondents, it being at 82.7%, are not opposed to the potential changes in multiple fields brought with quantum computers. There is still, minority at 17.3% expressing negative opinion, however with majority of them having insufficient knowledge of quantum computers, suggesting some uncertainty among the public

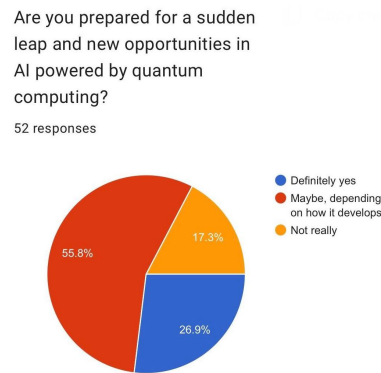


Fig. 5.

From the graph, it can be seen that most people hold neutral stance regarding quantum computing prospect in fields related to AI(Artificial Intelligence) at 55.8%. However there is also non-negligible support and opposition to quantum computing use in AI, being 26.9% and 17.3% respectively. It is also worth noting that there are outside factors relating to either AI or quantum computing which may affect the responses related to the question. However the data is still valuable for recognizing the general trend.

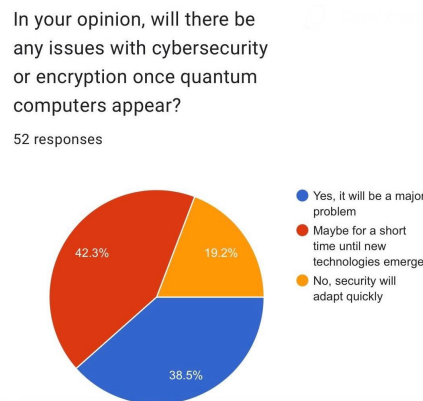


Fig. 6.

According to the graph, it can be seen that vast majority of respondents acknowledge the possible risks and issues related to the introduction of quantum computers on cybersecurity and encryption fields, with 42.3% responding with it being present until new technologies are present, and 38.5% holding stronger opinion with it being a major problem. There is, however, still about 19.2% respondents answering with period of vulnerability being brief.

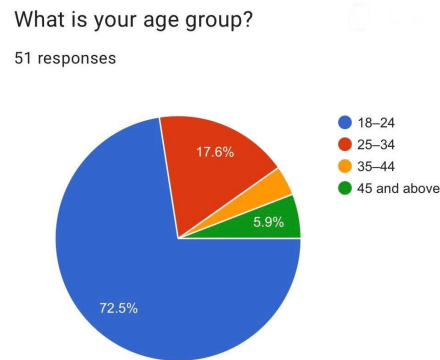


Fig. 7.

The survey was conducted among the groups which revealed that most respondents are young adults (72.5% of those aged 18–24), who are either pursuing higher education or working in the professional sector (85.5% students, 25.5% employed). The younger group has shown general trend to be well aware of quantum computers and the sentiments being more favorable to the changes these technologies could bring. However, similarly to older groups, younger groups are concerned about the issues with possibility to live in a secure digital world that could be disrupted.

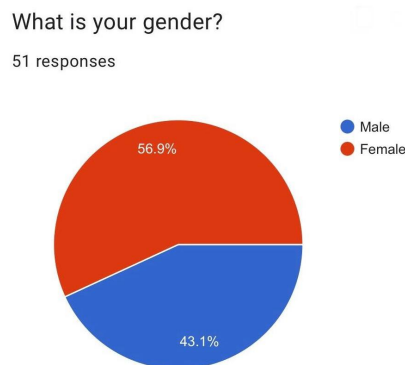


Fig. 8.

The overwhelming majority of respondents were women (56.9%), with the remainder being men. No meaningful differences were observed between the responses of men and women, leading us to conclude that gender is irrelevant in this regard. However there appears to be noticeably higher proportion of males in specialized fields in comparison to females among the respondents, however due to insufficient sample specifically of specialists, it can't be regarded as representative of specialist proportion.

IV. CONCLUSION

The main goal of this research was to understand and find out whether the world is ready for a quantum computer era and its future progress consequences. The studies which were selected always mentioned that quantum computers will have a profound impact on many areas, such as cybersecurity. However, there were studies that proposed working systems for combating quantum cyberattacks and new quantum encryption methods. As a result, people are quite prepared to prevent the threat of quantum cyberattacks by implementing new data protection methods. [6] All reviewed studies examined the prospects of quantum technologies and their possible future implementation. Currently, NISQ systems are noisy and error-prone. [1] Over time, a transition to hybrid systems is expected, in which conventional computers will work together with quantum ones. [5] Which is further supported by some studies that note that quantum computers are unlikely to completely replace conventional ones, as there are many challenges, such as maintaining their stability and error correction. Furthermore, the advent of such powerful technologies raises many new questions about security, ethics, and trust. Therefore, the most likely future for quantum computers is a hybrid operating system.

Based on the research that was done, it became clear that quantum computing still has some challenges to overcome, but at the moment, this technology is still too raw for full use, and there are risks in the future that could change the way the world is seen in the era of quantum technologies.

Over the course of this research, it was often mentioned that quantum systems possess quantum supremacy, or, in other words, problems that classical computers cannot solve in a reasonable amount of time due to exponential growth in complexity. However, the exponential growth of computing power with increasing qubits and true parallelism in quantum computers makes it possible to solve problems related to machine learning, chemistry, and other fields with very low time and energy consumption compared to classical architectures. [10] Experimental research and the development of digital twins will be crucial in the future, since the effective implementation of quantum systems cannot be guaranteed without first models that illustrate their working principles.

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