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6G WIRELESS AND QUANTUM COMPUTING: A DISRUPTIVESYMBIOTICMODEL

Prafulla Kumar Padhi
Independent Researcher
The Founder, Global Governance LLC
GGLLC2009@GMAIL.COM

ABSTRACT
The deployment of 5G wireless technologies won't provide adequate security, lack ofsignificant reliability gains over existing wireless networks, and going to pose impediments enablingthe far-reaching applications, particularly in the Internet of Everything (IoE) domain. Such shortcomings are encouraging activities to focus on the 6G wireless aiding terabit per second speeds (terahertz frequencies) needed for true microsecond latency with unlimited bandwidth to provide pervasive IoE applications and adequate security as well as dependability benefits. Smattering technologies will mature along the same time of 6G wireless to play a symbiotic role in the standardization process. One such prominent and eye-catching technology is quantum computing. The aim of this conceptual research is to present a quantum computing communication (QCC) framework that explores the integration of quantum computing and 6G wireless offering a disruptive symbiotic model (DSM) disrupting markets globally making the products, process and services superior during the next decades. The methodology comprises of a thorough literature review focusing on QCC perspective and applications in creating sustainable value co-creation (SVCC). Contribution of this research includes several recommendations creating an exciting agenda for entrepreneurs, investors, scholars, practitioners, marketers, academia, and policymakers to assuage forward-looking vision for the years to come. The author concludes by providing a roadmap towards a symbiotic relationship between quantum computing and 6G wireless communication to serve as a basis for stimulating out-of-the-box relevant research.

Keywords
6G Wireless, Quantum Computing, Disruptive Symbiotic Model,Sustainable Value Co-Creation

INTRODUCTION

A new generation of wireless technology has transpired almost every decade since the 1G was introduced in 1982. 5G wireless principal benefits over current wireless platforms are proclaimed as latency reduction, therefore, 6G will emerge to satisfy the expectation not met with 5G. Assuming the mobile technology trend continues, 6G wireless will emanate several years after 5G is embraced and will offer terabits per second along with microsecond latency.

The two emerging technology trends (6G wireless and quantum computing) are expected to have a disruptive impingement in the years ahead creating breathtaking opportunities globally. The future will be elucidated by advances in quantum cloud computing, quantum machine learning, Internet of Everything (IoE), and multisensory eXtended (XR) reality services supported by 6G wireless secure connectivity. In this study, the author delineatesand has coined the term quantum computing communication (QCC) as the integration of quantum computing and 6G wireless.

Despite recent 6G wireless initiatives, the fundamental architectural and performance components of the 6G system remain largely undefined and will transition from the smartphone paradigm into a new era of smart surface devices. The author contends that 6G will explore and include relevant technologies that are left out from 5G, or simply outside the 5G defined scope and integrate terrestrial wireless with satellite communication systems (SCS) for global ubiquitous always-on broadband network coverage. 6G will be a significant evolution from 5G with self-aggregating networks to accommodate various types of networks (technologies) in a dynamic way. 6G mobile network will be an autonomous system with infrastructure that becomes self-aware to foster its own evolution and make predictions negotiating with relevant stakeholders. 6G will become an initial market reality around 2025 and will purview commercial maturity stage by 2035 along with the timeframe when quantum computing intelligence (quantum computing and artificial intelligence) matches with autonomous

systems in a collaborative and symbiotic relationship. https://www.cablefree.net/wireless-technology/4g-lte-beyond-5g-roadmap-6g-beyond/

Currently, advance research efforts are focused on the quantum realm to intersect with 6G wireless development. The SCS may consist of navigating satellite networks and earth imaging satellite networks. The goal of 6G ought to integrate satellite networks enduring multimedia Internet connectivity, network position identifier, and information services such as climate conditions globally to the users. The integration of 6G will include 5G and satellite networks contributing at least the following features and benefits : (i) ultra-fast Internet access with data rates will be up to 10-11 Gbps, (ii) smart homes, smart cities, and smart villages, (iii) may be used in the production of energy from the galactic world, (iv) home automation, and defense applications, (v) satellite to satellite communication, (vi) natural calamities can be controlled with 6G networks, (vii) sea to space communication, (viii) mind to mind communication. The drivers of 6G will be a confluence of past trends (e.g., densification, higher rates, and massive antennas) and emerging trends that include new services in wireless devices. https://www.networkworld.com/article/3285112/get-ready-for-upcoming-6g-wireless-too.html

Quantum computing [1] is an exciting new computing paradigm and is the ultimate in parallel computing with the potential to tackle problems that conventional digital computers can't handle. A quantum computer, completely different from a binary digital computer that performs computing using quantum-mechanical phenomena and would theoretically be able to solve certain problems much more quickly than any digital computer. Where current digital computers would require tens of billions of years to solve some of the world's most challenging problems, a quantum computer would be able to find a solution in only minutes, hours, or days enabling researchers to develop new catalysts, state of the art materials, new smart fashion surface wearables, improve medicines, accelerate advances in artificial intelligence, and even answering questions about the origins of the universe.

In 2019, IBM announced the world's first commercially available quantum computer called IBM Q "System One" harnessing the power of the 20-qubit machine over the cloud and has made quantum computing as a cloud service available to the world for the first time. The IBM Q experience (cloud-based quantum computing) is an online platform provides users to access to a set of IBM's quantum processors via the Cloud, an online Internet forum with a set of tutorials to program the IBM Q devices, and educational materials about quantum computing. Intel also has announced the delivery of a 17-qubit superconducting test chip for quantum computing to research partner Qu Tech in the Netherlands. (https://newsroom.intel.com/newsroom/wp-content/uploads/sites/11/2017/10/17-qubit-fact-sheet.pdf, https://www.ibm.com/blogs/nordic-msp/ibm-unveils-groundbreaking-quantum-computing-system/)

This research contributes to the discussion on QCC perspective and sustainable value co-creation (SVCC) by identifying the following unit of analysis: (i) a disruptive symbiotic model is proposed, (ii) emphasis on QCC applications, (iii) the symbiotic relationship between 6G and quantum computing, (iv) value is co-created as stakeholders integrate resources in practices, and (v) disruptive symbiotic model constituents as a key unit of analysis for the enhancement of SVCC.

This study concludes with the persuasive and meaningful purpose of value co-creation by introducing the importance of the concept REACT [2] towards a QCC disruptive symbiotic model enriching new knowledge to the literature.

RESEARCH MOTIVATION & STUDY JUSTIFICATION

So far, no academic study has investigated to fill the void in the literature with regards to integration and symbiotic relationship between quantum computing and 6G wireless that creates disruptive market opportunities and widespread applications to attain sustainable value co-creation (SVCC). Value co-creation requires a multidimensional approach and performance by the firms those who aspire to develop, manufacture and market disruptive technologies like quantum computing and 6G wireless. Sustainable value is multi-faceted with the integration of the economic, environmental and socio-cultural dimensions of sustainability concerns and the challenges have consequences for every aspect of a company's business strategy. Yet, the most top leadership

team of technology firms consider sustainable development as a one-dimensional opportunity. Hence, this conceptual research justifies filling the void in the literature by proposing a disruptive symbiotic model to provide new knowledge important for all stakeholders as a multidimensional opportunity for the quantum computing communication (QCC) market contributing to the discourse on sustainable value co-creation domain. Considering the above scenario, it is worthy of attention to fill the knowledge vacuum by conceptualizing quantum computing communication (QCC) model.

This conceptual study is important and directed towards the stakeholders of various industries and shall have the benefit to the wider audience to understand the changes and challenges contributing to the discourse of SVCC for an enterprise and principally relevant to two main groups:

(i) Entrepreneurs, investors, industry leaders, management practitioners will be able to make decisions about the implementation of sustainable value co-creation (SVCC) capabilities for the development of quantum computing and 6G wireless business opportunities.

(ii) Researchers, academic faculty members, and students will learn a methodology that explores principally the literature review focusing on QCC disruptive symbiotic model in creating sustainable value co-creation (SVCC).

RESEARCH BRACKGROUND

Historical background (1G to 5G)

Wireless technologies are booming nowadays helping people in many ways. Various wireless (2G, 3G, 4G) technologies are available globally today to users for mobile computing and communication. These wireless technologies differ from one to another based on coverage, range, availability, and performance. Currently, 3G and 4G are the most popular globally. To enhance the experience developers are now considering 5G broadband access technologies. 5G is being developed and commercially deployed in some parts of the world is emerging to offer a wide range of features that are mentioned below in comparison to the previous technologies:

- Speed - 1 to 10 Gbps.
- Latency will be 1 millisecond (end-to-end round trip).
- 1,000x bandwidth per unit area.
- Feasibility to connect to 100 number of devices.
- Global coverage.
- 90% reduction in network energy usage.
- Battery life will be much longer.
- The whole world will be in Wi-Fi zone.

However, 5G wireless technology has the following limitations: (i) most of the old devices would not be competent to 5G, hence, to be replaced with new one — expensive proposition, (ii) high cost for infrastructure development, (iii) security and privacy issues are inadequate, and (iv)coverage distance of up to 2 meters (in indoor) and 300 meters (in outdoor) can be achieved due to higher losses at high frequencies (millimeter waves suffers from penetration loss, attenuation due to rain, foliage loss, etc.). It will take some time for the common person to make use of 5G technology.

6G Wireless

Concepts and functions of 6G technology is at the nascent stage of development. 6G wireless is upcoming in the field of mobile communication technologies and is based on a set of standards that enable devices for Internet of Everything (IoE) applications with broadband wireless access. 6G wireless technology promises to be at least twice the speed of 3G standard for cellular data and 2.7 times more legit than the 5G iteration of 4G wireless technology moving beyond the Software Defined Network (SDN) to the Market Defined Network (MDN).

While most carriers may claim to offer the speeds of 6G wireless technology, Ting is the first company in North America to market with the 6G wireless technology rebranding of today's LTE standard offering faster and more reliable in the field of wireless technology. TING 6G mobile network technology is set to take over as the

new mobile marketing buzzword and Ting is the first carrier to bring this brand-new mobile buzzword to market. https://ting.com/blog/ting-first-market-6g-mobile-network-technology/

As per Google search, 6G is among the top 17 most searched keywords today. 6G is promised to provide increased data speed up to 1000 Megabits per second and 6G devices are expected to move up to 1GB or even more than that improving data and voice quality with video calling rich media as well as better security for wireless data transmission standards.

The key objectives of 6G are to integrate the three kinds of satellite networks (navigation satellite networks for a global position, the telecommunication satellite networks, earth imaging satellite networks) to provide position identifier, multimedia, internet connectivity, and weather information services for mobile users.

Most devices connected nowadays are machines (Internet of Things - IoT) rather than people. Given the rise of smart homes, smart buildings and smart cities, 5G and 6G will involve exponential demands for machine-to-machine communications such as autonomous drone, robotic and transport systems. Some other trends projected for 6G involves ultra-dense cell networks, millimeter waves (mmWaves) for user access, enhanced optical-wireless interface, and intelligent networking to empower full immersive experience. Users will demand higher capacities, greater global coverage, and always-on connectivity for future Internet services and applications. Hence, the Internet-of-Everything (IoE) is a relevant development and 6G will be expected to deliver as shown in Table 1:

Table 1. 6G Wireless Overview

	6G
Generation	Sixth
World Wide Web (WWW) Support	Wireless WWW (WWWW)
Architecture	Open Wireless Architecture (OWA)
Frequency	Terahertz frequencies
Transmission Speed	Terabit Range
Useable Format	Mobile Internet Packet (IP)
Multiple Mobile and Network Access	Yes
Integration of Satellite Communication Networks	Yes (Satellite to Satellite Communications). Integration of three kinds of satellite networks (navigation satellite networks for global position, the telecommunication satellite networks, earth imaging satellite networks)
Applications	Futuristic – Autonomous System, Network Mix Reality, 3D Internet concept, Space technology and defense applications, home based ATM systems and Natural Calamities will be controlled by 6G. Mind to Mind communication is possible.
Remote Management & Diagnostics	Yes
Encryption	Yes (Flexible and Anti-Virus)
Memory Capacity	Large
Clarity/Quality (Audio & Video)	Yes, with 3D Video

Most of the 6G applications require higher bit rates than 5G catering to IoE applications such as eXtended Reality (XR) encompassing virtual reality (VR), augmented reality (AR) and mixed reality (MR) and wireless brain – computer interactions (WBCI). 6G should deliver around one (1) Terabit/second and will motivate exploration of frequencies beyond sub6 GHz requiring higher reliability providing pervasiveapplications.

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While live multimedia streaming applications will remain central to 6G, the key determinants of the system performance will be four new application domains:

1) Multisensory XR Applications: XR will yield many killer applications for 6G across the AR/MR/VR spectrum. Upcoming5Gsystemsstillfallshortofprovidingafullimmersive XR experience capturing all sensory inputs due to their inability to deliver very low latencies for data-rate intensive XR applications. A truly immersive AR/MR/VR experience requires a joint design integrating not only engineering (wireless, computing, storage) requirements but also perceptual requirements stemming from human senses, cognition, and physiology. Minimal and maximal perceptual requirements
2) Connected Robotics and Autonomous Systems (CRAS):
3) Wireless Brain-Computer Interactions (BCI):
4) Blockchain - Distributed Ledger Technologies (DLT).

The following are five mobile industry goals in the 6G era, as shown in figure 1:

- Boundless secured (encrypted) connectivity for IoE
- Innovation networks with optimal economics including satellite networks
- The digital transformation of industry verticals
- Transform the mobile broadband experience

. Integration of satellite networks

5)

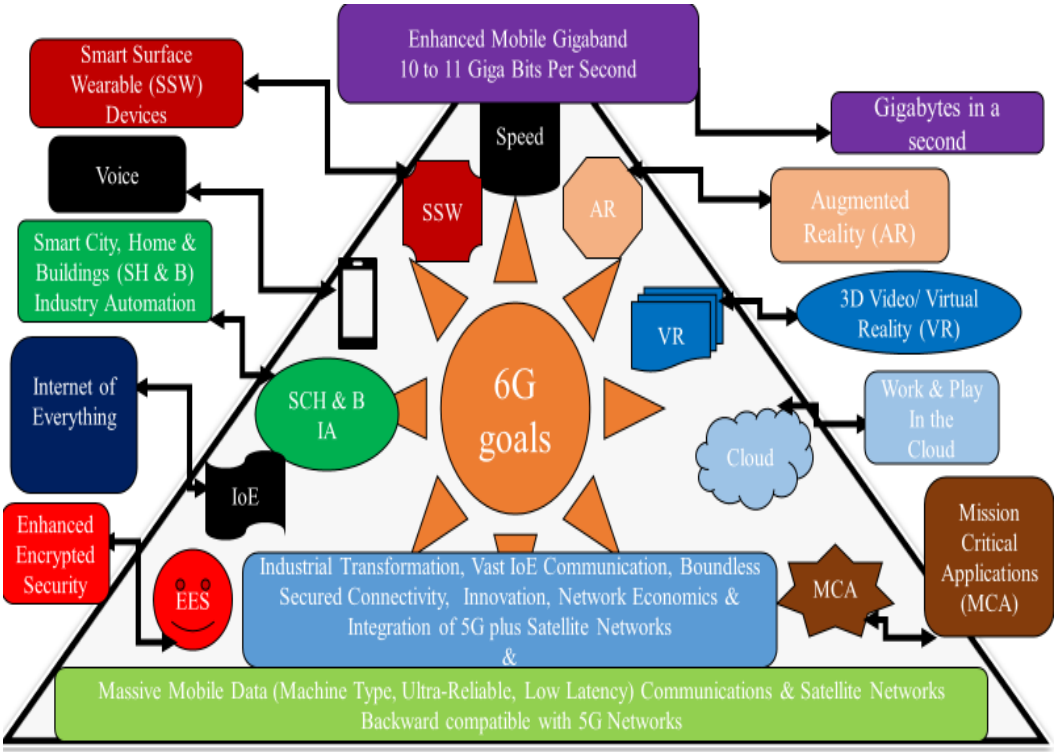

Fig. 1 6G Wireless Goals & Applications

6G Recommendations

- 6G ought to deal with ground and aerial users, encompassing smart surface wearables and XR devices.
- 6G systems should motivate new machine learning and data analytics techniques harnessing both big and small datasets across their infrastructure to enhance network functions and provide new services.
- Blockchain (distributed ledger technologies) motivate an urgent need for intelligent Self-Organizing Networks (SON) to manage network operations, resources, and optimization.Therefore, 6G requires a

paradigm shift from classical SON into a self-sustaining network (SSN) that can maintain its key performance indicators in perpetuity and rich 6G application domains.

- 6G must deliver multiple services for applications such as XR, BCI, CRAS, and DLT where tracking, control, localization, and computing are an inherent feature.

Quantum computing

The basic principle behind quantum computing is that quantum properties can be used to represent data to perform operations on it. Quantum computers will disrupt industries, businesses, markets globally by solving problems that are impossible today. MIT's quantum learning initiative has created in collaboration with IBM Q, and MIT – IBM Watson Artificial Intelligence (AI) Lab. https://quantumcurriculum.mit.edu/

Since 2016, IBM has introduced and released the following related to quantum computing:
May 2016 - Q Experience, with a five-qubit quantum processor.
July 2016 - Q Experience community forum.
January 2017 - several additions to the IBM Q Experience.
March 2017 - Qiskit to enable users to more easily write code and run experiments on the quantum processor.
May 2017 - made an additional 16 qubit processor available on the IBM Q Experience.
January 2018 - IBM launched a quantum awards program.
January 2019 - world's first commercial quantum computer called IBM Q "System One
https://www.technologyreview.com/s/613596/how-a-quantum-computer-could-break-2048-bit-rsa-encryption-in-8-hours/

Quantum computing building blocks

Constructing a quantum computer is a formidable task. Scientists are inventing to create innovative patterns of nitrogen-vacancy (NV) centers in diamond, an approach to computing and storing quantum data. Quantum computers could hypothetically perform specific calculations far quicker and better than digital computers. Diamond nanophotonic technology (DNT) is a key contender for future optical computers. This facilitates an appropriate roadmap for the mass production of quantum logic gates (QLG) that are an important element for quantum computing architectures. However, properly positioning these NV centers is a fundamental challenge. IBM Q systems are designed to one-day solve problems that are currently seen as impossible. Future applications of quantum computing may include finding new ways to model financial data. IBM Q System One is comprised of several custom components that work together to serve as the most advanced cloud-based quantum computing program available that includes the following:

- Quantum hardware designed to be stable and auto calibrated to give repeatable and predictable high-quality qubits;
- Cryogenic engineering that delivers a continuous cold and isolated quantum environment;
- High precision electronics in compact form factors to tightly control large numbers of qubits;
- Quantum firmware to manage the system health and enable system upgrades without downtime for users; and
- Classical computation to provide secure cloud access and hybrid execution of quantum algorithms.

IBM's indispensable history in computing goes back to the development of IBM's first line of business computers in the 1950s which revolutionized the world by changing the way businesses thought about computer hardware. The IBM Q System One is a major step forward in the commercialization of quantum computing critical in expanding quantum computing beyond the walls of the research lab to develop practical quantum applications for business and science.

The design of IBM Q System One includes a nine-foot-tall, nine-foot-wide case of half-inch thick borosilicate glass forming a sealed, airtight enclosure that opens effortlessly using "roto-translation," a motor-driven rotation around two displaced axes engineered to simplify the system's maintenance and upgrade process while minimizing downtime – another innovative trait that makes the IBM Q System One suited to reliable commercial use. A series of independent aluminum and steel frames unify, but also decouple the system's cryostat, control electronics, and exterior casing, helping to avoid potential vibration interference that leads to "phase jitter" and qubit decoherence.

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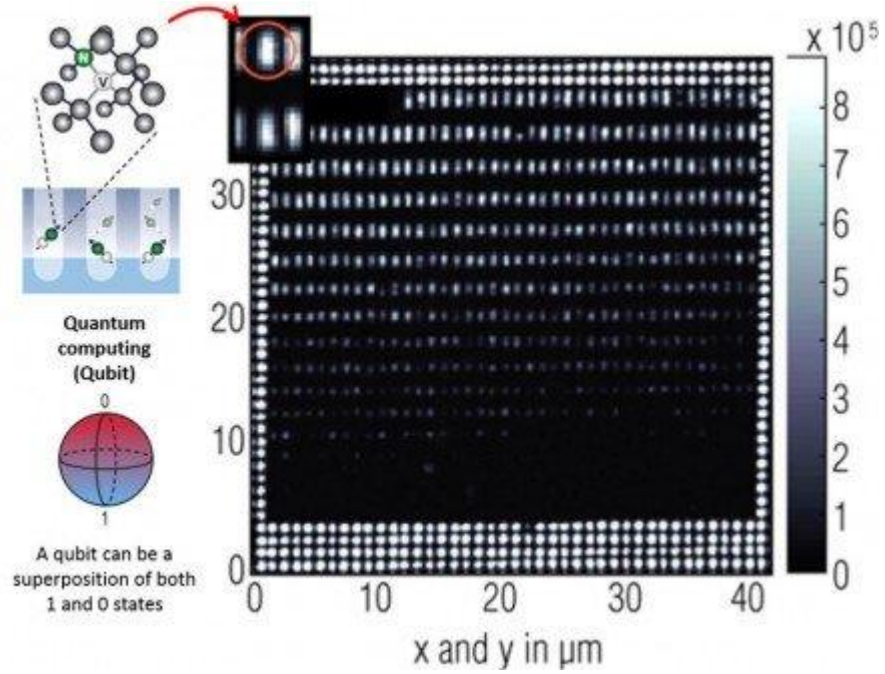

Fig.2 Quantum Computing Building Blocks

Source: Image courtesy of Dirk Englund, Massachusetts Institute of Technology (MIT), and Sara Jarret
Classical computers store data in bits that can have a state of either 0 or 1. Quantum computers store data in quantum bits (qubits) that can have a superposition of both 0 and 1 states. A graphical representation of nitrogen vacancy (NV) qubits fabricated within diamond. The NVs were made in precise, dense arrays (µm = micrometers) for future quantum computers.

A new study indicates that scientists have already found quantum computers to perform the code-breaking calculations, reducing the resources they require by orders of magnitude and quantum technology will converge with encryption standards to store data securely for decades.
https://www.technologyreview.com/s/613596/how-a-quantum-computer-could-break-2048-bit-rsa-encryption-in-8-hours/

DISRUPTIVE SYMBIOTIC PHENOMENON

Christensen's (1997) original theory focused on disruptive technologies. So far, the same theory has been used to explain all disruptive innovations[3]. The author contends that it is high time to have a new and better theory because different kinds of innovations have different competitive effects and produce different kinds of markets to be considered as distinct phenomena. Furthermore, a disruptive technological innovation is fundamentally different phenomenon from a disruptive innovation and a disruptive product, process, serviceinnovation. To appreciate different phenomenon, this research summarizes two specific types of disruptive innovations—namely, radical product, process, service innovations and business model innovations demonstrating radically different challenges and implications for managers even though both are disruptive innovations.

The digital revolution is accelerating market disruption. Innovations on integrant technologies (Internet of Things - IoT, 5G wireless and beyond, blockchain, quantum computing, artificial intelligence, cloud computing, and edge to edge intelligence) are game-changers in various industries providing tremendous opportunities for transparency, greater precision, and secured connectivity leading to inclusive, socially and environmentally impactful business models. The quantum computer (QC) is going to displace the digital computers and 6G wireless is emerging to dislodge 5G wireless changing the way human being work, play and communicate.The symbioticrelationship between quantum computing and 6G wireless is going to define thenewest contours of our times. The world has entered a quantum computing communication age where innovation forces are going to create new businesses.

Imagine the phenomenon of symbiosis and the different types of symbiotic relationships exist in the eco-system. A "symbiotic" relationship is an interdependent relationship between two (or sometimes more) entities which is mutually beneficial for the stakeholders of the relationship. The relationship between the computing and communication industries began during the birth of the modern computing industry and has a stronger symbiotic relationship over the past decades. Hence, there is a positive sum gain from the relationship**.**Computing devices are becoming more communications driven. Communication networks are computing centric. Increasingly the success of computer-enabling services connecting millions of people in useful ways depends on broadband wireless data. Technology and business have become indivisible and advancements in technology have transformed the way one communicates. Technology facilitated the business world with instant communication. Mobile communication applications provide ubiquitous connectivity no matter where one in the world. Having access to the internet, onehas access to business and technology have fundamentally transformed the efficiency of business communication.

Having said the above, the integration of quantum computing and 6G wireless will provide far reaching applications to perform the code-breaking calculations, reducing the resources by orders of magnitude.and quantum technology will converge with encryption standards to store data securely for decades. There's absolutely no doubt that the most disruptive changes evoked by quantum computing and 6G wireless will be speed, performance, data security and efficiency in every aspect of business. One can do more, see more, take more, sell more, and perform it all instantly.

The promise and symbiotic relationship of QCC demonstrates the leap of imagination into a world that will disrupt markets and industries globally. The QCC is an emerging new reality. The physicists, material scientists, researchers, engineers, and practitioners who are active at the frontiers of this emerging QCC multidisciplinary field virtually no limit to the shape and size of the devices and applications that can be made in the 21st century. The author believes that the relationship between quantum computing and 6G wireless is symbiotic and foment ingenious activity and need bold ecosystems and support. Consequently, this symbiotic model facilitates new business formation and economic growth raising and sustaining standards of living. Fully integrating quantum computing and 6G wireless is going to open a huge range of opportunities. New techniques, architectures and insights will be developed into self-organizing principles of QCC will be the world's freshest expression of human creativity.

Over the last decades, several technologies have disrupted peoples' lives. Among the notable fundamental changes in the human society is the way humans interact with each other involving the computers, smartphones and the social media. This type of technology is called "Disruptive Innovation". The new technologies (6G wireless and quantum computing) have the domino effect of previous emerging technologies offering symbiotic relationship that includes wireless communication, autonomous vehicle, the blockchain and Internet-of-Everything (IoE). This trend is hoped to speed up the implementation of the emerging technologies globally guiding policymakers, practitioners and research scholars in understanding the phenomenon that will manifest itself and be experienced. The author has coined this phenomenonas disruptive symbiotic phenomenon (DSP).

SUSTAINABLE VALUE CO-CREATION

Value Co-creation is a new appraoch to create valueoffering the best opportunities to disruptive innovations.Objective (tangible) value is the value which can be readily quantified by the customer.Subjective (intangible) Value is the value when benefits cannot be quickly quantified.Innovation lies at the intersection of invention and value. If product or service does not offer value , it is not innovative. Innovation is not a measure of the change one makes. It is a measure of the need one addresses.The two-best-known processes for co-creation of a value chain:

(i) Stakeholder´s revetment process - the brand like Apple, able to cut promotional costs. Why is Apple so profitable? Among many other reasons, it draws its stakeholders to market to each other. Apple doesn't have to spend marketing dollars to promote the products and services (https://www.Apple.com).

(ii) Product or service development process - the company like IBM, engage third-party resources in product and service development processes. Why is IBM able to reduce its R&D cost? By setting up

"Collaboratory's" where its co-partners, as key stakeholders, not only bring their expertise in specific domains but also underwrite some of the cost of that research and development (https://www.IBM.com).

Sustainable value denotes the approach to sustainable management, calibration of environmental and socio-cultural resource-based impact assessments on the enterprise valuable contribution to the society. Sustainable value co-creation (SVCC) - a business strategy focused on inscribing social issues by recognizing competitiveadvantage sources that bring about community benefit. It's also about diverting business exertions in a way that makes the enterprise profit and empowers communities.

Quantum computingand 6G wireless are the leading examples of the most disruptive technologies in the world and going to be a very powerful co-creation tools that triangulates manufacturer, developer and end user.The relentless parade of new disruptive technologies such as 6G wireless and quantum computing is unfolding on many frontsas a breakthrough and have the potential to disrupt the status quo, transform the way people live and work, and rearrange value co-creation pools.

QCC & Value Co-Creation

The literature on value creation can be divided into three classifications: (i) a value model, that can be applied to firms or ventures specifying customer demands and the marketing environment, (ii) adaptive value model that is applicable to companies defining customers' need; and (iii) the value co-creation model, which can be applied to enterprises with complex environments and vague customer demands [4].

Co-creation is about the joint creation of value by a company and its stakeholders. Co-creation of value with stakeholders happen only when stakeholders embody their experience using a company value proposition. It is not the firm trying to please the stakeholders but allowing the stakeholders to co-construct the product - service experience to suit the context. Creating an experience environment in which stakeholders can have the active dialogue and co-construct personalized experiences is vital. QCC Product - service may be the same, but stakeholders can construct different experiences. Co-creation process includes two pivot steps:

(i) Contributions by the stakeholders (co-producer, co-distributor, co-promoter, co-manufacturer, co-consumer, experience creator, co-innovator, co- creator, co-evaluator, co-designer, co-tester, supplier, integrators, end user, and the society) to the QCC firm.

(ii) Selection of the most reassuring and entrancing contributions.

For the persuasive and meaningful purpose of value co-creation, the author introduces a concept that involves the following five building blocks - Risk, Exchange, Advantage, Communication, and Transparency (REACT) as shown in figure 3:

(i)**Risk** – Since technology is at the core of QCC innovation, adopting continual innovation could be risky. Concerns prevail in organization's data analytics not to work as intended or inappropriately used which raises risk perception. There is also a correlation between risk and profit, therefore QCC may avoid risk-taking and stick with existing tested products. Co-creation process aims at finding innovative ideas from the stakeholders, which echo their needs. Hence, the new product - service is developed to meet specific stakeholder needs, and the risk could be low.

(ii)**Exchange** - is a vital building block in the co-creation view. The QCC market is viewed as an exchange between the stakeholders, and the QCC firm such as IBM. Exchange implies engagement, and willingness to act by both parties. But the exchange is strenuous if stakeholders do not have the appropriate communication and transparency to relevant information. Both communication and transparency are important building blocks to have a meaningful exchange.

(iii)**Advantage** -With the advent of disruptive technologies and pervasive marketing, particularly social media, stakeholders are onerous a larger role in the value creation process. Inputs to the product design and service offering come from stakeholders through market research surveys, focus groups, and customer real-time feedbacks.

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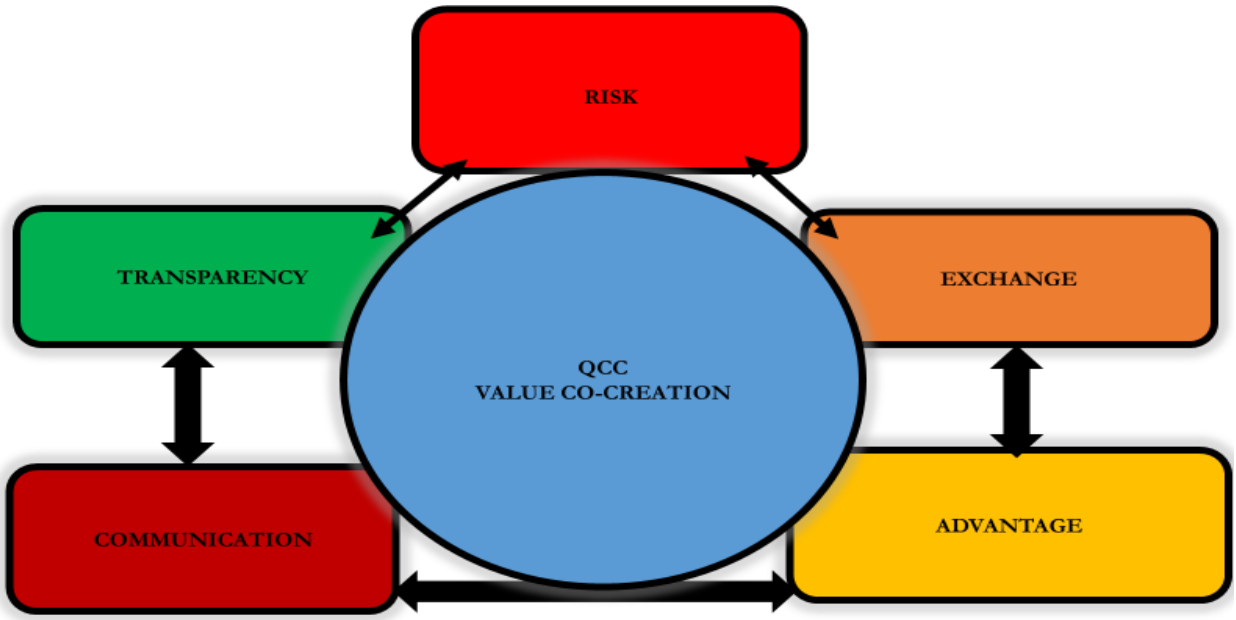

Fig 3. Building Blocks of QCC Value Co-creation

Based on insights developed within the enterprise, prospective stakeholders are aimed and marketed to. What's even interesting is that one doesn't need to pay some marketing firm to dispatch surveys to relevant clients to get their feelings. Nowadays, people love to talk freely on Facebook, WhatsApp, and Twitter for free regarding the success or failure of the product and service. QCC companies who are willing to involve stakeholders in the product design, production process, and service offering would be able to derive several advantages such as meaningful insights and foresight to innovate customer-centric products - services generating brand loyalty and cost reduction.

(iv)**Communication** -Effective communication is a building block of successful brand. Communication promotes motivation and is a source of information for decision making as well as plays a pivotal role in changing stakeholder attitudes. QCC companies adopting user experience (UX) research is an integral part to achieve innovation. Stakeholders are at the nucleus of the innovation process. UX researchers execute both quantitative and qualitative methods to build a nuance understanding about stakeholders. There is a gap between how stakeholders see the product design, service offering and how the production team sees the user experience. This is due to UX researchers are middleman in the process. User value proposition and experiences are delivered to the production team in the form of data. Hence, direct communication between the production team and other stakeholders is essential as an integral part of the development process.

(v)**Transparency –** is all about open flow and disclosure of information. That means no information asymmetry between the brand and the stakeholders. The brand and the stakeholders ought to satisfy the conditions of the building blocks as described in the concept REACT, specifically the QCC firm has the primary responsibility. Although the interaction between the five building blocks are important and must work in a cohesive manner to attain value co-creation successfully. Transparency has been realized as a critical element of the QCC value chain and an essential factor influencing stakeholder´s decision and consumption practice toward QCC products and services. Transparency is paramount pre-requisite for realizing the other four building blocks mentioned above. A pre-requisite for attaining for relevant information through the real communication between stakeholders and brand is essential. When the stakeholders participate in the brand's co-creation value, both the brand and the stakeholders are responsible for the value creation.Thus, both play the pivotal role in the benefits and risk assessment. Hence, transparency is not only an absolute pre-requisite but also paramount to achieve the full potential of communication and the risk-benefit assessment. QCC firm ought to strive for transparency to succeed in achieving sustainable value co-creation.

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RESEARCH METHODOLOGY

The choice of research methodology is dependent on the nature of the problem. Morgan and Smircich (1980) argue, "the actual suitability of a research method, derives from the nature of the phenomena to be explored" [5]. In this conceptual study, the research methodology uses exhaustive literature review that facilitates broad search, identify high quality peer reviewed papers and analysis to obtain SVCC perspective related to disruptive technologies, disruptive business model, 6G wireless, quantum computing and sustainable value co-creation.

Literature Review

The literature review [6] includes the following two segments:
1.Explores various terms broadly and the search keywords include explanation on the following sections mentioned above: (a)introduction, (b) research background (c) 6G wireless (d) quantum computing, (e) disruptive symbiotic phenomenon, and (f) sustainable value co-creation.

2.As shown in the figure 4,the literature review also focuses on the following nine principal constituents that are co-related to each other to drive QCC sustainability and SVCC attainment: (i)culture, (ii) creativity, (iii) leadership, (iv) disruptive thinking (v) disruptive value proposition and value capture, (vi) resources integration , (vii) strategy, (viii) product & service exchange, (ix) sustainable competitive advantage (SCA):

Culture

Culture is symbolic communication. A culture is a way of life - the values, symbols, behaviors, beliefs a team accept. Founding and endowing a culture of innovation is one thing but sustaining that culture is another. Technology companies can sustain a creative culture is by recognizing and rewarding the stakeholders, specifically employees. To create a culture of innovation in a company, the following steps are essential:

- Define the mission around innovation.
- Create a flexible structure allowing employees to experiment with new ideas in unstructured time
- Recognize stakeholder's, specifically employees, contribution to the innovation process
- Be intentional with concise innovation intent.
- Measure what's meaningful.
- Provide freedom and free time to think and innovate
- Give your employees the freedom and "free time" to think and innovate.
- Lead with the right example.

Creativity

Creativity is the thinking and innovation is the execution. Creativity is not innovation, but one needs both. Business leaders frequently interchange innovation and creativity. Innovation is not a mysterious black box. Leaders need to understand the difference between innovation and creativity to pursue inspiring work to build a culture of innovation. While business leaders can promote innovation, firms need to support innovation through the design and development process and cultural makeup. Take the example of Starbuck's Frappuccino which is one of the most popular and profitable drinks. It happened because someone was allowed, and even encouraged, to experiment with a new product that deviated from the company's core product line.

Leadership

Shape adaptable leaders who succeed through disruption. An enterprise with an innovation culture doesn't just happen. Developing an innovation strategy that aligns with organization's goals allows creating various aspects of success including identifying a leader and developing a vision. The following distinctive behaviors are essential from an innovation leader: (i) excellent strategic vision, (ii) a compelling customer focus, (iii) creating an environment of reciprocal trust, (iv) loyalty to do what's right for the organization and customer, (v) belief in a culture that amplifies upward communication, (vi) persuasive nature, (vii) excel at setting realistic goals, (viii) emphasizing speed with candid communication (ix) inspire through action.

Disruptive Thinking

The old mantra, "differentiate or die," is not enough and no longer relevant. The author argues, nowadays, there's too much emphasis on differentiation. So, instead of "differentiate or die," the real mantra ought to focus

on who to create an innovative solution to disrupt the market that surprises the market with excitement. An unconventional strategy leaves competitor scrambling to catch up to compete and takes an industry into its next generation. It's what the author calls disruptive thinking**.**

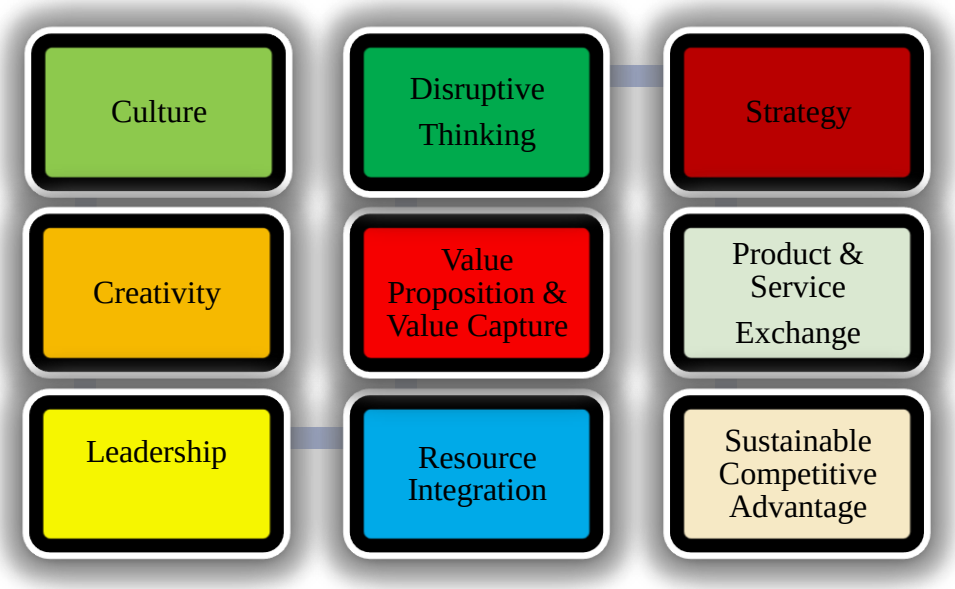

Fig. 4 Constituents to drive QCC sustainability and SVCC attainment

Value Proposition & Value Capture
Offering value propositions in the age disruption with new approaches and solutions is key to driving clients' business forward. To be disruptive is not about being critical; it's all about helping to take customers businesses to a higher level. Smart businesspersons welcome "positive disruptions" that ensures business to become productive, creating a barrier to competition, efficient, and prosperous. Customers want to do business with people who are forward-looking. Every problem presents with the opportunity to come up with a "positive disruptive" solution. Even though it may be one's idea, offering customers' ownership of the endeavor simply speeds up the journey to success. "Disruptive Innovation" drives to attain "disruptive value proposition",and creates new markets with enormous opportunity. "Sustaining Innovation" attains market share and ultimately become market share leader.

The difference of opinion between value co-creation and value capture is centuries old. The basic question - what is the ideal blend of time and effort is for value co-creation vs. value capture. There is no single answer. The company's product team need to focus exclusively on value creation. Some other teams (specialty team) help with value capture. Create a product that is compelling and engaging so that customers could not live without it. The bottom line: focus on value and always create more value than you capture.

Resource Integration
Various institutions play a vital role in resource integration between technology and organizations to encourage value co-creation. Orlikowski's view [7] on "duality of technology—a state that institutions and technology together generate resources integration." The resources exchanged between QCC firms and stakeholders can be divided into operand and operant resources. By confirming the relationship between value co-creation and sustainability, the mechanisms of resources integration bring advantages in terms of: (i) economic advantage to QCC firms, (ii) enhancing social well-being of stakeholders; and (iii) environmental benefits. The integration of technologies (quantum computing and 6G wireless) share a unique symbiotic relationship. Information technology (quantum computing) and communication (6G wireless) integration is about connecting quantum systems and applications in order to increase availability both on-premises and in the cloud. Integration should be viewed as a key data management system component and helps cross-pollinate across systems to broaden and

scale up organizational outreach. In addition to offering system and application connectivity, the integration (symbiotic) relationship is about merging corporate data—or providing data integration to deliver mission-critical information enabling disruptive value proposition.

Strategy
Despite vast investments of time and money, innovation remains a frustrating pursuit in many companies. Innovation initiatives frequently fail, and successful innovators have a hard time sustaining their performance. To build and maintain the capacity to innovate is daunting. The reason is a failure to execute and is rooted in the lack of an innovation strategy. Companies regularly define their overall business strategy specific to supporting various functions, namely marketing, operations, finance, and R&D. Based on the author's 4 decades of experience in technology companies, firms rarely articulate strategies to align innovation efforts with business strategies. A strategy is a commitment to a set of coherent, mutually reinforcing policies or behaviors aimed at attaining relevant competitive goals. A strategy is a commitment to a set of coherent, mutually reinforcing policies or behaviors aimed at attaining relevant competitive goals.

Products & services exchange (PSE)
The value should be considered from the social-economic context point of view. As per current service-dominant logic (SDL) literature, all providers are service providers, and service is the fundamental basis of exchange [8]. Based on the author´s extensive practitioner experience in value co-creation, this research is the basis for product, process and service exchange [9], a logic dominant in a product, process, and service system. Value is co-created with the stakeholders, measured based on value-in-context. Both communication and transparency are important building blocks to have a meaningful product, process and service exchange. The market is viewed as a product, process, and service exchange between the stakeholders and the QCC firm.

Sustainable competitive advantage (SCA)
Customer care and trendsetting is at the core of the sustainable competitive advantage. Maintaining quality is also one of the fundamental differentiations to attain sustainable competitive advantage (SCA) in the QCC creation and design. No QCC firm alone can fully satisfy stakeholder needs. Sustainable value is a way of managing and calibrating sustainability performance. So, in line with the SVCC framework described in this study, ecosystems can be the creation of technology promoted experiences for improving competitiveness to acquire a sustainable competitive advantage**.**

TOWARDS A DISRUPTIVE SYMBIOTIC MODEL

Sustainable value is multifaceted and all about the integration of the economic, environmental and socio-cultural dimensions of sustainability concerns. Still, to date, the most top leadership team of a firm consider sustainable development as a one-dimensional opportunity. Such a one-dimensional approach provides firms shortcomings to deal with the challenges in a strategic way. Hence, value co-creation requires a multi-dimensional approach by QCC firms to achieve optimum performance.

In this study, the development of a disruptive symbiotic model is focused on the co-creation value framework that involves QCC firm stakeholders and the relevant value chain in a multidimensional opportunity. The building blocks and practices of the disruptive symbiotic model to create sustainable value co-creation , as shown in the figure 5, are: (i) cooperation between the stakeholders of the QCC firm, (ii) stakeholders' participation in the entire value chain, and (iii) QCC products, process and services interactive actions with the application of REACT building blocks.

The concept of sustainable co-creation value (SVCC) is examined in the following manner: Co-creation of value comprises a two-phase process: first, firms like IBM co-create value with designers and developers for their customers or end users through sustainability awareness. Second, other QCC stakeholders co-create through a sustainable hybrid offering (a service bundled with a product). Such a proposition enables QCC firm to increase performance or to integrate sustainability into their supply chain. For each of the stakeholder, there is a different focus. For example, QCC integrators together with suppliersfocus on the system integration, synchronization, and convergence of their products and services. QCC customers add their inputs to receive the functional, emotional and social satisfaction through dialogue with QCC providers. All these activities will inevitably be linked to the surrounding society that empowers communities and promotes joint efforts to achieve both economic growth and sustainability.

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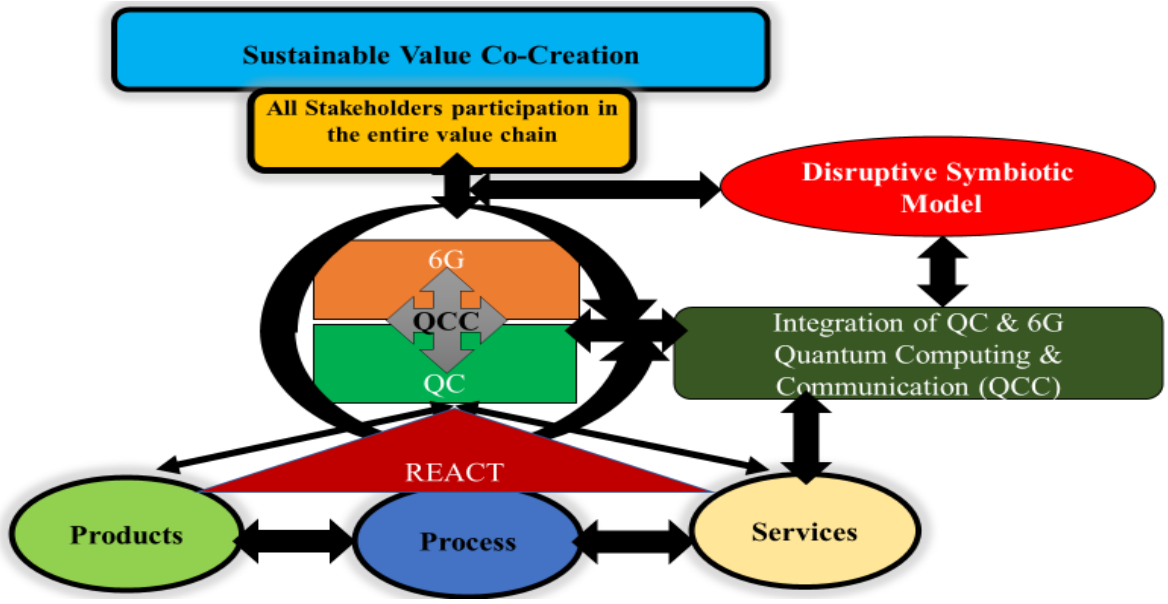

Fig. 5 Towards a Disruptive Symbiotic Model

Since co-creation of value is an important topic, manufacturers and service providers of various industries try to integrate it into their innovation practices. Value co-creation happens within organizations to connect, collaborate, solve problems and satisfy heterogeneous needs. As a practitioner, the author contends that value co-creation involves a variety of collaborative activities during which stakeholders contribute to an organization's innovation process.

Based on the discussion above, SVCC is constructed for the QCC firm in which it operates. Hence a sustainable-value co-creation framework is presented that connects the global sustainability challenges to the creation of stakeholder value by the QCC firm. This framework can be used as an education model and guide for all stakeholders including suppliers, providers, customers, decision makers and other industries who are seeking value co-creation for sustainable development.

CONCLUSION

Technologies are not a universal panacea for sustainability. Their impact needs to be assessed on a comprehensive level to ensure net positive gains of value co-creation. Sustainable production need to "do more with less" and profits need to be anchored to social benefits for people and the planet. The technological development is more rapid than ever. Firms who don't innovate continuously will be eliminated from the market. In a battle of unceasing innovation, the incumbent firms regularly win. However, in a battle of disruptive innovation, the new entrant firm wins. New disruptive technology companies don't compete for head-on with the incumbent firms. There are two different types of disruptive innovation, the low-end and the new-market disruption.

Value is co-created as stakeholders integrate resources in practices to make practices a fundamental unit of value creation. Greater resource density relevant to a specific practice and mission of the stakeholder corresponds to greater value. The realization of the fact that value creation occurs in networks of interdependent stakeholders pinpoints the need for increased transparency both between functional silos and between stakeholders. The QCC stakeholders need to understand the importance of the concept REACT to attain the SVCC, thus enriching new knowledge to the literature. This research demonstrates technologies such as quantum computing technology interacting with 6G wireless can inexorably facilitate the sustainable value co-creation in the quantum communication era enabling sustainability.

6G wireless and Quantum computing are emerging as disruptive technologies and have the potential to transform the way people live and work. Since there is still a wide gap between the practice and academic research in the quantum computing and communication (QCC) scientific knowledge, the author argues that

product and service exchange (PSE) in the value co-creation process is essential to explore the role of the stakeholders for the QCC firm.

QCC is the emerging new market disruption. The author has proposed a disruptive symbiotic model for firms to make a new growth business so that the processes can be designed to the disruption.QCC is envisaged to create a new value network and market disrupting the existing market and value network by dislocating products, processes and services creating tremendous opportunities globally.

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BIOGRAPHY

Prafulla Kumar Padhi, a serial entrepreneur, has over 43 years of global business experience and held the

Founder, CEO and Chairman of the Board positions for more than 25years and managed up to US$1.2 Billion revenue operations. His education qualification includes a Master of Science degree from the prestigious Massachusetts Institute of Technology (MIT), Cambridge, USA and a graduate of the Ivy League Wharton School of Business, University of Pennsylvania (USA) and holds seven diplomas from the Ivy League Columbia University (USA), the Ivy League Dartmouth College (USA), and Kellogg School of Management (USA). For more than 40 years, as a pioneer, Mr. Padhi has been involved in entrepreneurial venture endeavors in disruptive technologies and smart fashion wearable ventures globally. So far, he has done business in 46 countries and travelled to 142 countries. He is an author, independent researcher, teacher, innovator, pioneer, product marketing architect (patent/copyright holder) in the creation, design, marketing disruptive technologies and products.