BLOCKCHAIN FOR SMART CITY INFRASTRUCTURE

The Case of Dubai

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Realizing the new promise of the digital economy

In 1994, Don Tapscott coined the phrase, "the digital economy," with his book of that title. It discussed how the Web and the Internet of information would bring important changes in business and society. Today the Internet of value creates profound new possibilities.

In 2017, Don and Alex Tapscott launched the Blockchain Research Institute to help realize the new promise of the digital economy. We research the strategic implications of blockchain technology and produce practical insights to contribute global blockchain knowledge and help our members navigate this revolution.

Our findings, conclusions, and recommendations are initially proprietary to our members and ultimately released to the public in support of our mission. To find out more, please visit www.blockchainresearchinstitute.org.

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Foreword

In *Blockchain Revolution*, Alex Tapscott and I wrote about how blockchain can help forward-thinking leaders achieve better public outcomes. It can lead to improvements in infrastructure management, energy, waste and water management, environmental monitoring, emergency services, education, and public health.

In addition to improving efficiency, blockchain-enabled applications and the Internet of Things can improve public transportation and the deployment of green energy and clean technology. Running smart devices on a blockchain ledger can record data, coordinate usage, and optimize the life cycles of assets such as buildings, office and meeting spaces, vehicle fleets, computers, and other equipment. Governments can dynamically match available supply and demand by lowering security, maintenance, and energy costs through automated access, lighting, and temperature controls. They can also track location, repairs, and roadworthiness of government vehicles, as well as the safety of bridges, rails, and tunnels.

This case study outlines Dubai's goals to be a technology-enabled and data-driven city and provides a snapshot of progress. It sketches out how Dubai is automating its real estate registration and utilities management. It explores the potential for using blockchain to improve the security of systems, tourism, policing, identity management, and quality of the environment. These improvements are crucial for increased urbanization and the challenges it faces, such as the effects of climate change, especially rising sea levels and prolonged drought in the region.

We were pleased to recruit one of the world's top experts with respect to blockchain's impact on sustainable development goals. Alastair Marke is the co-founder of the Blockchain Climate Institute, which has recruited more than 80 experts from 30 countries. He currently serves as the director general of the Blockchain Climate Institute and Western Europe director of the Blockchain Commission for Sustainable Development. We look forward to reading his soon-to-be-published book on blockchain and emissions trading law.

DON TAPSCOTT
Co-Founder and Executive Chairman
Blockchain Research Institute

Cities are the linchpin of the economic productivity of most countries. They are also the hotbed of many administrative, organizational, logistical, social, and environmental problems.

Case in brief

» Cities face many administrative, organizational, logistical, social, and environmental problems. The best solution is the development of "smart cities," which is based on the digitization of urban systems and services that have created a data-driven economy. However, a major barrier hindering the rise of smart cities is data security concerns.

» Dubai has created the Smart Dubai program and chosen blockchain as the supporting technology because of its neutral, non-hierarchical, accessible and secure properties, and overall transparency.

» In collaboration with Emirates NBD (a recent merger between Emirates Bank International and the National Bank of Dubai)—and the General Directorate of Residency and Foreigners Affairs, Dubai Land Department (DLD), and Dubai Electricity and Water Authority (DEWA)—wasl Asset Management Group has launched a blockchain system that records all real estate contracts, including lease registrations.

» The distributed ledger links the tenancy contracts with DEWA, the telecommunications system, and various property-related billing systems to simplify the renting process in the Emirate and to ensure availability of electricity and water services for residents.

» Data from the tenancy-distributed ledger is set to feed into the "Smart Dubai Platform." It can generate a real-time data map of electricity, water, utility, land, and transportation to identify potential infrastructure improvement hotspots.

» While this case study focuses on the innovation and automation of real estates and utilities management in a smart city, we need further research on utilizing blockchain to improve its public transportation, tourism, policing, and infrastructure security against cyberattack.

The future is cities that go "smart"

Today, over 50 percent of the global population lives in cities. By 2050, the figure will reach 68 percent, according to the United Nations.[1] Despite cities being the linchpin of the economic productivity of most countries, they are also the hotbed of many administrative, organizational, logistical, social, and environmental problems.

The best solution to these problems is the development of "smart cities"—where *smart* refers to the application of information and communication technologies to a specific design space, and *city*

refers to the context of municipal services—to improve the efficiency and security of cities while protecting the natural environment, encouraging citizen participation, and stimulating the economy. The fastidious application of digital technologies in steering a city or megacity toward full recourse efficiency implies the automation of decision-making and action taking through self-executing regulations and enforcement, codified into machines.

The idea of smart cities is based on the digitization of urban systems and services to create a data-driven urban economy. The Internet and the Internet of Things (IoT) have transformed the world into a hyper-connected society, both among people and machines. Service providers are integrating other emerging technologies such as artificial intelligence and robotics into our lives. Coupled with the development of big data and open data, these emerging digital technologies are transforming how we manage municipal services such as energy and water supplies, and how we provide access to information to city dwellers.

Smart projects are underway in lots of cities, ranging from streetlights capable of assessing traffic flows to smart energy grids reacting instinctively to fluctuating demand. Yet, only a few cities can claim to be truly smart. We have the digital technologies to automate a myriad of infrastructural processes that support a city, but the key to promoting truly smart cities lies in data management.

The concept of a smart city originates in the digitization of urban systems and services to create a data-driven urban economy. The key is data management.

Dubai Desert, Burj Kalifa by Hans-Jürgen Schmidt (BS1920), 2012, used under Pixabay license.

Blockchain as a "hive builder" for data flows

Smart cities are complex systems that are highly interconnected. To exchange information across a city in real time, a truly smart city requires public systems and services composed of dispersed sensors, devices, and machines to be physically connected. In other words,

a smart city needs horizontal integration of all individual municipal services into a single, cross-cutting system. Thus, the challenge for city governments is to ensure:

» The security of the huge volumes of data created by digital technologies in smart cities

» The efficiency of the digital infrastructure in processing and analyzing such complex and diverse networks of data across the entire municipal services system

Blockchain could come in handy as a "super engine" for data exchange in smart cities.

To streamline such integration, a secure and transparent system with a common language and rules is essential.

Blockchain is proving itself a revolutionary technology, characterized by its distributed ledger, smart contract, and consensus mechanisms. Over the last few years, governments and businesses have invested significantly in blockchain to harness the benefits this technology has to offer. In particular, blockchain could come in handy as a "super engine" for data exchange in smart cities.

This research will delineate the application of blockchain technology in the smart city initiative in Dubai. It will also briefly discuss the unique value of blockchain for a smart city and the implications of blockchain-driven smart cities on low-carbon infrastructural development to address the impact of global climate change.

"The First Smart City on the Blockchain"

Dubai won the 2017 World Smart City Award and was named "The First Smart City on the Blockchain" at the Smart City Expo in Barcelona.[2] As the first blockchain-based smart city, the Dubai government boasts seven recognized complementary strategies: Smart Dubai platform, Dubai blockchain, Dubai data, Smart Dubai index, Smart Dubai guidelines, and Dubai Smart City initiatives. A core part of Dubai's Smart City initiatives is the Dubai real estate blockchain, which benefits every Dubai resident.[3]

Dubai's blockchain journey

Behind the accolade has been an exhilarating policy journey with ambitious goals set by the government of the United Arab Emirates (UAE). The UAE has launched the "UAE Blockchain Strategy 2021," which commits the country to conducting half of federal-level governmental transactions with blockchain by 2021.[4]

In parallel, Dubai aims to be the world's first blockchain city government even a year earlier—by 2020. The city government will shift to a 100 percent paperless government by applying blockchain in citywide logistics and storage systems.[5] Tasked with the mission of transforming Dubai into a "smart city" is the Smart Dubai Office established in 2015.

Dubai aims to be not just the "smartest" city on the planet, but also the "happiest" city.

Smart Dubai aims to have Dubai crowned with the standing of the "smartest" and "happiest" city on the planet by adopting blockchain to achieve four overarching objectives:

1. Efficiency to optimize resources

2. Seamlessness to integrate daily public services

3. Safety to protect people and information with risks anticipated

4. Impact to fulfill enriched life and business experiences

These objectives span across six dimensions:

1. Economy: driving of entrepreneurship with innovative economic tools

2. Governance: enhancement of transparency of government services

3. Environment: minimization of pollution and waste

4. Living: exceptional quality of education, healthcare, and cultural lifestyle

5. Mobility: seamless and efficient transportation

6. People: fostering a culture of learning and innovation[6]

Regarding the environmental dimension, Smart Dubai Office advocates citywide installation and integration of smart grids, smart meter water irrigation, smart sewage water treatment, smart storm water management, and smart waste management.

Desert Camels Dubai by Jacqueline Schmid (Schmid-Reportagen), 2014, used under Pixabay license.

In the interest of holistic implementation of the Smart City initiatives, Smart Dubai Office coordinates the work programs across various government departments (including DEWA, Roads and Transport Authority, Department of Tourism and Commerce Marketing, Department of Economic Development, Dubai Police, and Dubai Health Authority) by formulating a blockchain ambition roadmap. It consists of action plans for the following:

» Government efficiency in policy areas such as energy, transport and logistics, tourism, health, education and employment, economic development, safety and justice, social services, municipal and land works, and so forth.

» Industrial creation through policy development, a "blockchain accelerator," global blockchain start-up competitions, and private sector engagement.

» Thought leadership in the development of skills and intellectual capital across the academia, organization of blockchain speaker series, and an international blockchain award.

The Smart City initiatives, together with other strategies as a package of measures, are under the "command" of the Smart Dubai Platform. With data generated by the smart city systems (i.e., dispersed sensors, devices, and machines), the platform serves as the central application and control for the entire Dubai smart city by managing the municipal infrastructure, thanks to the sophisticated functionalities that include data ingestion, aggregation, storage, advanced analytics, and sharing.[7]

With data generated by the smart city systems, the platform serves as the central application and control for the entire Dubai smart city.

Thanks to Smart Dubai's data aggregator, Dubai Pulse, Smart Dubai Office also launched in 2017 the Smart Decision-Making Platform, where decision-makers can view live, citywide multifaceted data movement along with projections of future trends to improve the quality of various municipal policy decisions.[8] According to Sultan Butti bin Mejren, director general of the DLD:

Following the launch of the Dubai Blockchain Strategy by H.H. Sheikh Hamdan bin Mohammed in October 2016, which aims to make Dubai the first government in the world to apply all transactions through this network by 2020, DLD created a smart and secure database that records all real estate contracts. This makes DLD the first government entity in the world to implement all of its transactions through the blockchain network.[9]

Dubai real estate blockchain: The pioneer

DLD became the world's first government entity to process all real estate transactions with blockchain in October 2017.[10] Eliminating all the usual paperwork, the Dubai real estate blockchain is a digital platform linking databases across the government—including DLD and DEWA, property agencies, third-party solutions providers, and financial institutions—with the purpose of streamlining the entire

process by which Dubai residents can manage daily transactions, especially the payment of utility bills.[11]

The department has created a secure distributed database on a blockchain that records all real estate contracts (including lease registrations), which are being linked with DEWA, the citywide telecommunications and property-related billing systems.[12]

To gain the confidence of global property investors, Dubai Land Department intends to enhance its global leadership in blockchain innovations and the efficiency of government administration.

Dubai real estate blockchain is one of DLD's initiatives to develop its 26 major services comprehensively. To gain the confidence of global property investors, it intends to enhance its global leadership in blockchain innovations and the efficiency of government administration. Not only does the initiative ensure the continuous improvement of real estate services in Dubai, but it also enables DLD to be immediately responsive to customer needs. Real-time customer service cuts down waiting time, reduces administration costs, and improves both the quality and accuracy of transaction processing. These benefits will be conducive to the city's ranking in the Global Competitiveness Index.[13] According to Mureed Basheer Mustafa, director of operations at Emirates Real Estate Solutions:

> *It is important to provide smart solutions for the real estate sector by developing smart channels and applications that rely on blockchain and artificial intelligence, with the aim to strengthen Dubai's global position as a preferred destination for living, working and investing.[14]*

Ownership, sale, and leasing of property

Under DLD's real estate blockchain initiative are three capabilities: ownership verification in DLD mobile application, property sale by developer, and smart leasing process.[15] The initiative will streamline DLD's collaboration with other parties involved in Dubai's real estate market. Using blockchain technology can also create secure digital assets.

In October 2017, DLD launched the title deed blockchain solution. Through its blockchain ownership platform, it has secured more than 500,000 title deeds on blockchain. Today, more than 250 title deeds are registered daily with 1.5 million records (including accurate data of owners, brokers, properties, transactions, etc.) already on this blockchain.[16] Users can verify or update ownership and titles of the properties. In addition, the DLD launched smart leasing process in January 2018.

To offer tenants more convenience, this blockchain-based platform combines the following:

» Know-your-customer Dubai ID (also linked to the General Directorate of Residency and Foreigners Affairs)

» Rental listing of properties under wasl Asset Management Group (one of the largest real estate developers in Dubai)

» Smart cheque through Emirates NBD (one of the largest banking groups in the Middle East)

» Utility services such as electricity and water provided by DEWA.

Users buy and sell properties based on title deed blockchain equipped with smart contracts.[17]

Eight features of the Dubai real estate blockchain

1. Removal of infinite reproducibility from a digital asset

2. Provision of scalable, secured, transparent, shared, and immutable property data to all the participants of the trusted network with end-to-end property transactions written onto the real estate blockchain

3. Replacement of paper documentation with digital records and digitally signed documents

4. Elimination of manual processes by integrating required stakeholders (customers, developers, payment channels, DLD, DEWA, Dubai Municipality, Dubai Naturalization and Residency Department, etc.) participating in the smart system through the blockchain network

5. Provision of a hybrid platform for the real estate market to be shared across different private or government entities for real-time data about transactions of participants

6. Sharing of information among entities to serve the open data initiative

7. Security and simplification of the overall property transaction processes

8. Enhancement of operational efficiency

Source: Dubai Land Department, "Blockchain Project," Government of Dubai, last updated 28 Jan. 2019. www.dubailand.gov.ae/English/Pages/Blockchain.aspx, accessed 27 Jan. 2019.

"The technology will allow investors residing in Dubai and around the world to verify property data."

SULTAN BUTTI BIN MEJREN
*Director General
Dubai Land Department*

Sultan Butti bin Mejren of the DLD was clear:

The technology will allow investors residing in Dubai and around the world to verify property data that is backed by timestamp signatures, enhancing the accuracy of data, the credibility of investment transactions and the transparency and clarity of the market. … The platform will connect renters not only to landlords, but also to other property-related billers, such as electrical, water and telecommunications utilities. [Tenants are allowed] to make payments electronically without the need to write cheques or print any paper … within a few minutes at any time and from anywhere in the world.[18]

It is DLD's goal to unite all real estate and department services on a single platform to be completed from 2019 through 2020. Sultan

Butti bin Mejren said, "This initiative is still in a stage of infancy. In the near future, we will see many partners joining blockchain to improve their client services, including banking, mortgages, and utilities and maintenance operations."[19]

Skyline of Dubai by K-H. Gebhardt (Charly-G), 2013, used under Pixabay license.

Widespread installations of smart meters for water and electricity, solar photovoltaic panels, a water-leakage alert system, and electric vehicle charging stations are enabling residents to make sustainable resource consumption decisions.
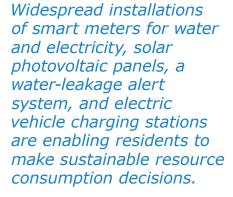
Smart metering of utilities

Today, DEWA's database houses data from smart meters across its electricity and water supply networks. DEWA has introduced widespread smart meter installations for water and electricity as part of the smart applications through smart meters and grids initiative.[20] As of August 2017—two years after the city announced this smart transformation initiative—80 percent of DEWA transactions have been completed virtually instead of physically in its service centers.[21]

By installing smart meters for Dubai residents, DEWA enables residents to make sustainable energy decisions. Complementary to smart metering are several other initiatives, including Shams Dubai and Green Dubai. Shams Dubai encourages building owners to install solar photovoltaic (PV) panels connected to DEWA's grid. To date, there are solar PV panels installed on over 1,145 buildings, which contribute a capacity of 50 megawatts to the grid.

Green Dubai encompasses a water-leakage alert system that flags higher than normal levels of water consumption so that customers can check for possible leaks. Under Green Dubai, there is also the EV Green Charger initiative. Since it was launched, over 100 electric vehicle charging stations have been installed with the target of doubling this number by the end of 2018.

Thus, DLD's connecting its real estate blockchain with DEWA's database is tantamount to connecting it with millions of smart meters across Dubai.[22]

Blockchain's unique value proposition

Blockchain offers ambitious solutions to streamline processes and improve municipal service delivery for Dubai to become an authentic smart city. The major barrier to building a smart city rests on the difficulty for a government to manage the most personal and private data of its citizens, ranging from identity to real estate transactions and financial records, efficiently and securely. At this juncture, blockchain offers efficiency and security that help us build a robust case for integrating it into a city's public service delivery system.

The major barrier to building a smart city is the difficulty of managing the most personal and private data of citizens.

Identity management

For a smooth integration of blockchain into a government system, blockchain converts physical assets to digital form. Asset owners need to create a digital link or identity in order to participate in this trusted system.

Pain points

» Absence of a cross-sector standard for identity establishment and verification processes in the provision of public services.

» A central entity managing huge amounts of personal data being at great risk for cyberattack.

Value proposition of blockchain

» A single, secure digital identity enabling efficient and safe transactions across asset classes.

» Identity data accessible only via explicit consent of the identity holder.

Dubai Skyline City Architecture Skyscrapers by Martinschuschi, 2017, used under Pixabay license.

Land or property registration

Titling and land deeds, which guarantee the protection of private property rights, are critical to economic growth.[23] Blockchain provides unique and non-corruptible property records that we can securely update.

Pain points

» Paper-based and intermediary-centric registry processes and licenses render transactions inefficient, costly, and susceptible to unauthorized changes.

» Millions of dollars spent every year by property owners covering real estate title risks.

Value proposition of blockchain

» Removal or reduction of the intermediary-centric processes with a standardized and decentralized platform for land registration records (where all relevant information is approved by both the buyer and seller), which are low-cost, efficient, and trusted among parties involved.

» A blockchain-based property recording platform with an encrypted title ledger (which a real estate company and other relevant parties can access) offering administration cost savings that amount to billions of dollars a year.

New business models for the utility markets

Blockchain-based smart contracts are set to revolutionize the entire utility market along its value chain from generation end users by automating transactions and empowering "prosumers" in completely new business models; the most remarkable of which is peer-to-peer energy trading. Of paramount importance to a successful trading market is the low risk of credit, fraud, error, or invalid transactions—which blockchain can offer with its trusted ledger mechanism.

Pain points

» Meter read error, supplier's estimation error, or invoice calculation error.

» Imbalance of demand and supply on centralized, operator-centric grid systems.

Value proposition of blockchain

» Automated trading and billing with smart contracts based on flexible retail prices in microgrids (including trading of renewable energy credits upon proof of origin of generation source).

Smart contracts are distributed applications that mimic the logic of business agreements.

» Grid resilience (i.e., more efficient real-time monitoring and maintenance of utility infrastructure) by enabling prosumers to participate and demand response more actively for balanced energy flows and instant payments (including through charging stations of electric vehicles seamlessly connected with grid infrastructure).

Blockchain, therefore, serves as a "super engine" that optimizes the digitization of urban systems and services, thereby creating a data-driven local economy, which qualifies a city for the smart designation.

Impact on low-carbon infrastructural development

Blockchain-driven smart cities would have great implications for the development of low-carbon infrastructure worldwide, which we urgently need to develop, as the international community has committed to the 2°C rise trajectory stipulated in the Paris Agreement.

As cities emit 70 percent of the world's greenhouse gases, blockchain (combined with IoT solutions) in a smart city can offer tremendous opportunities for significant reduction of emissions.[24] These smart technologies are robust drivers of sustainable, low-carbon cities in five areas:

Dubai Government estimates that a "blockchain government" would save 1.6 billion kilometers of driving and 389 million documents.

» Monitoring and managing the carbon footprint of the city for decision-makers

» Connected mobility solutions for model shift toward electric vehicles

» Distributed and community energy solutions

» Smarter buildings with transparency in their energy consumption and generation

» Smart energy, water, and waste management[25]

Coincidentally, these five areas are compatible with the programs introduced by DLD and DEWA—though not necessarily related to the Dubai Government's Smart City initiative.

Dubai Government estimates that a "blockchain government" would save 1.6 billion kilometers of driving and 389 million documents.[26] Globally, it is estimated that smart city solutions (i.e., energy use optimization as well as electricity, water, and waste tracking) could reduce greenhouse gas emissions by 10 to 15 percent or 7.8 gigatons of carbon dioxide (equivalent of €600,000 or $684,000 worth of energy savings and carbon price) by 2020, and up to 20 percent of carbon savings by 2030.[27]

Museum Dubai UAE Arabic Ancient Historic by TadM, 2011, used under Pixabay license.

Key takeaways

» **Blockchain as the smart city platform.** Blockchain may be the only technology that can manage complex data exchanges in a smart city in a high-speed, yet low-cost way. Smart city infrastructure thrives only in a data-driven environment, characterized by the complexity and multiplicity of data exchanges among consumers and suppliers of various municipal services (i.e., energy and water supplies). A smart city represents many owners and users of distributed assets working in concert with exchange of data orchestrated by millions of smart devices to provide dwellers with reliable and efficient services. Blockchain, if complemented by other emerging digital technologies (e.g., cloud, remote sensors or IoTs), can enable seamless sharing of big data across citywide infrastructure to facilitate a decentralized marketplace of utility services. Cities can also use it across government authorities to improve the quality of policy decisions in municipal planning.

» **The need for leadership and commitment.** Building a blockchain-based smart city requires cross-government leadership and commitment to innovation.[28] To provide an enabling environment for blockchain applications in smart cities, policymakers should adopt a fresh way of thinking by encouraging experimentation and supporting innovation in the delivery of municipal services, including access to energy and water supplies, transport services, and the property market. The deployment of the right digital technologies in

A smart city represents many owners and users of distributed assets working in concert with data exchanges orchestrated by millions of smart devices to provide residents with reliable and efficient services.

a smart city does not require huge investment in capital but in curiosity or a "can-do" mentality. To shift the mentality of policymakers toward the innovation side, government should engage a much broader range of stakeholders than the traditional circle of players such as wholesalers and large utilities companies. Stakeholder engagement for urban planning should extend to property developers, managers, and other relevant authorities.

» **The need for regulatory clarity and support.**
Policymakers can capture full benefits from blockchain in smart city development by providing an enabling regulatory environment. Officials designed the existing regulatory framework for a centralized utilities market. For example, energy market regulations define how a networked tariff is created, how transactions should happen, how retailers charge consumers and how consumers pay for energy. Government should create sandboxes in which innovators can demonstrate how blockchain and other digital technologies function and which benefits are possible in enabling smart cities. A sandbox should be an environment in which start-ups, technology firms, regulators, and other stakeholders can undertake open, risk-free exploration of blockchain and other digital technologies. The outcomes of a sandbox should then inform the necessary regulatory reform that redefines the trading model of the entire economy, including mechanisms to ensure the cybersecurity of data exchange.

Governments should create sandboxes, virtual spaces in which new or untested blockchain protocols and other digital technologies can be run securely, so that innovators can demonstrate their benefits to smart cities.

Burj Al Arab Dubai Hotel by Free-Photos, 2015, used under Pixabay license.

About the author

Alastair Marke is currently the director-general of the Blockchain Climate Institute and Western Europe director of the Blockchain Commission for Sustainable Development, where he works with a number of UN agencies to deploy blockchain in achieving sustainable development goals. In the United Kingdom, he chairs the Energy, Climate Change, and Green Finance Committee of the British Blockchain Association. He also serves as an ad hoc expert advisor to the All-Party Parliamentary Group on Blockchain while maintaining his commitment to development of ISO 14097 climate finance and ISO TC307 WG2 and WG5 blockchain use case and governance standards.

Alastair is a seasoned sustainability and innovation policy advisor supporting a wide range of institutional clients such as the Department for International Development, GIZ, European Commission, AusAID, and NDC Partnership. Aspiring to be a thought leader in this field, he has published papers on various policy issues, including food and energy security, climate finance, low-carbon investment planning, emissions trading, and associated green growth issues. Seeing the dire need to accelerate global efforts to fill the current climate finance gap, Alastair has co-founded the Blockchain Climate Institute composing over 80 experts from 30 countries. They have produced the world's first book on blockchain and climate change issues, *Transforming Climate Finance and Green Investment with Blockchains*, which was released in July 2018. He is also a founding member of the Climate Chain Coalition with the United Nations Framework Convention on Climate Change Secretariat. His forthcoming book will be on blockchain and emissions trading law.

Acknowledgments

About the Blockchain Research Institute

Co-founded in 2017 by Don and Alex Tapscott, the Blockchain Research Institute is a knowledge network organized to help realize the new promise of the digital economy. It builds on their yearlong investigation of distributed ledger technology, which culminated in the publication of their critically acclaimed book, *Blockchain Revolution* (Portfolio Penguin).

Our syndicated research program, which is funded by major corporations and government agencies, aims to fill a large gap in the global understanding of blockchain technology and its strategic implications for business, government, and society.

Our global team of blockchain experts is dedicated to exploring, understanding, documenting, and informing leaders of the market opportunities and implementation challenges of this nascent technology. Research areas include financial services, manufacturing, retail, energy and resources, technology, media, telecommunications, healthcare, and government as well as the management of organizations, the transformation of the corporation, and the regulation of innovation. We also explore blockchain's potential role in the Internet of Things, robotics and autonomous machines, artificial intelligence, and other emerging technologies.

Our findings are initially proprietary to our members and are ultimately released under a Creative Commons license to help achieve our mission. To find out more, please visit www.blockchainresearchinstitute.org.

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