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QUANTUM COMPUTING FOR TRAVEL OPTIMIZATION IN THE TOURISM SECTOR: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

The study examines the usage of quantum computing in the travel industry: Looking at different ways of using quantum computing to improve crucial optimisation challenges, including route planning, pricing and resource allocation. The research methodology involves an in-depth review of the literature in the field of quantum computing for optimisation tasks. The study will highlight the opinions and advantages of quantum computing in the travel industry. Key aspects to be explored include the potential acceleration of route planning, enhanced pricing models with quantum machine learning, and resource optimisation for tourism-related services. Bibliometric analysis is conducted to understand the trends and work done in Quantum computing. In the last 5 years of the Scopus-indexed database, 14457 articles have been used, and bibliometric analysis has been conducted to understand the country's, universities', institutions', and authors' contributions in the field.

KEYWORDS: Quantum, Computing, Travel, Tourism, Machine Learning, Industrial Growth, Product Innovation.

1. INTRODUCTION

Quantum computing is often described as the next great wave in technological innovation; the advent of the first practical quantum computers would bring about a new era of computational power.[1][2], [3]Ultimately, they could lead to new ways of thinking about ourselves and our world. Classical computers operate using bits that store information in one of two states: 0 or 1. A quantum computer performs its computations on 'quantum bits or Qubits. Quantum mechanics can exist in superpositions of both 0 and 1 (and even more complex states) at the same time. [4] Qubits also have a quantum mechanical property called entanglement, which meaningfully affects their states, even when the qubits are miles apart. This feature permits quantum computers to solve many types of problems exponentially faster than classical computers. [5]. In this way, quantum computers have the potential to completely transform the fields of cryptography, optimisation and simulation. Through these applications, quantum computers have the potential to discover new and more effective pharmaceutical drugs. The term quantum computing was first introduced in the 1980s by the American physicist Richard Feynman, who realised that we could build a quantum system that would better simulate other quantum systems than a classical computer. In the late 20th century, more significant progress was made, including the first algorithm proving that quantum computers could perform exponentially faster than classical computers in 1994 (written by the American mathematician Peter Shor and focused on factoring large numbers). But the biggest breakthrough came when Lov Grover in 1996 showed how to search through an unsorted database using a quantum computer.[6][7]

Advances have been made, but ensuring fault tolerance remains something of a mirage since qubits are fragile and easily disrupted by decoherence. Developments in quantum error correction seem endless, but there are currently no such procedures proven to work.[8], [9], [10], [11]. In January 2022, Google claimed to have demonstrated 'quantum supremacy' that a quantum computer could solve a particular problem faster than any known classical computer.[12] [13]. It promises to allow us to solve practically intractable problems for classical computers, and laser pioneer Charles H Townes recently stated that 'quantum computing is going to be groundbreaking in its abilities as a computer.' At this early stage, it's hard to imagine what interesting applications quantum computing may have in the future. However, sustained research efforts in quantum computing will undoubtedly pave the way for quantum processors that can crack severely difficult problems in fields including machine learning, security, cryptography, medicine and more.[12], [14], [15], [16].

This is one of myriad optimisation challenges in the dynamic and interconnected travel market, including route optimisation; optimisation of pricing and inventory (how many of a particular type of room at a certain price should hotels offer at different times of the week or year?); and optimising yields (which combination of amenities will best match the demands of different guests, driving the highest profit margins as well as guest satisfaction?). In its current form, computing can't handle the complexity and scale of many of these optimisation tasks, resulting in suboptimal and inefficient outcomes. It promises the ability to perform these tasks at an unprecedented speed and scale by leveraging the operations of our quantum world.[17], [18], [19].

Research aims to investigate how quantum computing can revolutionize the way optimization problems in travel can be approached and solved, through theoretical examination of quantum computing and practical implementations in real-world travel scenarios. By employing the systematic and rigorous process of hypothesis generation, literature review and analysis, a disruptive solution to challenges across the destination could bring about significant transformational advantage within the travel sector.[18], [20], [21][22].

Quantum computing might be able to speed up optimisation algorithms that are relevant to travel. For instance, planning algorithms could benefit from the use of quantum algorithms that could explore the various search engines in less time than current algorithms can, because quantum algorithms can take advantage of inherent parallelism and superposition. [2][23], [24].

The study addresses resource planning for service in the tourism sector, such as by optimising hotel bookings, scheduling transport and allocating human and equipment resources. Quantum computing may enable greater optimisation of resources through exploring the solution landscape (explored by conventional computing) more efficiently, meaning that optimal solutions to a problem (for each specific scenario) could easily be obtained to minimise cost and maximise efficiency. Thus, by using quantum optimisation algorithms, we could subsequently improve the performance and management of travel companies in delivering high-quality travel and tourism services.[25], [26], [27], [28]

2. REVIEW OF LITERATURE

Quantum Computers, which operate on quantum mechanics, hold great promise of revolutionising computational capacity and have been the subject of much interest over the past decade. Nielsen and Chuang introduced the science behind quantum computing and its potential algorithms in their book Quantum Computing: Foundations and Potential Applications. [29]. Chris Bernhardt, in his book 'Quantum Computing for Everyone', mentions that the concept of Quantum computing is a very systematic version.[30].

Recent studies in quantum computing have focused on the application of optimisation problems, given the known advantages it has over classical algorithms. In 'A Quantum Approximate Optimisation Algorithm' (2014), Farhi et al [31]present the Quantum Approximate Optimisation Algorithm (QAOA), a quantum algorithm that can be used to approximate solutions to combinatorial optimisation problems. The authors demonstrate that they can solve various optimisation problems with high accuracy, opening the door for exploring their application to real-world problems, such as routing and scheduling in the travel industry.[32]

Algorithms responding to current market conditions and the dynamics of demand create dynamic pricing strategies for the travel industry.[33] Schuld et al discovered that quantum machine learning can optimise dynamic pricing through quantum-enhanced algorithms. Computational handling of market data would require the analysis of huge datasets; therefore, dependent on quantum-computational power.[24]. In this way, operators would quickly be able to adapt their pricing strategies to current market conditions if quantum computers become available in the next 10- 20 years and can be used in a cost-effective manner. Revenues would then be maximised in the process, and this would lead to increased competitiveness in the travel industry. [34]

Resource allocation is another area where tourism companies often run into difficult optimisation problems, from scheduling hotel bookings, buses and taxis, to staff accommodations and staff shift patterns, and even optimising the location and staffing levels in retail outlets serving tourists. Quantum optimisation approaches, such as Quantum Integer Programming (QIP), can be used to assign resources, putting forward practical examples of how it can be successfully applied to the specific problems experienced within the travel industry.[35], [36].

Although there is still an abundance of theoretical works on quantum computing and corresponding algorithmic results, practical and industrial applications of compiled quantum computing (especially in specific domains) are now becoming important research directions. Gómez [37]reported on the usage of applied quantum computing techniques for airline scheduling and crew-rostering processes from a real-world airline operator's perspective [38] The impact of quantum algorithms on collaboration between airlines and passengers through meaningful reduction in airline scheduling, operational cost and improved user satisfaction, as reported in the work, is particularly interesting and can lead to insights on how to expand the application of quantum computing (notably compiled quantum computing) to travel optimisation.

High-level discussions in academia and industry suggest that there is potential for quantum computing to help solve optimisation problems in the travel industry. There are already some examples of using quantum algorithms to solve optimisation problems and even implement them. [39] Vazquez-Alvarez et al (2020) point out a number of hurdles that quantum algorithms must overcome before they can be used for real-world applications. There are limitations with algorithm scalability, many quantum devices require error mitigation and many more. They lay stress on the need for interdisciplinary cooperation between quantum computing experts and domain-specific practitioners if the optimisation potential of quantum computing is to be exploited. [40], [41].

2.1. Challenges and Future Directions

Quantum computing could herald radical optimisation opportunities for the travel industry, despite some obvious challenges. [39] Álvarez-Gaumé & Vázquez-Mozo (2012 discussed parallelisation challenges and resource limitations based upon the current state of quantum hardware, scalability, and known mitigation strategies for errors in quantum algorithms. They also highlight the need for interdisciplinary solutions that leverage collaborations between quantum computing experts and domain-specific practitioners: 'Due to these constraints, it is extremely important to bridge the gap between pure quantum computing research and applications' by drawing on expertise from multidisciplinary teams.' Quantum computing could transform travel and hospitality optimization problems and security protocols.[42]

a). Improved Optimisation for Routes Planning and Scheduling- One of the best applications of quantum computing is the optimisation of complex processes. Accordingly, this could be applied to optimising current route planning and scheduling for the travel industry. This is true for airlines, cruise lines and ground transportation: quantum algorithms can be used to choose better routes, minimising travel times, fuel consumption and, ultimately, even operational costs[1].

b) Revenue management and pricing – QC can help to optimise revenue management systems, with algorithms that can be updated in real-time to crunch through huge amounts of data and adapt pricing models, for example, fluctuations in demand or seasonality within hotels, airlines and other terms and conditions offered by those involved in hospitality.[43]

c). Improved Data Security: Quantum computing can also help with cybersecurity, particularly in areas where data protection is a critical aspect of the business. For example, protecting customer data against misuse and privacy violations. Quantum-resistant cryptographic algorithms can help to secure passwords and other sensitive tokens against attacks by quantum computers. Quantum-resistant crypto algorithms ensure that passwords and other cryptographic tokens that are published on unprotected (classical) channels can be kept private even if an attacker has access to a quantum computer[44], [45], [46], [47], [48], [49].

d) Personalised Customer Experiences: The speed with which quantum computers can process vast amounts of data generates more personalised customer experiences. For example, in the hospitality or entertainment industry, quantum algorithms can derive a more thorough analysis of customer preferences, habits, buying trends and feedback, which can subsequently inform follow-ups such as product recommendations, promotions and services. This enhances customer experience and improves customer loyalty.[50] [51][52]

e) Supply Chain Optimisation: Quantum computing could unlock enhanced supply chain management that would benefit the travel and hospitality industries. By executing advanced inventory and logistics management with complex systems, maximising usage and minimising waste, and utilising systems to predict demand fluctuations, quantum algorithms could achieve previously unachievable efficiencies for the industry.[32], [53], [54]

f) Tourism: Better weather forecasting for better travel planning. If the weather were more predictable, how much better would travel planning be? Identifying and marketing the seasons for optimal viewing of wildlife or scenery would be much easier. Weather forecasting would be substantially improved with quantum computers, particularly for the travel industry, air travel and cruises. [55][56]

3. BIBLIOMETRIC ANALYSIS

3.1. Analysis Of the Data Showing Country Contribution and Co-Authorship in the Field of Quantum Computing

The United States dominates quantum computing research, as shown in this visualization. One can see this because the US node is the biggest one, suggesting it has many publications. The edge thickness from the US to other countries also shows this - the US has co-publications with many other countries.

Other Leading Contributors: China, Japan, Germany and the United Kingdom are also leading contributors to quantum computing research. These countries, similar to the USA, have more nodes (publications) and have many other collaborators (thicker edges).

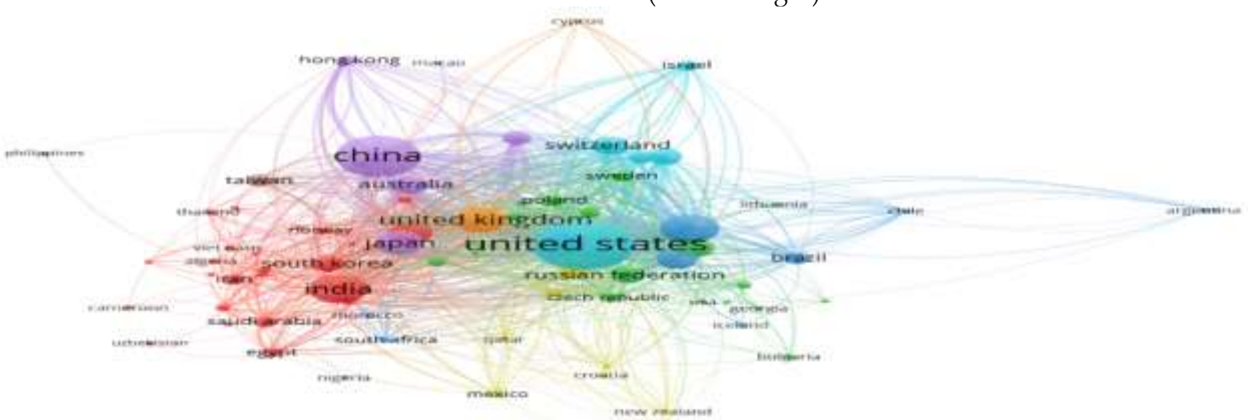

Figure 1.0: Bibliometric analysis of Countries' contribution and Co-Authorship Network.
(Source: It Was Created by Authors Via Vosviewer).

Regional collaboration: Looking at the visualisation, one can see regional clustering, for instance, a cluster between Canada, France and Switzerland. Also visible is a cluster between South Korea, Taiwan and Singapore. These countries might be sharing resources, expertise and infrastructure to drive research forward.

3.2. *Keyword Analysis on the Topic of Quantum Computing and the Relationships Between Them:*

Central Cluster: The centre of the map is made up of a set of interconnected terms that form the core paradigm of quantum computing:

Quantum entanglement: This is a situation where two quantum systems are held together such that their fates are correlated.

Quantum algorithms: Specialised procedures that can be run on quantum computers to solve hard problems that are intractable for classical computers.

Quantum information science: a broad field encompassing the theoretical foundation of quantum computing and quantum communication.

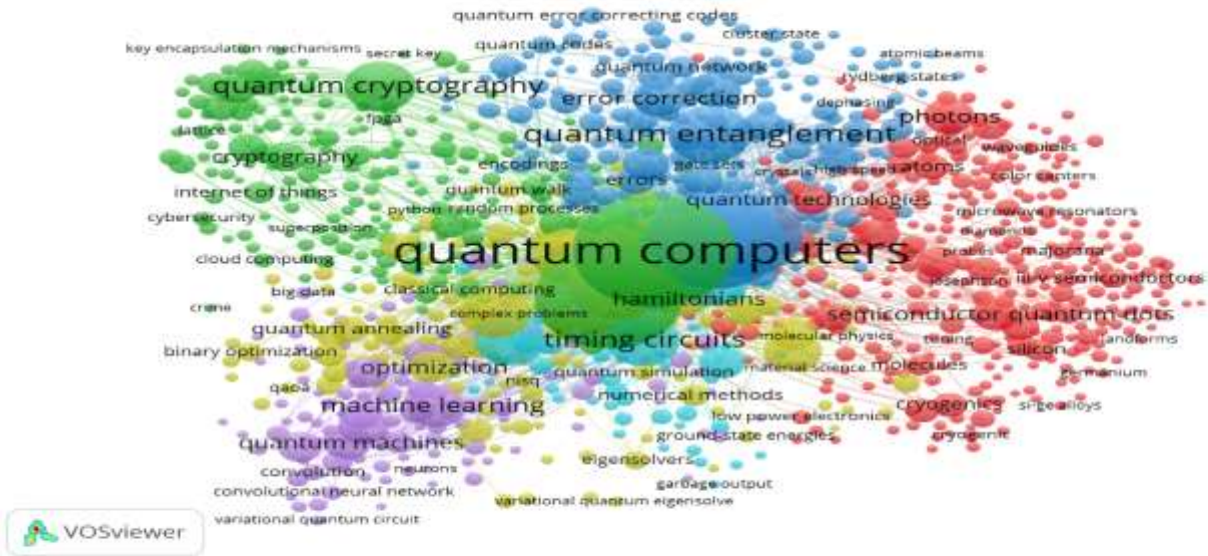

Figure 1.2: of Keywords Analyse.
(Source: It Was Created by Authors Via Vosviewer).

Quantum cryptography: where one has unbreakable communication based on the strange properties of quantum mechanics.

Quantum systems are also very 'fragile', requiring this field to develop techniques to spot and correct errors in quantum computation.

Quantum Technologies: Emerging from the central cluster are terms that are associated with specific areas of research and development within quantum technologies:

Quantum simulation: This is the study of how to use quantum computers for modelling of physically realistic systems, such as those that occur in materials science or chemistry.

Quantum annealing – a type of quantum algorithm targeted at optimisation problems.

Quantum communication: An area where security is built on principles of quantum mechanics.

Quantum metrology: The best ways for quantum systems to make precise measurements.

The outermost layer of the map consists of terms describing potential use-cases for quantum computing:

- Big data: It could be able to process large datasets more quickly than classical computers. Quantum computers could develop new machine learning algorithms or speed up existing ones. Machine learning is a branch of AI in which computers can make associations with data. Quantum computers should also be able to accelerate machine learning or develop new algorithms.
- Materials science: New materials with needed properties can be tested via quantum simulations.
- Combinatorial chemistry: The huge number of possible molecules exceeds the traditional laboratory's capacity for testing.
- Cryptography. Quantum computers can break existing encryption standards, but they could also enable entirely new kinds of cryptography that are unbreakable.

Other Connections: A more speculative outcome of a knowledge map is revealing affinities between terms that might seem at first to be unrelated. 'Cryogenics', for instance, is neighbour to 'superposition' and 'ground-state energies. Quantum computers must typically work at super-cold temperatures to function well, as it's difficult to maintain a quantum state in a normal environment, and noise from the environment is a source of chaos.

Each node (circle) is sized by the prevalence of the term across the dataset sampled to create this map; thus, "quantum entanglement" is a magnitude more common than "quantum walk". Each edge thickness showing connections between nodes is a proxy for the frequency of two-term co-occurrence across publications; this is why there is a thick line connecting 'quantum algorithms' to 'quantum complexity theory', since the two areas are often studied simultaneously. The colours of the nodes have been mapped randomly to this visualisation, and therefore are of no consequence.

3.3. The Table Shows the Number of Published Documents and the Number of Literature Citations by Institutions And

Table 3.3: Academic Institutions' Contributions.

S.no	Organization	Documents	Citations
1	Beijing Academy of Quantum Information Sciences, ChinaB22BB2:B21+B2:B29	83	820
2	Shenzhen institute for quantum science and engineering, southern university of science and technology	45	508
3	Department of physics, Harvard University, Cambridge, 02138, ma, united states	46	2225
4	Research laboratory of electronics, Massachusetts institute of technology, Cambridge, 02139, ma, united states	51	3485
5	Institute for quantum computing, university of waterloo, waterloo, Canada	42	576
6	Department of physics, Massachusetts institute of technology, United States	29	2124
7	Perimeter Institute for Theoretical Physics, Waterloo, N2L 2Y5, Canada	46	613
8	Guangdong Provincial key laboratory of quantum science and engineering, Southern University	29	169
9	Department of physics, southern university of science and technology, Shenzhen, China	24	143
10	Shenzhen key laboratory of quantum science and engineering, southern university of science and technology	22	137
11	Frontier science centre for quantum information, Beijing, 100084, China	24	346
12	Beijing national laboratory for condensed matter physics, institute of physics, Chinese academy of sciences	30	511
13	Department of electrical and computer engineering, duke university, Durham, 27708, NC, U.S	30	452
14	Department of Physical Chemistry, University of the Basque Country upv/ehu, Apartado 644	27	468
15	Pritzker school of molecular engineering, university of Chicago, Chicago, 60637, il, US	34	1015
16	CAS centre for excellence in topological quantum computation, University of Chinese Academy of Sciences	23	551
17	CAS key laboratory of quantum information, university of science and technology of China	42	294
18	Hefei national laboratory, university of science and technology of China, Hefei, 230088, China	42	64
19	State key laboratory of low dimensional quantum physics, department of physics, Tsinghua University	23	247
20	AWS centre for quantum computing, Pasadena, 91125, CA, US	39	732

(Source: It Was Created by Authors Via Vosviewer).

Massachusetts Institute of Technology (MIT), with publications (51 or 29, depending on the department) and the second-highest total citations (3485), shows up twice on the list. Its proud position signals the importance of this institute to quantum computing research.

Institute for Quantum Computing, University of Waterloo, published 42 documents (much lower than the highs), ranked 3rd among the listed institutions in citation numbers, 576 citations.

Southern University of Science and Technology, the department of physics at this university, as well as the Guangdong Provincial Key Laboratory of Quantum Science and Engineering, both had anomalously high counts of documents (24 and 29, respectively) but markedly low citation counts (143 and 169, respectively).

Harvard University, 46 documents published – 9th position; and 2225 citations – 4th position. Department of Physics, Harvard.

University of Science and Technology of China, The Centre for Excellence in Topological Quantum Computation and the Key Laboratory of Quantum Information, managed by the university, both appear on this list and have published highly regarded research (with 23 and 42 documents respectively). But, as at SUSTech, the number of citations they have received is far more modest (551 and 294).

3.4. The Table Shows the Number of Papers Published by Authors in the Field of Quantum Computing and the Number of Citations Generated on Publication

Table 3.4: Of The Authors' Contribution in the Field of Quantum Computing.

S.no	Author	Documents	Citations
1	Chong, Frederic T.	71	1185
2	Pan, Jian-wei	27	2784
3	furusawa, akira	31	187

4	Endo, Mamoru	22	111
5	Asavanant, Warit	23	142
6	Yoshikawa, Jun-ichi	19	122
7	Charbon, Edoardo	41	632
8	lin, jin	13	332
9	Xu, Yu	13	332
10	Wille, Robert	84	968
11	Gong, Ming	12	352
12	Zhu, Xiaobo	11	498
13	Lu, Chao-yang	17	1815
14	Takase, Kan	15	71
15	Liang, Futian	10	320
16	Tan, Xinsheng	18	203
17	Wu, Yulin	10	341
18	Deng, Hui	8	339
19	Wang, Shiyu	8	339
20	Yu, Yang	19	209

(Source: It Was Created by the Authors Via Vosviewer).

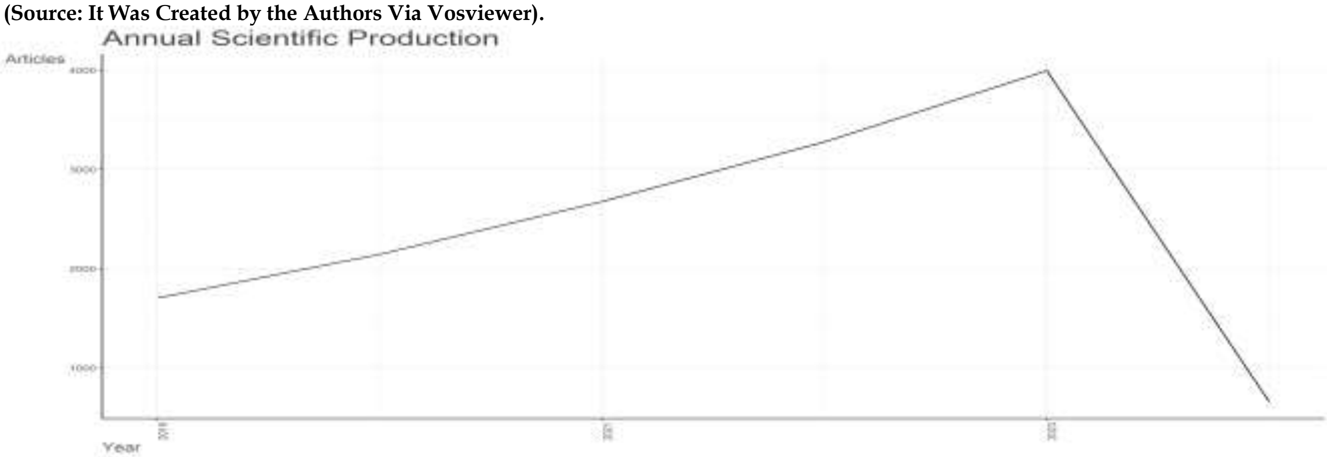

Figure 3.5: Of Annual Scientific Production in the Field of Quantum Computing.

(Source: It Was Created by the Authors).

Highly Cited Authors: Several authors on the list **have published a substantial number of papers and have also received a significant number of citations. These include:**

Frederic T. Chong (71 papers, 1185 citations)

Jian-Wei Pan (27 papers, 2784 citations)

Robert Wille (84 papers, 968 citations)

Chao-Yang Lu (17 papers, 1815 citations)

Varying Productivity. Some authors have produced more papers than others. For instance, Frederic T Chong has authored many papers, while Futian Liang (10 papers, 320 citations) has authored fewer papers.

Citations and Publications: Sometimes, the number of citations a researcher earns over a period of time does not correlate with the number of papers they publish. This is because the research they've conducted might be particularly influential in a given field. The physicist Jian-Wei Pan might be an example of this. Though he's published fewer than some of his contemporaries on the list, his significantly higher number of citations indicates that his research is particularly noteworthy in its field.

3.5. The Chart Shows the Number of Papers Published Annually

The analysis shows the annual production over five years (between 2019 to 2014). The data in the table below shows the steady growth in the annual production of research papers in quantum computing. In 2019, 1709 documents were published in Scopus-indexed journals. The trends show that there was an increase in papers. In the year 2020, the number of articles increased to 2145. In 2021, the number of documents further increased to 2677. In 2022, the number of papers was 3278. The year 2023 reported a significant increase with 3994 papers. However, in 2024, the number of documents dropped to 657, as the data used is from April 2024.

Year	Documents
2019	1706
2020	2145
2021	2677

2022	3278
2023	3994
2024	657

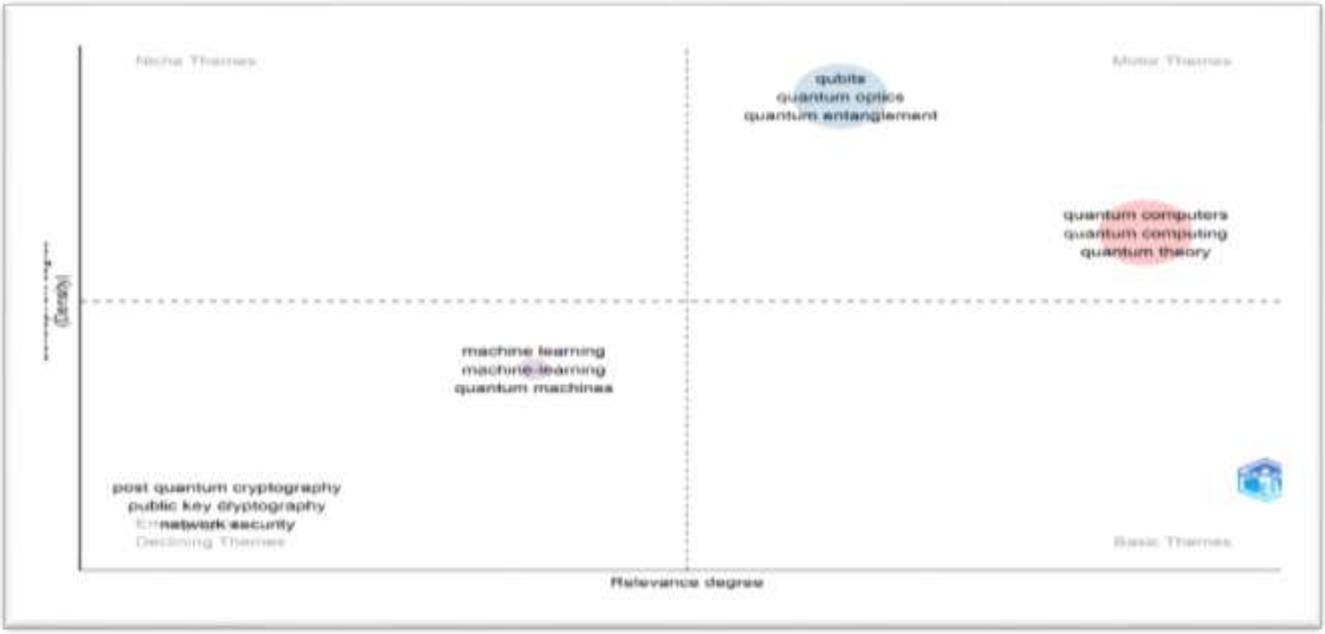

Figure 3.6: Of Conceptual Thematic Map With 4 Quadrants.
(Source: It Was Created by Authors).

3.6. The Figure Shows the Thematic Map

The figure shows the conceptual thematic map. The purpose of a thematic map is to understand the trends and what the future may look like. It helped researchers and stakeholders involved to understand what topic might be important in future. The thematic map consists of a network analysis of keyword occurrence to explain the trends in the research topic, theme, and study pattern. The upper right quadrant (Q1) represents the “Motor Theme”, and the upper left quadrant (Q2) represents the

“Niche Theme”. The lower right quadrant (Q4) represents “Basic Theme”, and the lower left quadrant (Q3) represents “Emerging or Declining Theme”. Looking at the figure, “qubits, quantum optics, quantum entanglement, quantum computers, quantum computing, and quantum theory” occurred in the motor theme (Q1), which suggests that these are the leading themes in the field of quantum computing. The Q3 theme consists of machine learning, machine-learning, quantum machines, post-quantum cryptography, public key cryptography, and network security. This indicates that these areas need to be developed.

3.7. The Chart Shows the Countries' Collaboration World Map

The connections between the authors can be shown on the world’s collaboration map. The figure represents the country’s collaboration in quantum computing. The shade of colour shows the intensity of the relationship. The darker shades exhibit a stronger relationship, while the lighter shades represent a weaker relationship. The grey colour shows no relationship. The marron colour line represents the connection between countries. The analysis reveals 1044 collaborative relations, and the USA, China and Germany are dominating countries. Data shows that the USA has collaborated with 68 countries, Germany has collaborated with 59 countries, and China has collaborated with 57 countries. It has been observed that the strongest collaborative link is between the USA and China with 291 papers, the USA and Canada with 211 papers, and the USA and Germany with 202 papers.

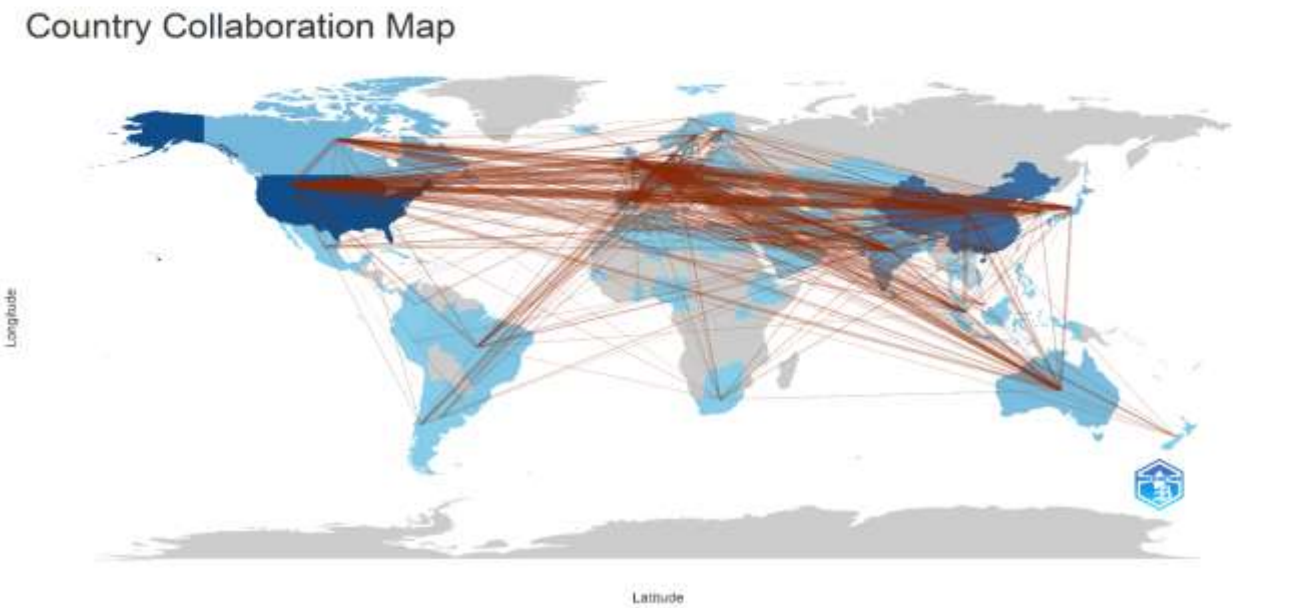

Figure 3.7: of Collaboration Map Between Various Countries.
(Source: It Was Created by Authors).

3.8. The Figure Shows the Sources Involved in Quantum Computing

The figure above presents the analysis of the most pertinent sources for the published articles. It was observed that a total of 2521 journals published papers on quantum computing. Notably, "Physical Review A" emerges as the most relevant journal with 943 papers specialised in "Quantum Computing". Followed by Quantum Information Processing with 484 published documents, "Physical Review Letters" with 384 documents, "Lecture Notes In Computer Science (Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics)" with 372 documents, "Physical Review Research" with 362 documents, "Physical Review Applied" with 295 documents, "Physical Review B" with 282 documents, "PRX Quantum" with 261 documents, "IEEE Access" with 260 documents, and "Quantum Science And Technology" with 240 documents.

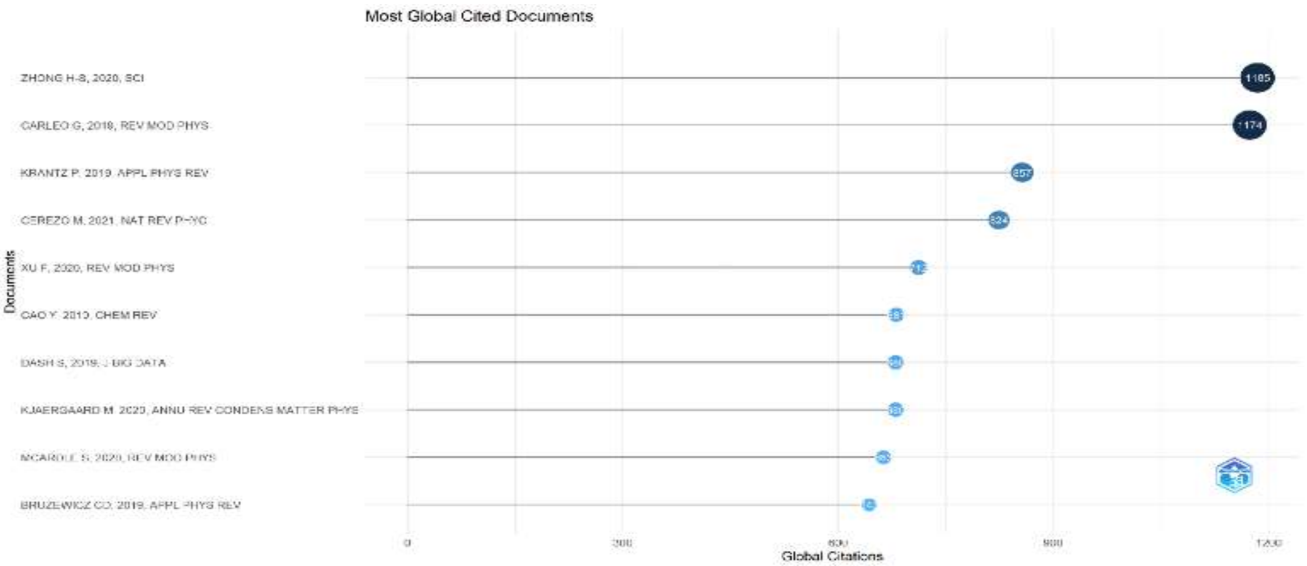

Figure 4.8: of leading journal in Quantum computing.
(Source: It Was Created by Authors).

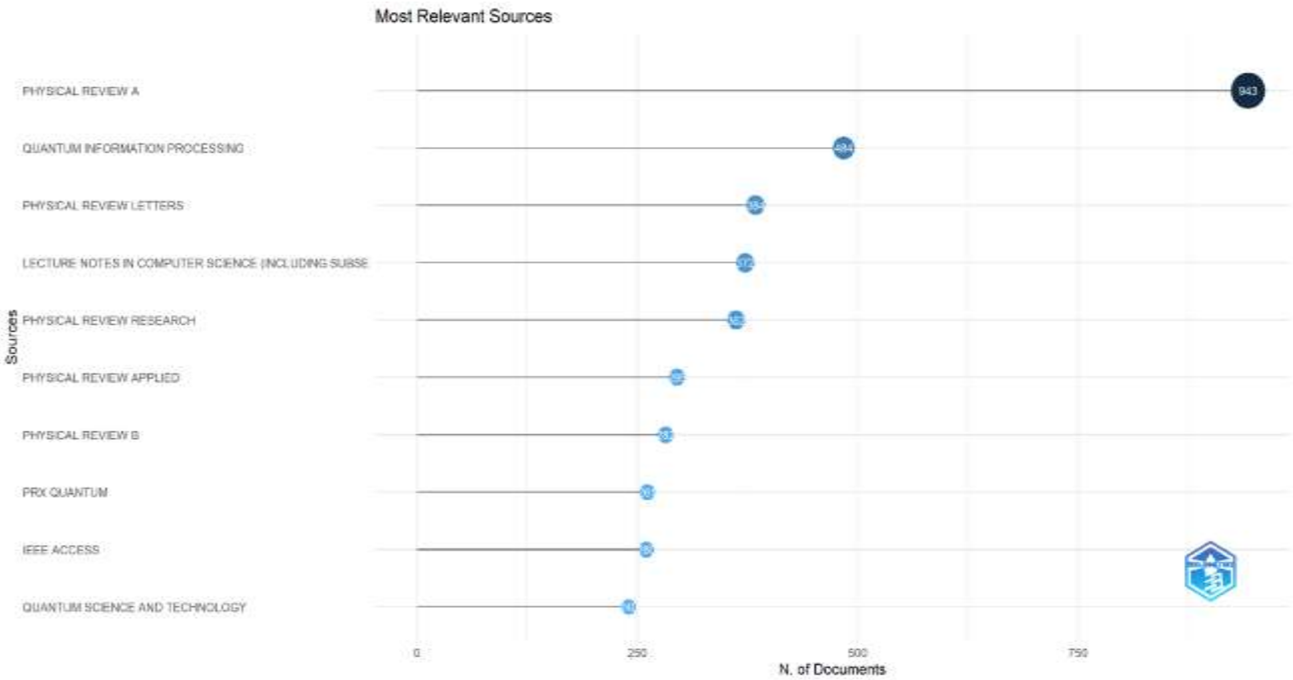

Figure 3.9: Of the Most Influential Papers in Quantum Computing.
(Source: It was created by authors).

Sources	Documents
PHYSICAL REVIEW A	943
QUANTUM INFORMATION PROCESSING	484
PHYSICAL REVIEW LETTERS	384
LECTURE NOTES IN COMPUTER SCIENCE (INCLUDING SUBSERIES LECTURE NOTES IN ARTIFICIAL INTELLIGENCE AND LECTURE NOTES IN BIOINFORMATICS)	372
PHYSICAL REVIEW RESEARCH	362
PHYSICAL REVIEW APPLIED	295
PHYSICAL REVIEW B	282
PRX QUANTUM	261
IEEE ACCESS	260
QUANTUM SCIENCE AND TECHNOLOGY	240

3.9. The Chart Shows the Most Influential Papers in Quantum Computing

The figure represents the most cited documents in quantum computing. The analysis shows the presence of a total of 1,39,794 citations in 14,457 documents. The above-mentioned documents have 8099 citations, which is 6 % of total citations. Articles published between 2019 and 2021 have the most citations. The most cited document is "Quantum computational advantage using photons" with 1185

citations published in science emerged as the most influential paper in "quantum computing". The second most cited document is" Machine learning and the physical sciences" with 1174 citations. After that, "A quantum engineer's guide to superconducting qubits" is the third most cited article with 857 citations. The result shows that the "Review of Modern Physics" journal has been the most cited journal among the mentioned documents, contributing three documents. Another journal, "Applied Physics Review," also contributed two documents. "Variational quantum algorithms" got fourth place with 824 citations, and "Secure quantum key distribution with realistic devices" got fifth place with 712 citations.

Author	Documents	Total Citations
ZHONG H-S, 2020, SCI	Quantum computational advantage using photons	1185
CARLEO G, 2019, REV MOD PHYS	Machine learning and the physical sciences	1174
KRANTZ P, 2019, APPL PHYS REV	A quantum engineer's guide to superconducting qubits	857
CEREZO M, 2021, NAT REV PHYC	Variational quantum algorithms	824

XU F, 2020, REV MOD PHYS	Secure quantum key distribution with realistic devices	712
CAO Y, 2019, CHEM REV	Quantum Chemistry in the Age of Quantum Computing	681
DASH S, 2019, J BIG DATA	Big data in healthcare: management, analysis and prospects	680
KJAERGAARD M, 2020, ANNU REV CONDENS MATTER PHYS	Superconducting Qubits: Current State of Play	680
MCARDLE S, 2020, REV MOD PHYS	Quantum computational chemistry	663
BRUZEWICZ CD, 2019, APPL PHYS REV	Trapped-ion quantum computing: Progress and challenges.	643

3.10. The Chart Shows the Information About the Data.

The figure shows information from 14,457 documents obtained from the Scopus database on Quantum Computing. The documents obtained were published between 2019 and April 2024. These documents were published in 2521 journals. The documents consist of Articles (9173), books (25), book chapters (195), conference papers (4512), data papers (2), letters (24), notes (14), retracted (1), reviews (484), and short surveys (16). The average citation per document is 9.67 with 479629 references, and the document average age is 2.47. It is also observed that there are 28882 authors and 845 authors of single-authored documents. According to the table, the number of co-Authors per Doc is 4.63, which indicates that each document is typically written by four authors.

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2019:2024
Sources (Journals, Books, etc.)	2521
Documents	14457
Annual Growth Rate %	-17.37
Document Average Age	2.47
Average citations per doc	9.67
References	479629
DOCUMENT CONTENTS	
Keywords Plus (ID)	40854
Author's Keywords (DE)	18695
AUTHORS	
Authors	28882
Authors of single-authored docs	845
AUTHORS COLLABORATION	
Single-authored docs	1037
Co-Authors per Doc	4.63
International co-authorships %	27.38
DOCUMENT TYPES	
Article	9173
Book	25
book chapter	195
conference paper	4512
data paper	2
Editorial	9
Erratum	2
Letter	24
Note	14
Retracted	1
Review	484
short survey	16

5. CONCLUSION

The research studied the potential of quantum computing to revolutionise route optimisation by solving the complex challenges of route planning, pricing, and resource allocation in the travel and tourism industries. The analysis of the literature on the above problem shows that quantum algorithms may excel in optimisation tasks like those cited above. Specifically, quantum annealing and other algorithms exploit the need to search large pattern spaces and may achieve significant improvements over classical approaches. The combination of quantum machine learning with pricing models would constitute an enticing possibility. When topology changes, the quantum computer can also benefit, as the whole point of the device is to manipulate the wave function that describes the state of the system. For example, when travelling to a different city, the quantum computer can enhance the sensitivity of the pricing machine to new clues (bottom left), which now constitute the new initial condition. Quantum computing can offer improvements in pattern recognition and optimisation, allowing travel companies to develop dynamic pricing strategies.

The figures from bibliometric analysis provided a picture of a centralised collaboration network, with the United States taking the lead, but also showing regional collaborations, pointing out that they are indeed experiencing a global research effort. The keyword analysis served as a map of the field, listing the core concepts that constitute it and their interrelationships. It also gave a high-level view of the multiple applications of quantum computing from big data analysis to materials science. The review of the prominent institutions and authors active in quantum computing, along with their works, helped to paint a picture of the ongoing research and development. While MIT is taking the lead in this field, highly cited researchers, such as Jian-Wei Pan, are working toward achieving the viability of quantum computing. Beyond its potential applications in the travel industry, quantum computing could revolutionise the way one travels and optimise various processes related to the industry. Solving complex optimisation problems at speeds and with accuracies quantitatively unmatched by classical computers. Quantum computing is capable of major transformations in travel, both for travel companies – who could achieve optimal routes, with carefully calculated fares – and consumers, who could benefit from lower costs and new possibilities. Although the achievement of a fully fault-tolerant quantum computer seems distant, research into new quantum logic gates, more efficient circuitry and better error-correction codes is increasing, and the developing field of quantum computing is slowly moving toward a future where quantum processors will speed up and optimise travel. This study could pave the way for further research and analysis. Studies highlight that both operational strategies and psychological factors significantly influence organizational and consumer outcomes, where Six Sigma implementation enhances organizational flexibility and efficiency, while destination reputation, trust, and self-esteem shape tourists' visit intention and engagement in niche tourism contexts [57],[58]. As the potential of quantum algorithms to revolutionise the current travel industry's processes becomes increasingly apparent, additional research could investigate the specific applications of quantum computing to travel optimisation. Case studies detailing the implementation process of quantum computing solutions could help travel agencies see the real-world conditions and possible applications, while also highlighting the ethical questions and disruptive potential Quantum computing as a disruptive technology to travel could encourage proposing deeper research into the potential applications of quantum computing to various aspects of travel, such as navigation systems, automated control, forecasting and resource management, or marketing and pricing, among others. As the quantum revolution draws nearer, its transformative potential for the travel industry will help us explore the world in new ways.

Declarations

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