

BLOCKCHAIN

TRANSFORMING YOUR BUSINESS
AND OUR WORLD



MARK VAN RIJMENAM
& DR PHILIPPA RYAN



Blockchain

The internet was envisaged as a decentralised global network, but in the past 25 years it has come to be controlled by a few, very powerful, centralised companies. Blockchain is a technological paradigm shift that allows secure, reliable, and direct information transfer across individuals, organisations, and things, so that we can manage, verify, and control the use of our own data.

Blockchain also offers a new opportunity for humanity to fix some major problems. It can authenticate data, manage its analysis, and automate its use. With better data comes better decision-making. In this way, Blockchain can contribute to solving climate change, reduce voting fraud, fix our identity systems, improve fair trade, and give the poor an opportunity to improve their lives by monetising their (digital) capital. A world built upon peer-to-peer transactions and smart contracts can empower individuals and communities.

This book offers a fresh perspective with which to consider this transformative technology. It describes how Blockchain can optimise the processes that run our society. It provides practical solutions to global problems and offers a roadmap to incorporate Blockchain in your business. It offers a blueprint for a better world. Filled with easy-to-understand examples, this book shows how Blockchain can take over where the internet has fallen short.

Mark van Rijmenam is Founder and CEO of Datafloq and Imagin, author and speaker, The Netherlands.

Philippa Ryan is a Barrister and Lecturer in the Faculty of Law at the University of Technology Sydney, Australia.

“The authors tackle a timely and important new technology in an accessible and engaging way. This is a book that will reward you for the time you spend reading it, and we are already looking forward to reading it a second time. It is a worthy addition to the emerging collection of informative and helpful books on the world of blockchain.”

Simon Cocking, Editor in Chief, Irish Tech News & CryptocoinNews

“The digital revolution’s first era failed to solve pressing social, economic and environmental challenges. Blockchain offers a once-in-a-generation opportunity to get it right. *Blockchain* skillfully champions the opportunities offered by a new internet of value.”

*Don Tapscott, Executive Chairman, Blockchain Research Institute
and Co-author of Blockchain Revolution: How the Technology Behind
Bitcoin is Changing Money, Business, and the World*

“So much more than JABB (Just Another Blockchain Book). Van Rijmenam and Ryan take you on a tour of the world’s potential with the blockchain trust protocol and its ability to change our world. When you’re done reading this book, you’ll be sketching the art of the possible . . . not dreaming about it.

Trust is a competitive advantage. You earn it in droplets and lose it in buckets. Van Rijmenam and Ryan turn the typical boring blockchain book upside and create a journey on how trust can change our world. More so, the book makes you dream big – not just about the changes that are coming, but ones that you can participate in or imagine on your own. Never really had a ‘Must Read 2018 Books’ list . . . until now.

Blockchain will do for trust what the internet did for search. In a world of good and bad actors, where trust becomes a differentiator, Van Rijmenam and Ryan expand the blockchain aperture from the ubiquitous (and overwritten) cryptocurrency discussion, to a discussion how trust can change the world: business, social, equality, and more.”

Paul Zikopoulos, IBM, VP Cognitive Systems, Big Data speaker and author

“This is a fine and important read, especially the Blockchain history. I thoroughly recommend you read, ponder and absorb for your token strategy planning.”

Thomas Power, Board Member, 9Spokes PLC New Zealand

“Blockchain’s potential is so much more than digital currency. *Blockchain: Transforming Your Business and Our World* is a step towards bringing that potential to life, exploring positive use cases and practical solutions to a diverse range of global social issues, from climate change and healthcare access to digital identity and poverty. For anyone interested in how we can build a better world with blockchain technology, this book provides an educational snapshot into what a more decentralized future could look like.”

Vinny Lingham, CEO and Co-Founder of Civic Technologies, Inc.

Blockchain

Transforming Your Business and Our World

Mark van Rijmenam and
Philippa Ryan

First published 2019
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

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British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data

Names: Van Rijmenam, Mark, author. | Ryan, Philippa, author.

Title: Blockchain : transforming your business and our world / Mark van Rijmenam & Dr Philippa Ryan.

Description: 1 Edition. | New York : Routledge, 2019. | Includes bibliographical references and index.

Identifiers: LCCN 2018015347 | ISBN 9781138313224 (hbk) | ISBN 9781138313248 (pbk) | ISBN 9780429457715 (ebk)

Subjects: LCSH: Blockchains (Databases)

Classification: LCC QA76.9.D32 V35 2019 | DDC 005.74—dc23

LC record available at <https://lcn.loc.gov/2018015347>

ISBN: 978-1-138-31322-4 (hbk)

ISBN: 978-1-138-31324-8 (pbk)

ISBN: 978-0-429-45771-5 (ebk)

Typeset in Bembo

by Swales & Willis Ltd, Exeter, Devon, UK

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Foreword

A major cause of poverty and conflict is the failure to transform resources into capital without predation by intermediaries (e.g. government corruption, corporate mischief) in that process. As an economist and entrepreneur, I am passionate about Blockchain's potential to plug such structural leakages.

In September 2015, more than 150 world leaders gathered at the United Nations' headquarters in New York for the Sustainable Development Summit. That event was the launch pad for action by the international community and national governments to promote shared prosperity and well-being for all. The UN wants to end poverty by 2030. The question is *how*.

I first heard about *Blockchain: Transforming Your Business and Our World* during the Third Global Blockchain Summit held in Shanghai in September 2017. After delivering my keynote, I attended a lunch hosted by one of its sponsors. Seated next to me was one of the co-authors of this ambitious and inspirational book. We talked about ways that blockchain-based business solutions and philanthropy could address some of the world's 'Wicked Problems', as the authors call them. It is in this spirit that Van Rijmenam and Ryan have approached their book. Focusing on five of the UN's 17 Sustainable Development Goals, the authors suggest practical and commercially applicable blockchain-based solutions.

From the outset, this book makes explicit its intention: to identify ways that blockchain technology can solve some of the world's more complex problems. Drawing on the cultural and philosophical forces that combined make the blockchain's primordial soup, the authors have applied their democratic and optimistic vision of how sophisticated distributed ledger technology can be used for social good. They also make a compelling case for how it can be adapted to meet commercial and business needs. Van Rijmenam and Ryan demonstrate in each of their proposals that they are adherents to the view that sustainable development is about ensuring transparency, fair trade, independent media, and financial inclusion. Indeed, we live in times when no one on the planet is immune to fake news, corruption, identity theft, counterfeit labelling, and bad data.

Starting with a clear and relevant explanation of how blockchain technology works, each chapter in this book builds on the one before. From identity to censorship and welfare fraud to tax havens, each analysis identifies a particular problem, the traditional or incumbent attempts to solve it, and the features of blockchain technology that can be applied to achieving those solutions. It is already well established that this revolutionary technology will transform systems and processes that manage payments, identity, and supply chains. However, until this book, it has been unclear how blockchain can also be applied for social good. There is a danger that not everyone will have access to the benefits that will flow from improved security and efficiency in tracking and storing information and assets, but Van Rijmenam and Ryan spell out how blockchain will help us build a better society for all.

It is refreshing that this work can be read as both a useful resource and a call to action. For governments, professionals, businesses, industry, and academics, this book offers an insight into blockchain technology, and makes accessible some of its more complicated features. For technologists, it lends purpose to their work and articulates the often-silenced expectations of the millions of unbanked, underemployed, and displaced peoples from countries plagued by corruption, political unrest, and natural disasters. These same people represent new markets of potential consumers keen to unleash their entrepreneurial potential in the world.

Just as the UN has called upon global leaders to work together towards the 17 Sustainable Development Goals, this book calls upon those working to reach those Goals to think about how new technologies like blockchain can help to achieve them. I found this book to be a thorough guide to the transformative potential of blockchain technology.

Patrick M. Byrne, PhD
CEO, Overstock.com

Acknowledgements

This book would not have been possible without the help of the following people who each provided valuable input and feedback on the different aspects of this book: Andrew Latchford, Andrew Tobin, Christopher Yong, Daniel Gasteiger, Daniel O’Quinn, David Peyronnin, David Birch, David Schrier, Haroon Oppal, Jason Williams, Jean-Marc Fisz, Jerry Qian, Jon Holmquist, Kaustubh Varade, Ken Bonar, Kevin Coleman, Martijn Bolt, Max Kaye, Nidhi Chamria, Olivier Rikken, Ott Sarv, Patrick Feeney, Phil Windley, Prahalad Belavadi, Robbert Naastepad, Ronald van de Meent, Samuel Brooks, Parag Jain, Sandris Murins, Duncan Brown, Shree Sule, Sina Ghazi, Sumit Sharma, Sushant Mayekar, and Virgil Griffith.

Special thanks to Cindy Lam for proofreading our book.



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Blockchain and Wicked Problems

Problem /'prɒbləm/: a thing that is difficult to achieve

1.1 Introduction

We live in a time of accelerated change and today's world is changing faster than we have ever seen before. The end of the 19th century and beginning of the 20th century were a period of technological upheaval and re-concentration of populations into urbanised centres. These shifts were made possible by the massive infrastructure projects that saw canals and railways connect cities and ports with producers of agriculture and mining. Communications systems were revolutionised by the laying of telegraph cable and the invention of flight. Now, in the 21st century, new technologies are driving even more dramatic changes in the way we live, work, and socialise. These developments and innovations challenge traditional ways of distributing goods and services, doing business, and making payments.

If our recent past is anything to go by, our immediate future seems set to change at a speed unlike any we have ever seen before. In fact, it sees a potential change in what it means to be human. Our interaction with automated processing, data, and the Internet of Things has changed how we store information, how we remember, and how we recall those memories. Decision-making has become something we do in concert with machines. With the advance of technology, we have the potential to create a world in which technology is used for good, while ensuring that the privacy of consumers is respected, a world where data is owned by individuals and used to improve the lives of all—essentially, a world that is better for all. In the future, it is all about algorithms, machine learning, big data, and artificial intelligence. This change comes about because of the development of robotics, 3D printing and augmented reality, nanotechnology, and quantum computing. There is disruption at all levels, resulting in system-wide innovations that can revolutionise an industry in years, rather than decades.

Blockchain technology will enable the decentralisation of the web and the disintermediation of many, if not all, of the services that are offered online.

The web was originally envisaged as a decentralised network, but somehow, in the past 25 years, it ended up in the hands of a select handful of very powerful companies. As Sir Tim Berners-Lee said during the Decentralised Web Summit in 2016:

The web was designed to be decentralised so that everybody could participate by having their own domain and having their own webserver and this hasn't worked out. Instead, we've got the situation where individual personal data has been locked up in these silos.

Fortunately, Blockchain will allow us to bring back power to the users and create a decentralised society. Already, Blockchain challenges many industries, of which financial services will see the largest impact in the coming years. Accordingly, this necessarily begs the question—how will Blockchain have an impact on other global problems?

1.2 The problem

Despite the best intentions and efforts of well-meaning world leaders and non-government organisations, over-population, poverty, climate change, and political strife continue to create vulnerable and displaced populations. According to The World Bank's most recently published statistics (in 2017), 10.7% of the world's population has an income of just US\$1.90 or less per day [1], whereas only 64% of adult men and 57% of adult women (aged over 15 years) have an account with a financial institution [2]. In the 55 years from 1960 to 2015, carbon dioxide emissions have quadrupled [3], and yet 15% of the world's population still has no access to electricity [3] and 56% has no internet access.

It has long been accepted that efforts to improve economic growth in developing countries are often hampered by government officials using their authority for private gain and implementing public policies from which they directly benefit [4, p. 417]. Corruption increases income inequality and poverty by reducing economic growth and rates of compliance with tax systems [5, p. 2]. It also distorts the government's role in distributing vital resources such as education, health, social security, welfare housing, and community amenities [5]. The direct causal relationship between corruption and disadvantage suggests that a reduction in corruption will alleviate poverty and its related evils [4, p. 426].

Eradicating corruption is not straightforward. In many developing countries corruption is culturally entrenched in the way that governments do business, both domestically and internationally. It is a symptom of institutional weakness and it reduces economic growth [6, p. 682, 7]. For this reason, many aid organisations send their own trusted people to deliver disaster relief in person, but these measures do not address the cultural problems that persist. Such issues

must be addressed if there is to be meaningful long-term change. A key element in the equation is the rule of law, which, if embraced, will aid in the fight against corruption.

The law should afford adequate protection of fundamental human rights. The term ‘human rights’ was mentioned seven times in the United Nations’ founding Charter. The Charter of the United Nations, which was signed on 26 June 1945, in San Francisco, at the conclusion of the United Nations Conference on International Organisation, came into force on 24 October 1945. Article 1 of the Charter identifies the purpose of the United Nations and includes the aim to achieve international cooperation in solving international problems of an economic, social, cultural, or humanitarian nature, as well as promoting and encouraging respect for human rights and fundamental freedoms for all, without distinction as to race, sex, language, or religion. In 1948, the Universal Declaration of Human Rights brought human dignity and fairness into the realm of international law. Since then, the UN has diligently protected human rights through legal instruments and on-the-ground activities. Human rights, as defined in the UN’s founding Charter, remain a key purpose and guiding principle of the organisation.

The Universal Declaration of Human Rights was the first legal document protecting universal human rights. Included in the Declaration are the following: the rights to equal pay for equal work, privacy, freedom of movement and residence, freedom of thought and freedom of expression; the right to leave and return to any country; the right to nationality; the right to own property; the right to freedom of assembly and association; as well as special protection for motherhood and childhood. Seventy years later, many of these Universal Rights are under strain due to increases in world population and limited natural resources [8, 9, p. 31].

Seventy years ago, the population of the world was less than 2.5 billion [10]. Since then it has tripled. In 1948, the year that the UN published its Universal Declaration of Human Rights, the world’s average life expectancy was just 45 years. It is now 65 years. From 1950 onwards, the world experienced rapid population growth mainly due to a reduction in mortality. The period 1950–1965 saw the fastest growth in world population, slowing since then mainly due to contraception [11]. However, with 7.5 billion people living mainly in urban areas, the pressure on the planet to feed and house its population is at an all-time high. The relationship between the environment and peace has never been more tenuous.

In recent decades, we have seen how environmental problems such as resource scarcity and climate change can create or exacerbate conflict. In 2007, UN Secretary General Ban Ki-moon described the conflict in Sudan’s Darfur region as the world’s first climate change conflict [12]. The assumption was that water scarcity from changed rainfall patterns, caused by climate change, contributed to this conflict. His thinking reflects the findings to date that the incidence of conflict is likely to

be higher in years of lower precipitation [12, 13]. With rising water levels caused by melting polar ice caps, island nations and low-lying areas will soon need to move their inhabitants to higher ground. Island nations such as Kiribati and the Maldives, which have no natural high ground, will have to choose between sinking and shifting. To deal with these challenges and defend against changing conditions, these countries need to advance economically, although, in a seemingly paradoxical twist, their economic woes are underpinned by climate change.

As long as scientists cannot explain or predict climate change with precision, there will be room for deniers to exploit this imprecision as a basis for the argument that climate change is either non-existent or not man-made. This expectation that scientific discourse should be based on exact data undermines the overall message. A lack of political will in some parts of the world to accept climate change being caused by human activity is in part driven by the prohibitive cost of dealing with it. Political parties and politicians all over the world are prepared to include tackling climate change in their campaign speeches, but the harsh reality of how environmentally-friendly policies will impact on the electorate and the economy in any given election cycle is political poison. Manufacturing, transportation, fishing, the production of food, and the extraction of natural minerals are all resource-hungry activities. Global market forces and price competition make carbon emissions policies very unpopular.

There is strong evidence to support the view that poverty and human insecurity may arise as a result of climate change [14, p. 19, 15, p. 22]. Many important aspects of human development also relate to people's security. In this way, 'human security' can be defined as people's freedom from fear and freedom from want in a broad sense. Human security has always been tied to climate because want causes fear and conflict. Climate security focuses on the needs of individuals and communities and the idea of freedom from harm and fear. People need to be able to adapt in the face of any imposed harm. From this human security perspective, the central analytical issues are vulnerability, adaptation, and justice.

The issues of *human security* and conflict in relation to *climate* change have evolved to a place where they now constitute a recognised and important component in the *climate*-change conversation, and are being addressed at a diverse range of forums through meetings, reports, and changes in policy. Societies with more climate-sensitive economies, largely in the developing world, will be most affected because climate change acts as a 'threat multiplier' and adds to existing burdens. Decreasing availability of resources due to regional effects of climate change—such as drought and desertification—leads to intensified competition for these resources. And this, when compounded by pressures such as rapid population growth, tribalism, and sectarianism (as in Darfur and Somalia), could result in armed violence. As meteorological disasters become more frequent and intense with global warming, already struggling societies

will be weakened further, making them more vulnerable to political instability, as in Haiti. It therefore follows that global warming may directly increase conflict. It is these issues that drive the UN's Sustainable Development Goals.

These goals, which were adopted by member countries in September 2015, were initially drafted to address 17 global challenges, with a view to protecting the planet and tackling climate change. At the top of the agenda are poverty, hunger and food security, health, water, and sanitation. Other aims include quality education, innovation, reduced inequality, sustainable cities and communities, strong peace and justice institutions, and responsible production and consumption. Blockchain technology can play an important role in achieving some of these goals fairly and transparently. For example, this book looks at how distributed ledgers can support Fair Trade by enabling transparency in the treatment of those who produce and distribute food and resources.

There is a basic core definition of human rights that has almost universal acceptance. It can be summed up in two points: (1) that the people and government should be ruled by the law and obey it; and (2) that the law should be such that people will be willing and able to be guided by it [16]. At the core of these principles are the notions that no one shall be punished except by a court of law and everyone is innocent until proven guilty. In addition to these process-driven values, there is a body of rights or truths within the rule of law that ensures dignity, free speech, and privacy. Of course, these private rights may from time to time compete with public interests. Where there is such a clash, it is important for the human actors in government institutions to know what the law is, and the extent and limits of their power to enforce those rules.

Upholding ethical standards of conduct and bringing those who fall short to account are all mechanisms that operate to motivate respect for the rule of law. Equally, the media and historians have a duty to report accurately and fearlessly the truth of what is observed and heard. Clearly articulated ethical standards have long played a key role in engineering practice and in recent years they have been extended to the work of computer scientists. Managed by the Institute of Electrical and Electronics Engineers (IEEE), the ethical foundation of science and technology dates back to the late 1870s with the invention of the electric light globe and the telephone. The IEEE's mission statement is that its core purpose is to foster technological innovation and excellence for the benefit of humanity. Significantly, the IEEE reviewed its Code of Ethics in November 2017 to include recognition and support for the UN's Sustainable Development Goals. Addressing its 430,000 members in 160 countries, the revised policy stipulates that members agree to hold paramount the safety, health, and welfare of the public, and to strive to comply with ethical design and sustainable development practices. This edict recognises that the fabric of our modern, technology-driven society is enmeshed in such a way that all of these forces and drivers play a part in ensuring stability and promoting peaceful and respectful debate in complex modern societies.

Technology has an important part to play in holding all actors to account. Blockchain has the potential to play an important part in how rule of law might be more readily discernible and therefore rooted in existing systems that are particularly vulnerable to abuse.

Meanwhile, fake news is more than just a political problem. Whether it is deliberate (disinformation) or inadvertent (misinformation), ‘fake news’ is a term that connotes manipulated reporting and information about political, historical, economic, or social events and phenomena. With the rise of social media and the ease with which news and current affairs are reported and distributed via the internet, reporting on the conduct of our institutions has become more problematic. News reporting has changed utterly over the past decade and traditional methods of disseminating what happens in parliament, in court, and in public have shifted to news consumers. With hand-held devices that record with clarity both sound and video, people are instant reporters and publishers of events as they unfold in real time. The problem is that the lens of a phone has a limited point of view and it is difficult to reveal situation and context. Rationalising data and facts has become more challenging than ever. Distinguishing satire and parody from serious discourse can have significant consequences. Reporting on complex scientific or legal issues requires expertise [17]. In 2017, fake news became known to the larger public with the election of Donald Trump as President of the United States of America. With his constant remarks on ‘The Fake Media’, Donald Trump defined a new era in journalism, an era of which we should not be proud. His remarks demonstrate the significant influence that tech giants such as Facebook and Google have on the propagation of fake news. *Digital Deceit*, a 2018 report co-authored by Dipayan Gosh, previously a privacy and public policy adviser for Facebook, shows that the central problem is that an entire industry is founded on advanced technology that is purely focused on driving traffic and selling advertising. Of course, nefarious actors can benefit from this advanced potential to target specific demographics. Meanwhile, social media platforms such as Facebook benefit financially from these arrangements and so have no inherent motivation to prevent the distribution of fake news. Accordingly Gosh considers that disinformation operators can ‘leverage this system for precision propaganda [and] the harm to the public interest, the political culture, and the integrity of democracy is substantial and distinct from any other type of advertiser’ [18, p. 4].

As a result of this modern phenomenon, the factual and authoritative reporting and analysis of important matters has suffered. However, there are innovative ways to rate the veracity and usefulness of information. This technology has been tested on social media platforms such as TripAdvisor and Reddit.

It appears that Blockchain’s capacity to monitor and report transactions and data has limitless potential to impact our online businesses, personal relationships, and interactions. This book explores censorship in light of the UN’s expression of the right to freedom of expression and the right to privacy.

It provides examples of how blockchain is being used to disseminate and verify information, while at the same time protecting it from government manipulation and control. This capacity to track, monitor, and verify can positively impact the processes and information being managed by the use of blockchain technology. The technology underpinning blockchain can create trust where there has been distrust, and enable secure financial transactions and information exchanges in times of conflict and unrest.

1.3 The culture of Blockchain

The beating heart of blockchain technology is consensus and immutability. The participants in a distributed network can verify and authenticate other users' transactions and exchanges. For this reason, the community values its own worth and reputation. *Reputation* management across distributed systems is one of the most important protocol developments supporting *blockchain* applications. Although blockchain's reputation system has limitations in preventing fraudulent registration by participants, it is very powerful in detecting fraudulent activity by those participants. It is for this reason that many proponents of blockchain technology argue that the first priority is to solve how proof of identity can be digitally validated and authenticated, before moving on to its proof-of-work mechanisms. Blockchain's crypto-mechanism gives users in a digital network the power to rate, include, or exclude interactions and content. This essentially means that the social activity and values of the community can be 'watched' by the technology; this, in turn, provides cultural support for the network.

Reputation systems need to be built into (or on top of) blockchain protocols to ensure that both peer-to-peer human and machine ecosystems can sustainably survive strategic bad actors. It is important to note that, at the time of writing, blockchain technology is better equipped to detect false information than false participants. It is for this reason that proponents of blockchain technology argue for an identity solution before proceeding with the business of supply chains, smart contracts, and reliance on trust and governance protocols. At this time, fraudulent conduct is easier to detect than the responsible fraudsters.

A major barrier to addressing the problems identified in the UN's Sustainable Development Goals is the fact that action must be collective and popular. It needs to be coordinated by non-government organisations or governments. Either way, funding is required. In order to raise money to solve these problems, the institutions raising the funds must be trustworthy. However, trust in our institutions is at an all-time low. This lack of trust is particularly evident when you consider the criticism faced by governments following their responses to the 2008 global financial crisis, particularly with regard to their decisions to grant corporate bail-outs and their failure to bring the architects of the economic collapse to justice.

Meanwhile, globalisation has led to cheap manufacturing and food production in the developing world, which has forced car and technology manufacturers in developed countries out of business [19, 20]. The resulting unemployment and widening gap between the rich and poor are regarded as major forces behind the United Kingdom's Brexit shock and (to a greater extent) Trump's US presidential success in 2016. While the US Congress tries to roll back Obamacare, thereby stripping millions of Americans of health-care insurance, the corporate tax gap created by the complex offshore financial arrangements is expanding. The most recent estimate of the Annual Tax Gap in the USA is US\$406 billion [21]. In Australia, the tax gap figure for 2016 was approximately US\$3.8 billion [22]. With revenue collection in the hands of government-controlled departments and the banking system regulated by legislation, it is understandable that negative sentiment about economic woes would be aimed directly at government.

1.4 Seven Wicked Problems

In this book, we propose ways in which blockchain technology can solve problems that we refer to as 'wicked'. This use of the term 'wicked' is a play on words. It has three meanings: first, 'wicked' can mean 'evil'. This is intended to connote a sense of evil that readers will accept as a fair description of some of the problems this book aims to solve. For example, tax evasion is despicable, particularly in societies where there is also chronic poverty and suffering. Second, 'wicked' is a modern slang term used oxymoronically by some millennials to mean 'awesome' or 'wonderful'. This use suggests the positive outcomes that can be expected if these problems are solved. Finally, 'wicked' is an adjective used to characterise a particular type of problem that is difficult or impossible to solve due to incomplete, contradictory, and changing requirements that are often difficult to recognise. It refers to problems wherein many stakeholders with conflicting values are involved and information is confusing.

The seven wicked problems that may benefit from blockchain-based technology are set out in five of the UN's Sustainable Development Goals. Just as education can influence outcomes for these Sustainable Development Goals [23], so too can some technologies. The UN's Goals set an ambitious agenda for the developing world. They aim to achieve discernible change by 2030, including the eradication of poverty, zero hunger, decent work and economic growth, climate action, reduced inequalities, peace and justice, and strong institutions. Whereas action in education can raise awareness of these issues and improve the economic prospects of women and children in developing countries and of vulnerable minorities, technology can enable and support these initiatives for change and key institutions for reform.

Blockchain technology offers the potential for us to establish the most sophisticated tracking and transparency systems that we have seen to date. It is possible to use such technology to establish robust personal identification systems, which

are critical to the success of many development programmes. Traditionally, personal identification has been a two-step process: the person seeking to prove their identity produced a physical artefact (for example, a credit card with a data-loaded magnetic strip). In conjunction with using this, they rely on a pin or password or receipt of a four-digit code on their device. The problem with this process is that, if the person has lost or does not have the physical device or ID, then they may face being locked out of the service or system they seek to use. For this reason, many authorities are exploring replacing the card with the use of the person's mobile phone number. If you include the country code, all mobile numbers are unique. More recently, biometric identification (for example, matching data banks of fingerprint images with a given sample) and facial recognition technology have become very popular and proven particularly reliable. However, they still depend on an existing database against which to compare or match the human. Regardless of the methods used, proving identity is becoming a priority for governments around the world.

Blockchain technology also enables the tracking of assets and information in supply chains and across transactions. Accordingly, the use of blockchain has the potential to readily hold accountable recipients of aid and other funding, while at the same time protecting suppliers of Fair Trade agricultural products and natural resources from exploitation and the imposition of excessively onerous conditions in order to qualify or participate in economic and business networks.

The UN's aid efforts have historic problems with fraud, mismanagement, and bureaucratic red tape. Blockchain technology provides a mechanism to circumvent governments and banking institutions, and therefore transfer aid far more efficiently. In late 2017, several UN agencies identified the Ethereum blockchain as a potential solution for the distribution of aid to refugees across the world and for several other philanthropic purposes [24]. This idea is not novel. The World Food Program (WFP) is already using the Ethereum blockchain in a pilot programme called 'Building Blocks' to distribute food vouchers to refugees in Jordan. There are plans to expand the programme to refugees in the 80 other countries where the WFP operates. In addition, at the UN's 2016 Climate Conference in Germany, the Ethereum blockchain was proffered to help combat climate change.

Meanwhile, Alexandre Gellert Paris, an officer of the UN's Framework Convention on Climate Change, argues that 'blockchain could contribute to greater stakeholder involvement, transparency and engagement and help bring trust and further innovative solutions in the fight against climate change, leading to enhanced climate actions' [25].

In July 2017, the UN's Department of Economic and Social Affairs (UNDESA) published its Sustainable Development Goals Report. Based in New York, UNDESA is a secretariat that operates as the interface between global policies in the economic, social, and environmental spheres, and national action. Its work is guided by the 2030 Agenda for Sustainable Development.

The 2017 Sustainable Development Goals Report noted that progress has been uneven. For example, in the period between 2010 and 2015, the average global gross domestic product (GDP) grew more than in the previous five years (2005–2010). This apparently good news is soon tempered by the reality that only the USA, Canada, Europe, and eastern and south-eastern Asia are responsible for that statistic. Under-developed countries and developing land-locked countries lagged behind and recorded GDP growth rates behind the performance of the previous five years. The Report also identified that the effective tracking of progress is hampered by the lack of reliable, current, and available data. Although the quality and availability of data have improved worldwide, statistical capacity and analysis require strengthening. It is not only the UN and international aid organisations that face these challenges. The private sector and governments in the most developed countries also face challenges in relation to the accuracy and completeness of datasets.

It is important to note that small, big, and meta-data are all subject to manipulation. With this in mind, systems must be employed to address these vulnerabilities—bad data can lead only to bad decisions. In adding a layer of verification and transparency to data use, blockchain technology can be used to ensure that policies are formulated on the basis of accurate and reliable information.

1.5 Conclusion

Wicked problems are often composed of multiple interrelated issues. Accordingly, they cannot simply be resolved by addressing each issue on an individual basis. This description typifies some of the most challenging social problems addressed in this book. This book offers insights to organisations on how to apply Blockchain technology to develop products and services that will help the poor, combat climate change, and create a better world. It will help governments understand how Blockchain can be used to build a more transparent system, combat tax evasion and voting fraud, and reduce corruption.

Technology that verifies and authenticates human identity, scientific data, provenance, and transactions can also break down the barriers that have impeded previous attempts to end poverty, deliver sustainable energy, reduce inequality, and increase the accountability of institutions. Ultimately, what blockchain creates is a relationship of trust between users and content. Blockchain technology allows all users to see and verify all transactions and settlements, thereby removing the need for a third party or intermediary to manage counter-party risk or escrow funds. This capacity to manage and monitor exchanges can be applied to the exchanges of non-financial assets, including information, provenance, identity, and data.

We have formulated our solution to seven Wicked Problems in terms that reflect aims articulated in five of the UN's Sustainable Development Goals. These Goals are the eradication of poverty, availability of decent work and economic

growth, support for industry innovation and infrastructure, systems for responsible consumption and production, and peace, justice, and strong institutions.

Poverty is more than the lack of income and resources to ensure a sustainable livelihood. Its manifestations include social discrimination and exclusion as well as the lack of participation in decision-making. Those who do not have access to education, land, or the labour market cannot fully contribute to society or the economy [26]. The social inclusion of people living in poverty is not just a fundamental moral imperative—it can also help to reduce economic and social costs by providing sustainable jobs. According to the UN, a key requirement for economic equality and progress is financial transparency [27]. Technological progress is the foundation of efforts to achieve environmental objectives, such as increased resource and energy efficiency. The relationship between human development and climate is inextricably linked. When climate is extreme and intemperate for long periods, resources become scarce. When resources are scarce, conflict and fear soon set in. Countries that rely on agrarian economies soon become vulnerable. Without technology and innovation industrialisation will not happen, and without industrialisation development cannot happen [28].

Blockchain's capacity to track workflows and supply chains via the immutable authentication of transactions can enable and ensure financial inclusion, respect for provenance, and the verification of human identity. However, before we examine each of the seven Wicked Problems and our proposed blockchain-based solutions, it is important first to understand the particular features of blockchain technology that make these proposed solutions possible.

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