# THE DEFINITIVE GUIDE TO BLOCKCHAIN FOR ACCOUNTING AND BUSINESS

# ENDORSEMENTS

**Praise for *The Definitive Guide to Blockchain for Accounting and Business***

I have no doubt that Professor Dutta's book will be very well-received. He presents a clear and comprehensive overview of developments in blockchain technology that is both timely and highly accessisble to those looking to understand its wide range of business and industry applications.

Deborah Terry. *AO Vice-Chancellor,*
*Curtin University, Perth, Australia.*

A very intuitive and comprehensive book on blockchain technology and its business applications. Particularly relevant for professionals to understand the implications for business and accounting.

Wes Bricker, *Vice Chair—US and Mexico Assurance Leader,*
*PricewaterhouseCoopers (PwC), U.S.A.*

Blockchain technologies have redefined the way businesses operate. A great book for those who want to master the knowledge of blockchain.

Deborah Leung, FCPA, *Executive General Manager International,*
*CPA Australia, Hong Kong.*

A well written book that provides a timely examination of the many challenges and opportunities afforded by blockchain technology. Thoroughly recommended reading for professionals, managers and educators.

John Cordery, *Provost,*
*Curtin University, Perth, Australia.*

Through the description of various scenarios, this book illustrates blueprints for possible applications of blockchain. This book will lead in the education of future professionals in accounting and business.

Birong Dong, *Vice President,*
*Nanjing Audit University,Nanjing, P. R. China*

A great account of evolving blockchain technology and its application across varying industry sectors. Will be a key resource in educating accounting and business professionals of the future.

Colin Pavlovich, *Group CFO,*
*Navitas, Australia.*

An excellent coverage of blockchain evolution with an industry perspective of how it will mature in the future. It has several examples of how blockchain will be used, and that makes it easier for readers to apply the blockchain techniques as well.

Shyam Mamidi, Director,
*Natsoft Corporation, Singapore.*

Professor Dutta is a brilliant researcher, recognized teacher and an accomplished administrator. In this timely book, he guides a non-technical reader through a complex topic with effortless ease. A must-read for everyone connected with Business.

Bin Srinidhi, *Carlock Endowed Distinguished Professor,*
*University of Texas at Arlington, U.S.A.*

Professor Saurav Dutta has been engaged in accounting education and research for many years. The blockchain era has arrived which will bring many changes to accounting and finance professions. This book will enhance our understanding of the subject, deeply and comprehensively.

Xiao Xue. *Editor in Chief*
*Friend of Accounting. P.R. China*

A valuable resource for business and accounting professionals to gain a non-technical perspective on the inherent opportunities in blockchain.

Professor Carla Wilkin, *Head of Accounting,*
*Monash University, Sydney*, Australia.

This is a timely book explaining the essence of blockchain technology as digital ledger creating an incorruptible and de-centralised record-keeping system. Professor Dutta discusses the potential impact on bookkeeping processes and the required skillsets. The book is highly recommended for teaching students and upskilling professionals in the industry.

Claus Otto, *Director, Oil and Gas Innovation Centre,*
*Curtin University, Perth, Australia.*

An outstanding and valuable work for the accounting professionals and learners to understand how to apply the method of blockchain on accounting and business management.

Professor Tao Meng, *Dean of International Business College,*
*Dongbei University of Finance and Economics, Dalian, P.R. China.*

Professor Dutta has provided a fascinating and comprehensive introduction to a technology with critical applications to financial reporting, risk management, and auditing.

David Marcinko, *Emeritus Professor*
*State University of New York, NY, U.S.A.*

# THE DEFINITIVE GUIDE TO BLOCKCHAIN FOR ACCOUNTING AND BUSINESS

## Understanding the Revolutionary Technology

**Saurav K. Dutta**
*Curtin University, Australia*


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INVESTOR IN PEOPLE

# DEDICATION

*I dedicate this book to my beautiful wife Ushashi*
*who for over thirty years has maintained*
*a detailed, easily accessible, immutable and time-stamped record*
*of my every foible, folly and flub.*

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# FOREWORD

Saurav Dutta's *The Definitive Guide to Blockchain for Accounting and Business: Understanding the Revolutionary Technology* is a timely tour de force for blockchain business understanding. It's crisply written with clear concise non-technical explanations of the key concepts that business professionals need to understand around the technology. But it's not a technical primer, rather it stands out as a seminal work in bridging the gap between technology and business. By first building or solidifying the reader's understanding of the core foundational concepts of blockchain and distributed ledgers, Saurav provides a graceful onramp into an exploration of the implications for business and accounting professionals. Through the highlighting of emerging business models built on these new technologies, then exploring the implications for careers in accounting and internal controls, the reader is provided an unbroken view of the whole region surrounding and supporting the emergence of one of the most important technologies of the twenty-first century.

David Deputy
President, Accounting Blockchain Coalition
Director, Strategic Development and Emerging Markets
Vertex, Inc. (U.S.A.)

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# ABOUT THE AUTHOR

Professor Saurav Kumar Dutta is the Head of School of Accounting at Curtin University, Australia. He previously was the Chairman of the Department of Accounting and Business Law at the State University of New York and has held faculty appointments at Rutgers University (New Jersey, U.S.A.) and the City University of New York. He holds a Bachelor of Technology from the Indian Institute of Technology, Bombay (India), and a Ph. D. from the University of Kansas (U.S.A.). He was awarded the 1989 Robert Beyer Silver Medal for securing the second highest total score in the CMA examination and was also the recipient of the National Talent Search Scholarship awarded by the Government of India.

Throughout his academic career, spanning over 25 years, he has engaged in high-impact research which has greatly informed industry practices. He has influenced public policy in his role as an Academic Fellow in the Office of Chief Accountant at the U.S. Securities and Exchange Commission (SEC). In that role, he helped implement the Dodd-Frank Act and other measures from 'lessons learned' during the 2008 global financial crisis. While at the SEC, Saurav also served as a liaison with FASB, PCAOB, IASB and IAASB, all of which are critical standard-setting bodies that affect the accounting profession.

Saurav has been engaged by the New York State Attorney General's Office to investigate billing practices for a multi-national wholesale distributor. He was also engaged by the SEC to determine appropriateness of derivative accounting of a Fortune 50 insurance company and treatment of consolidation accounting of a Fortune 500 company resulting in settlement and

imposition of monetary fines on the companies. Under the purview of the United States District Court of the Southern District of New York, he was involved in designing statistical procedures to aid in the disbursement of amounts ranging between $500 million and $6.1 billion for settlements of MCI-WorldCom, Global Crossing, Cendant, and HealthSouth. He was also involved with the reparations of more than 400 million Swiss Francs from the Swiss banks to Holocaust victims, under the purview of the U.S. District Court of Eastern District of New York. Recently, he was engaged by Apple Computers as a defense expert in $600 million lawsuit under the jurisdiction of the U.S. District Court in the Northern District of California.

Saurav has authored a book, *Statistical Techniques for Forensic Accounting*, published by Financial Times Press in 2013. He has also authored White Papers and Course material for the Institute of Management Accounting. He has published more than 40 academic papers in reputed U.S. and international journals and has presented his work in numerous national and international venues.

# ABOUT THE CONTRIBUTORS

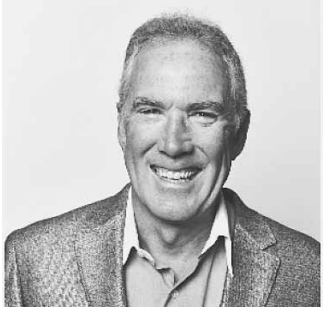
**Roger M. Benites (Chapter 7)**

Roger has been in the finance sector since 2010, starting in Fort Lauderdale, Florida, and then moving to Lima, Peru in 2012. Roger was introduced to Bitcoin and Blockchain technologies in 2013 due to the Argentinian and Venezuelan economic crisis. Roger assisted in establishing one of South America's first cryptocurrency exchanges. In 2017, Roger assisted state legislators in drafting Connecticut's first blockchain bill. Most recently he has been working with the Bitcoin Center, featured on Netflix's "Banking on Bitcoin", developing blockchain education and incubator programs.

**Phillip G. Bradford (Chapter 7)**

Dr. Bradford is the director of the computer science program at the University of Connecticut, Stamford. He worked for General Electric Asset Management, BlackRock, Reuters Analytics, and he co-founded a firm. He also was on the faculty at University of Alabama School of Engineering and at Rutgers Business School. Phil was a postdoctoral fellow at the Max-Planck-Institut für Informatik. He earned his PhD in computer science at Indiana University, an MS in computer science from the University of Kansas, and a BA in mathematics from Rutgers University.

**Gerard (Rod) Brennan, CFE, MBA, Ph.D. (Chapter 12)**



Rod is the Audit Technologies Director for Lukka, based in New York, New York. He is the former Audit Director and North America Risk & Internal Control Officer for Siemens Corp. and an Adjunct Professor at Rutgers Univ. Rod is an audit practitioner, frequent speaker and published researcher on the topics of blockchain, continuous auditing/monitoring/analytics, Rod continues to speak and do research in the area of automated audit and reporting for applications on DLT / Blockchains.

**Mike Rogers, CPA (Chapter 8 and 10)**

In 2018, Mike founded Millennials In Blockchain (MIB), a globally distributed learning collaborative. Mike currently serves as the head of MIB Consulting, a New York based digital transformation firm. Mike's tokenization research has been distributed by numerous corporations, including Securitize, Inc. and Deloitte. Mike formerly worked in financial services at Ernst & Young and The Blackstone Group L.P. He holds a B.S. in finance and a M.S. in accounting from The University at Albany, where he graduated Summa Cum Laude.

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Dr. David Lee Williams MD CCBOM is Minespider's regulatory expert with 15 years of experience in industrial raw material policy. He was previously the occupational health and safety regulatory expert for Michelin and chair of the technical group for the Cobalt Reach Consortium. He has been involved with blockchain since 2016.

**Nathan Williams (Chapter 9)**

Nathan Williams is a Canadian blockchain entrepreneur, based in Berlin, Germany. He is the Founder & CEO of Minespider, a decentralized protocol for responsibly sourced raw material data. Nathan has been featured in Forbes, Bloomberg, CNBC, Huffington Post, and Wired Germany. He is a UNECE/CEFACT Expert with a focus on blockchain and traceability related matters. He has his B.Sc. in computer science from McGill University, and his MBA from Concordia University in Montreal, Canada.

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# 1

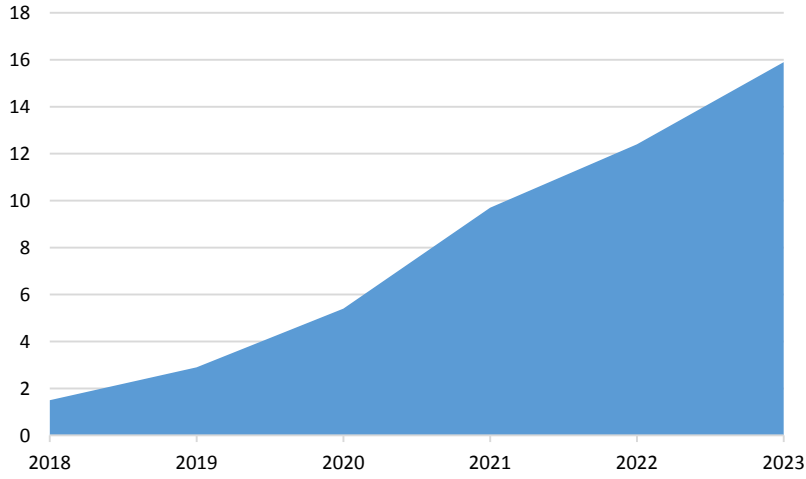
# INTRODUCTION

A decade back, the words cryptocurrency, Bitcoin, blockchain, etc., were relatively unknown; however, over the past decade, cryptocurrency has gained popularity in both academia and popular culture. As one of the most successful cryptocurrency, Bitcoin's market capitalization in early 2020 was around $120 billion. It had reached a maximum of $237 billion in the fourth quarter of 2017, up from $70 billion the previous quarter. The almost 300% gain in value over that quarter didn't go unnoticed and public interest in cryptocurrency and its technology grew. Since then, in about two years,[1] the number of blockchain wallet owners increased from less than 17 million in third quarter 2017 to around 45 million worldwide.

With increased popularity of Bitcoin, blockchain the infrastructure supporting Bitcoin also received extensive attention. The features of blockchain in maintaining detailed and trusted records were recognized to have many useful features. Over the past few years, 2017 onwards, blockchain-based applications are proliferating in many industries, and not just in financial industry. While there still remain challenges to be overcome, blockchain's potential currently seems unbounded, as evidenced by increased worldwide investment in its development.

Worldwide, the spending on blockchain solutions almost doubled from $1.5 billion in 2018 to $2.9 billion in 2019. The spending on blockchain development is expected to continue to grow at the same pace, projected to be about $15.9 billion by 2023 (see Fig. 1.1).[2] The financial sector leads the spending in blockchain solutions by investing more than $1.1 billion in its development, followed by the manufacturing sector and the distribution sector, each investing upwards of $600 million. The United States had the largest blockchain

**Fig. 1.1: Projected Worldwide Investment in Blockchain (Billions of US$).[3]**




spending at $1.1 billion, followed by Western Europe and China. In October 2019, President Xi Jinping gave a speech saying China needs to "seize the opportunities" presented by blockchain, in what appeared to be one of the first instances of a major world leader backing the technology. Xi said blockchain is an "important breakthrough in independent innovation of core technologies."[4]

This great interest and large investment in blockchain technology is not without prospects. According to a leading research firm, Gartner, "by 2025, the business value added by blockchain will grow to slightly more than $176 billion, then surge to exceed $3.1 trillion by 2030."[5] Reflecting the same sentiment, more than half of business leaders surveyed by Deloitte in 2019 placed blockchain in the five most critical strategic priorities and an additional 27% noted that it was important though not critical.[6] In the same survey, over 80% of respondents believed there was a compelling business case for blockchain and that it will eventually be adopted by mainstream businesses.

Considering the above trend, it is imperative for business leaders and professionals to obtain a non-technical understanding of blockchain, how it works, what are its advantages and limitations, what are the security and privacy issues and the financial and regulatory hindrances, if any. This book is written to provide a non-technical explanation of the underlying technology and the features of blockchain for accounting and business professionals.

Blockchain is a recordkeeping system in which events termed as transactions are stored in a *block*. The blocks are appended to previous blocks,

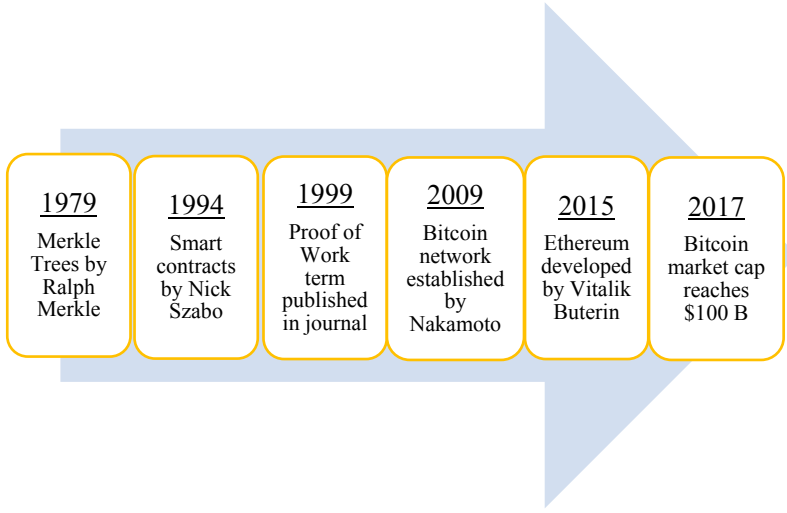
forming a *chain*. The uniqueness of the technology is that it ensures the way the blocks are added forms a *chain* and not a *tree*, in that there are no *forks* or major *branches*. The record or *ledger* is maintained at multiple locations and no single entity has control over the records, giving it the feature of being *distributed*. The mathematical discipline of *cryptography* and computer technique of *hash function* is widely used to help code the data for easier storage. The key characteristics of blockchain are decentralization, persistency, anonymity and auditability. One of the key advantages of blockchain is that it facilitates monetary exchanges between untrusting strangers without the services of a financial intermediary or a "trusted third party." This feature enabled transactions in cryptocurrencies and transfer of digital assets between unknown and untrusting parties.

One of the key features of blockchain is its immutability, which implies that when records are inscribed on blockchain those could not be erased or altered. Business functions or processes that require high reliability and honesty are therefore prime beneficiaries of blockchain adoption. Moreover, business processes that incur immense resources in cumbersome recordkeeping where authenticity of records is suspect, blockchain provides a solution.

Though gaining recognition, as of past decade, some computer science theories and algorithms that underwrite the functionalities of blockchain were proposed decades ago. Fig. 1.2 provides a timeline of the introduction of various computer science developments that support the functioning of blockchain.

A fundamental part of blockchain technology is what is known as the Merkle trees. Merkle tree is a structure that allows for efficient and secure verification of content in a large body of data. This tree provides blockchain the key property of auditability and verifiability. The concept of Merkle tree was developed by Ralph Merkle (1979) as his Ph.D. dissertation at Stanford University, USA. Merkle trees will be further discussed in Chapter 3. Independent of Merkle trees and research on data storage techniques, Nick Szabo (1994) proposed a concept which later came to be known as the "smart contract." Szabo defined smart contracts as machine readable transaction which creates a contract with pre-determined terms.[7] Smart contracts are discussed in detail in Chapter 5. In 1999, the term "proof-of-work" was coined in an academic journal article.[8] Satoshi Nakamoto launched Bitcoin on January 3, 2009, and the coin gained immense popularity. The white paper published by Satoshi Nakamoto is discussed in the next chapter. Vitalik Buterin, a Canadian teenager,[9] published a white paper that led to the launching of

**Fig. 1.2: Key Event Dates in Blockchain History.**




Ethereum in 2015. In August 2017, the market capitalization of Bitcoin surpassed $100 billion for the first time, and soon thereafter the market capitalization of Ethereum also exceeded $100 billion.[10]

The remainder of the book is organized in three parts. In Part 1, Chapters 2–6, we develop the basics of blockchain technology for non-technical readership. We start by discussing the linkage between Bitcoin and blockchain and why the infrastructure of blockchain was essential for enabling cryptocurrency transactions. In Chapter 3, we present the terminology and nomenclature of blockchain, we provide precise definitions of the words and contrast those with the common usage of that word in accounting and business terminology. Some of the confusions and over-selling of blockchains can be attributed to coining of terminology in blockchain by using well-known terminology in accounting and business and using those in broader or different context. In Chapter 4, we explain the consensus mechanism. In Chapters 5 and 6, we describe smart contracts and tokenization, respectively.

In Part 2, Chapters 7–11, we present use cases of blockchain applications outside of cryptocurrency. These are contributed chapters to the book by experts in the field. Chapter 7 develops the framework to evaluate whether blockchain is appropriate for a business application. In Chapter 8, a live case study of blockchain-based security offering of Curzio Research is presented.

It describes the process, the launch, the experience of the issuer and the advantages over traditional offering of securities. In Chapter 9, blockchain application in tracking of conflict minerals is presented. In Chapter 10, tokenization and blockchain trading of Japanese real estate is discussed. Chapter 11 provides a few additional interesting use cases of blockchain.

In Part 3, Chapters 12–14, we present the technical implications of blockchain for business and accounting. Chapter 12 discusses how the internal control processes would be impacted by incorporation of blockchain to record business processes. Chapter 13 presents the ramifications for auditing of financials when a business engages in transactions on blockchain. Chapter 14 concludes with a discussion of opportunities, vulnerabilities and threats that the technology currently faces.

## NOTES

1. From third quarter 2016 to fourth quarter 2019, according to Statista, data available at https://www.statista.com/statistics/647374/worldwide-blockchain-wallet-users/.

2. https://www.idc.com/getdoc.jsp?containerId=prUS44898819

3. *Source*: https://www.cnbc.com/2019/12/16/china-looks-to-become-blockchain-world-leader-with-xi-jinping-backing.html

4. Data obtained from IDC Research.

5. *Source*: https://www.gartner.com/en/newsroom/press-releases/2019-07-03-gartner-predicts-90-of-current-enterprise-blockchain

6. *Source*: https://www2.deloitte.com/content/dam/Deloitte/se/Documents/risk/DI_2019-global-blockchain-survey.pdf

7. "A smart contract is a computerized transaction protocol that executes the terms of a contract" (Szabo, 1994).

8. In a paper titled "Proof of Work and bread pudding protocols" (Jakobsson & Juels, 1999). Formalized the notion of proof-of-work which required, "a prover to demonstrate to a verifier that she has performed a certain amount of computational work."

9. https://blockchainlab.com/pdf/Ethereum_white_paper-a_next_generation_smart_contract_and_decentralized_application_platform-vitalik-buterin.pdf.

10. *Source*: https://www.forbes.com/sites/cbovaird/2017/10/20/bitcoins-market-cap-is-now-more-than-100-billion/#72cd48d22b8b

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# 2

# THE INFRASTRUCTURE SUPPORTING BITCOIN: BLOCKCHAIN

## 2.1. INTRODUCTION

Blockchain technology was developed concurrently with the launching of Bitcoin, one of the earliest and arguably the most well-known cryptocurrency. Though blockchain was an essential component that facilitated the growth and popularity of Bitcoin, its potential applications are possible in domains outside of cryptocurrency. Examples of adoption of blockchain technology for other business purposes and applications are discussed in latter chapters.

Prior to delving into the intricacies of blockchain technology and its potential applications, it is important to understand its genesis – the motivation for developing the technology, its purpose and its limitations. The concept of blockchain, though not the name, was introduced in a computer science research paper.[1] This chapter discusses the accounting, economics and financial problems of introducing a new currency, Bitcoin, which the computer scientists were addressing.

E-commerce was flourishing worldwide in the 2000s, with annual growth rate of about 30% at the turn of the century.[2] Despite its growth, financial transactions on the internet relied exclusively on "trusted third parties" to facilitate the transactions by processing electronic payments. These "trusted third parties" extracted a nominal commission for each transaction, adding a cost and thereby causing friction in the system. While the commission would be negligible for transactions of large monetary value, it would be disproportionate for smaller transactions, thereby inhibiting those.

Computer scientists and internet enthusiasts became interested in creating a system that will allow financial transaction between two unknown parties without the need for a financial institution to be an intermediary. PayPal was one of the earlier innovation in this space, and became the most popular third-party payment processor with an estimated 20% of all e-commerce transactions taking place through its platform. In that sense, PayPal's business model was to become an alternative to financial institutions as a trusted third party. Hence it was not interested in developing a system that would eliminate the need for a trusted third party. Consequently, with the advent of cryptocurrency there remained a need to develop a mechanism to facilitate e-commerce without relying on financial intermediaries or trusted third parties.

The remainder of this chapter is organized as follows. In the next section we take a historical perspective on how trade evolved and the role of money in that evolution. We next discuss the importance of trust in order for trade and economy to prosper. In Section 2.4 we introduce cryptocurrency and the many challenges it encountered. The following section introduces blockchain as providing solutions to the challenges inherent in cryptocurrency. Section 2.6 illustrates how Bitcoin transactions are recorded on blockchain. Section 2.7 concludes by arguing that features of blockchain have wider applicability than merely facilitating Bitcoin transactions.

## 2.2. EVOLUTION OF TRADE – BARTER SYSTEM TO CRYPTOCURRENCY

Trade, or exchange of goods or services, between individuals or societies has been traced back to the dawn of human civilization. Trade, in some form, predates money and was integral to the formation of modern society and has evolved through the ages as illustrated in Fig. 2.1. Trade that predated introduction of currency, was accomplished through bartering. Bartering can be traced back to 6000 BC and was practiced by the Mesopotamian tribes. Essentially, bartering is trading of goods and services between two parties without using money in the transaction. In the olden days, food, spices and weapons were commonly traded and one of the valuable medium of barter was salt. In fact, Roman soldiers were paid in salt.