Blockchain Readiness Index – On Techniques for Determining the Blockchain Readiness per Country

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Abstract

This research acknowledges the significance of blockchain technology and emphasizes the importance of countries understanding their readiness in the field. With blockchain evolving in various sectors, it becomes crucial for nations to evaluate their level of blockchain readiness and their suitability for hosting blockchain-based activities. Unfortunately, there is currently a lack of comprehensive tools available for such assessments. To address this gap, the research proposes the design of a Blockchain Readiness Index (BRI). The BRI is a composite index that combines a wide range of indicators from diverse sources, aggregating them into a single score. This quantitative methodology (index) enables the estimation of blockchain readiness on a per-country basis. The index developed in this study attempts to outline the blockchain readiness of countries, serving as a foundation for the professional endeavours, decision-making processes, and operations of organizations, investors, academics, and other parties within the blockchain industry.

This research initially presents an overview of the landscape of similar attempts to design such indexes by reviewing and identifying potential gaps and opportunities for improving their methodological design, leading to more relevant conclusions. In addition, the research aims to contribute toward the methodology for building a BRI using techniques from the information retrieval domain to normalize the non-normalized values and a cosine similarity measure to derive an index ranking that assesses countries globally. More specifically, the proposed BRI covers a wide range of blockchain and technological-oriented indicators, which are organized into the following "pillars": (1) Regulation, (2) Technological Advancement, (3) Blockchain Industry Presence, and (4) Local Users Engagement.

The methodology of this tool includes the selection of indicators according to community's assessment. This process includes assessing indicators of previously established scientific indexes and a survey gathering data from academically qualified participants who are providing the significance of suggested indicators by voting on weights. An additional characteristic which is embedded into the methodology is the flexibility on the weighting of indicators according to the end user's preferences. Besides relying on the judgment of academically qualified participants to suggest the importance of indicators, the study aims to provide additional flexibility by introducing three different variations of the BRI. Specifically, a) The BRI Standard Version, which assumes equal weighting of indicators, b) The BRI Community-Driven Version, which relies on the judgment of survey participants;

and c) The Weights-Adjustment Version, which allows end-users to adjust weights according to their customized views and preferences.

BRI aims to assess beyond the regulatory environment and examine several other factors, such as local engagement, expertise, investments, and the need for a decentralized provision of services. An empirical evaluation reports preliminary but promising results of the methodology showing evidence that the identified indicators are sufficient for developing the index compared to judgments made by human experts. Overall, the application of the BRI revealed a range of blockchain readiness levels among nations, distinguishing between the most promising and non-hostile countries for blockchain technology.

An interesting finding is that the top country rankings of the BRI 2021 Standard Version (Appendix V) and the BRI 2021 Community-Driven Version (Appendix IX) are identical, with *Singapore*, *Sweden*, *Malta*, *the USA*, and *Ireland* claiming the top 5 positions. In contrast, when applying different variations of the BRI 2021 Weights-Adjustment Version in section 6.2.3, there are changes in country positions and scores.

This research fills a significant knowledge gap in providing a dynamic methodology for assessing national blockchain readiness. Future research could further refine the BRI and explore its application in different contexts.

Keywords: Blockchain Readiness Index (BRI), Pillars, Indicators, Normalised Values, Cosine Similarity, Regulation, Technological Advancement, Blockchain Industry Presence, Local Users Engagement

Dedication

I wish to dedicate this work to my daughter, Marithea, who is the most precious human being in my life.

Furthermore, I would like to dedicate this work to my parents, Christos and Alexia, who have done everything in their abilities to provide me with the fundamentals to succeed professionally.

Acknowledgements

I am deeply grateful for the invaluable guidance and support provided by my supervisors and colleagues, Dr. Klitos Christodoulou, Dr. Elias Iosif and Prof. Marinos Themistocleous. Their expertise and dedication have been instrumental in shaping this research. I appreciate the countless hours they have invested in helping me navigate the dynamic landscape of the blockchain industry and in developing the proposed approach to assess blockchain readiness.

This work is a testament to our collective effort and commitment. While we have made significant strides, our journey is not yet complete. We remain dedicated to refining and advancing the Blockchain Readiness Index, with the aspiration of it becoming a pivotal tool in the crypto ecosystem.

Declaration

I declare that the work in thesis was carried out in accordance with the regulations of the University of Nicosia. It is a product of original work of my own, unless otherwise mentioned through reference, notes, or any other statements.

Date

Andreas Vlachos **1/6/2023**

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Abbreviation Index

ARI	Automation Readiness Index
AVRI	Autonomous Vehicles Readiness Index
BMPI	Bitcoin Market Potential Index
BRI	Blockchain Readiness Index
CMPI	Distributed Ledger Technology and Cryptocurrency Market Potential Index
CRI	Crypto-Ready Index
e-GDI	e-Government Development Index
DLT	Distributed Ledger Technology
NRI	Network Readiness Index

CHAPTER 1 INTRODUCTION

1.0 Introduction

This chapter introduces the reader to the field of research by analysing various aspects and the current status of the blockchain industry. As blockchain is a fast-changing industry with expected daily developments (Fahmideh et al., 2022), the reader needs to understand the importance of obtaining updated, relevant, and accurate data for this research.

There is a general trend towards constructing indexes to assess the readiness of countries towards innovative technologies, details of which are presented in Chapter 2. The reasoning behind this trend is that such indexes help countries to assess the progression towards a field and enables the public and private sectors to shape a strategy towards improving the aforementioned industry (Potnis and Pardo, 2011). Readers might use findings from such indexes to identify country's weakness and corrective actions.

Entering the age of the 4th Industrial Revolution, countries tend to compete in the progression of technological advancements. Disruptive technologies like blockchain are shaping the future of our societies and countries are in a constant race to adopt efficient growth practices (Mushtaq and Haq, 2019). Besides the public sector, the future status of private companies seem to pivot into disruptive technologies (Dalenogare *et al.*, 2018).

This chapter discusses the exponential growth of blockchain as a technology and its impact on the various industries. This knowledge is fundamental to understand in order to analyze the spectrum of methodologies for estimating the readiness of countries towards blockchain technology in the following chapters. The aim of the BRI is to provide intelligence to readers on improving their practices in certain areas where blockchain is considered a part of the country's strategy towards industrial growth.

In this chapter, there is a presentation of an overview of existing use cases based on blockchain technology or use cases that combine blockchain with other exponential technologies, such as artificial intelligence and internet-of-things (IoT), to achieve efficient processes. These use cases cover various industries like finance, insurance, shipping, attestation, and real estate, indicating the impact blockchain can source on business activities.

The central concept of the Blockchain Readiness Index (BRI) is introduced to assist countries in monitoring the level of Blockchain readiness according to their suitability for hosting blockchain-based activities. A lack of such a scientific tool is the research problem which this thesis is addressing. The research motivation is to propose a model which will be able to assess national blockchain readiness and contribute by filling this knowledge. The contribution outcome is considerable for the researcher, who has worked professionally in the blockchain industry for seven years. It has become a personal goal to contribute towards blockchain technology awareness, which may seem to be a long-term occasion.

The expected contributions of the BRI to the blockchain community are analyzed and linked with the aim of this research. As examined in the following chapters, the BRI aims to be established as a scientific industry standard. Chapter 1 demonstrates how the concept of such a tool and the research motivation is linked to producing the actual contributions toward the blockchain industry, the public, and the private business sector.

1.1 Setting the Scene

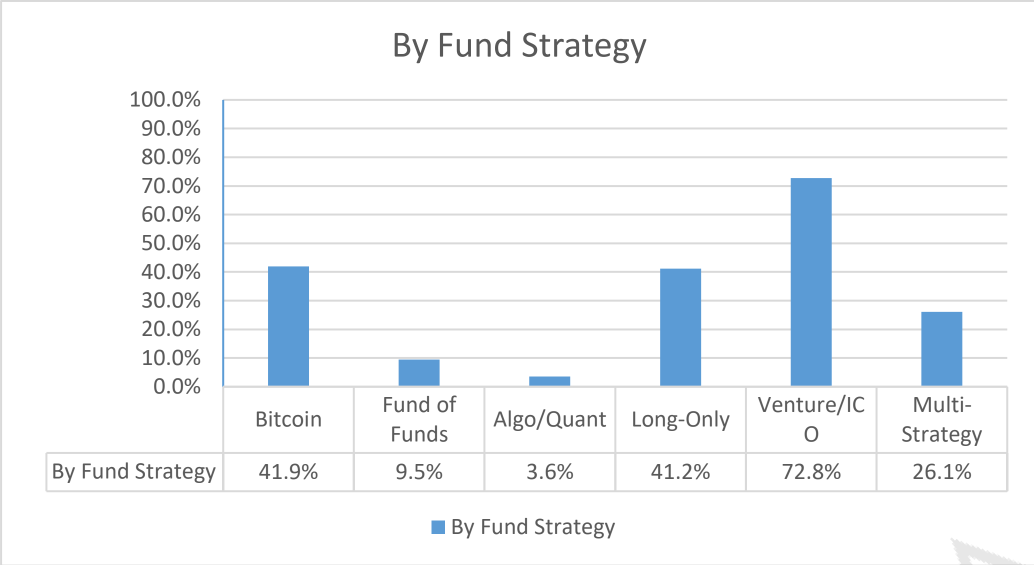
Significant financial and technological institutions consider blockchain technology a breakthrough concept. Consortia like R3 (Hearn, 2016) and Hyperledger (Elrom and Elrom, 2019) have been formed to transform business operations and encourage worldwide adoption of the technology as an internal and/or external part of business processes. These consortia bring together some of the most prominent financial and technological organizations globally, such as Barclays, BBVA, Citi, Wells Fargo, Accenture, IBM, and others. With significant institutions from a broad spectrum of domains leading the way in adoption, it is regarded that blockchain technology has been able to disrupt financial and social procedures from its early years (Nowiński and Kozma, 2017). Although we are experiencing a diversification in utilizing technology, the technology has yet to become a game-changer to traditional procedures and business models (Shaik *et al.*, 2020). This lack of adoption is mainly because certain parties in the industry experience a lack of Blockchain technology awareness and operate under a grey regulatory area (Cumming, Johan, and Pant, 2019), which may often lead to poor or immature decision-making.

There is a general belief that the blockchain technology revolution will accelerate identically to the rate followed by the evolution of the World Wide Web (WWW) during the 1990s (Sills, 2018). Blockchain technology solutions' decentralized nature and implementation complexity may indicate that the road to wide adoption is not as smooth as the WWW case. However, blockchain-driven disruption may probably affect society more significantly (or at least similarly) than the Internet, as the prominent use cases seem to involve the treatment of digital money and assets (Chen and Bellavitis, 2020).

The interest in exploring blockchain engagement per country was prompted after studying a quarterly study published by CryptoFUNDResearch (Crypto Fund Research, 2020). This study demonstrated an increasing number of crypto-funds launched, including hedge funds and venture capital. According to the research, by June 2018, Digital Currency Group, Pantera Capital, and Blockchain Capital were the top 3 venture capital investors with $78 million, $65 million, and $71 million value of the investment, respectively. Crypto Fund Research estimated that as of the end of Q2 2020, crypto funds collectively managed approximately $21.60 billion. This figure included crypto-hedge funds, venture funds, and index funds and embodied the highest number of assets under management for crypto-funds. According to a study published by the Statis Group, at least 80% of ICOs conducted in 2017 have been identified as “scams” (Liu, 2019).

This study (Crypto Fund Research, 2020) outlines the extraordinary number of 800 crypto-fund launches across the globe with primary offices in more than 80 countries. Despite the launch of new crypto-funds in Q2 2020, the pace of new launches slowed down in the first two quarters of 2020. On the other hand, assets under management by crypto-funds have grown since early 2018. This is mainly due to portfolio growth and investor inflows. Crypto-funds' collective assets under management figure exceeded $20 billion for the first time in 2020, gaining almost $3 billion compared to the previous quarter. Another interesting statistic derived from the CryptoFUNDResearch study is that 22% of crypto-hedge funds have a minimum $500,000 or more investment. During Q2 of 2020, all crypto-fund strategies managed to generate positive returns. As derived from Figure 1.1, the highest percentage (72.8%) represents Ventures/Initial Coin Offerings (ICOs) that were mainly projected to develop blockchain-based decentralized applications (dapps) in a vast number of industries rather than just the finance/banking sector.

Figure 1.1: Crypto Fund Performance (Q2 2020)



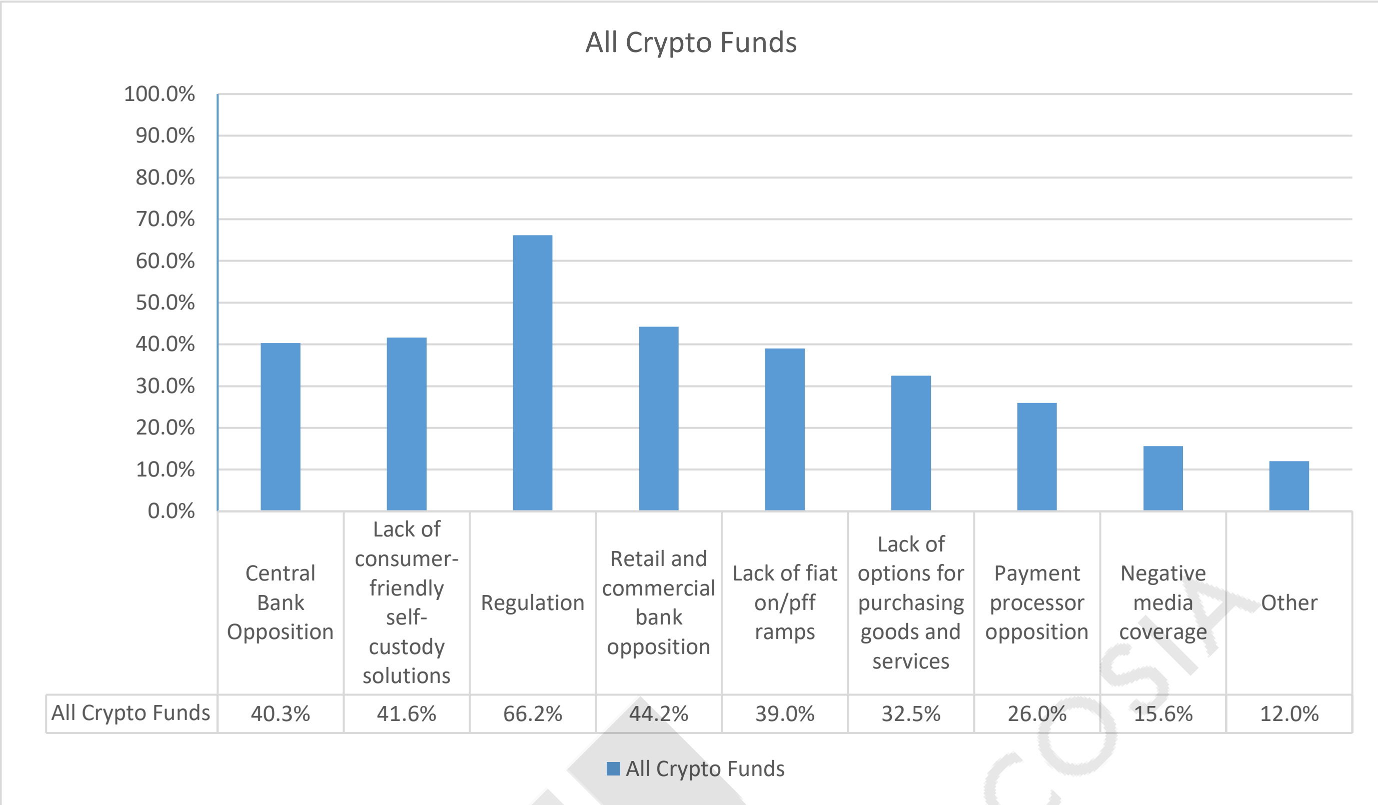
Source: Adopted from Crypto Fund Research (2020)

By Q2 2020, almost half of crypto-fund launches were located in the U.S.A., the United Kingdom, China/Hong Kong, Singapore, Switzerland, Canada, Australia, and Germany. All these regions have experienced a noteworthy launch of crypto-funds, while areas in Eastern Europe, offshore jurisdictions, and Russia are also experiencing increased activity recently (Athanassiou, 2021).

In recent years, the emergence of Decentralized Finance (DeFi) facilitated an exponential rise in total locked value (Stepanova and Erins, 2021). This shift towards decentralizing financial activities indicates the need for the industry to have a flexible tool that scientifically demonstrates areas and regions of emerging crypto activity. The total value locked in DeFi increased from $601 million in Q1 of 2020 to $239 billion in Q1 of 2022 (Amberdata, 2022). These figures demonstrate an increase of nearly 40,000%.

Even widespread crypto adoption within the finance industry is currently facing the issues outlined in Figure 1.2. The finance industry is positioned as the central area of blockchain disruption in society (Chen and Bellavitis, 2020). The main obstacle to adoption seems to be government regulation (KIM and Kang, 2020), which is one of the main pillars BRI assesses to conclude the final country rankings.

Figure 1.2: Obstacles to Widespread Crypto Adoption



Source: Adopted from Crypto Fund Research (2020)

The cryptocurrency and blockchain industry is emerging; however, we are still in the early adopters' phase. Consequently, there is a significant lack of knowledge in several research areas, including technology, regulation, and community engagement (Guo *et al.*, 2020).

The figures outlined above indicate the increasing interest of private businesses and governmental authorities in blockchain technology. It seems important for parties involved in the blockchain industry to apprehend the scale of blockchain-related operations worldwide, identify regions' suitability for hosting blockchain-based activities, and successfully adopt a blockchain regulatory framework. The legislation's importance and uncertainty are highlighted regularly within the blockchain community (Subramanian *et al.*, 2020). Countries which are on top of the BRI rankings shall be able to pursue their position as global blockchain hubs. The proposed index is of a dynamic character (Robinson, 1981). The proposed framework intends to enable the components of this index to be updated regularly to reflect new developments in the space.

1.1.1 Blockchain Disruptive Structure

The impact of blockchain technology innovation underlines the necessity of an industry tool like the BRI. Blockchain technology has made the recording and transfer of digital assets possible with finality, without reliance on a centralized party (Anceaum*e et al*., 2021). This feature has evolved for the first time via the launch of the Bitcoin Blockchain (Nakamoto, 2009), although the concept of anonymous digital transactions was discussed decades ago (Chaum, 1982).

Blockchain implementations aim to replace traditional business ledgers in finance and beyond (Bhowmick, 2022). Like blockchains, traditional ledgers are used to record economic activities and prove the ownership and the transfer of the value of assets among various parties such as consumers, suppliers, producers, and market makers. However, unlike blockchains, traditional ledgers are maintained by a centralized party, making the procedures slow, costly, and sometimes insecure for the end consumer. (Mainelli, Smith, and Mainelli, 2015)

Participants in a decentralized network record digital transactions transmitted in a shared ledger. Members of the network run algorithms to evaluate and verify the proposed transaction to add transactions. Suppose the majority of the members in the network agree that the transaction is valid according to rules set by them, known as the consensus algorithm (Bach, Mihaljevic, and Zagar, 2018). In that case, the new transaction is added to the blockchain. Any changes to the ledger are reflected in all blockchain copies in seconds or minutes. When a transaction is recorded, it cannot be changed or removed. Since all members in the network have a complete copy of the blockchain, no single member has the authority to alter historical data (Mukta, 2023).

Blockchains are maintained by a network of computers running code, usually open-source, i.e., Bitcoin, Ethereum, and most cryptocurrencies. The value of such cryptocurrencies is derived from supply and demand, while the units are issued algorithmically (Martin, 2022). A decentralized network is secured by computers running software to validate and verify the authenticity of blockchain transactions. Therefore it is beneficial for the participants to remain trustworthy so that the network maintains its reputation and monetary value. Even if malicious parties attempt to alter blockchain transactions, such an attack is considered economically unfeasible and minimally probabilistic for large decentralized networks (Pan, 2018), (Christodoulou *et al.*, 2020).

In most cases, transactions in blockchain networks are pseudonymous rather than anonymous, since traceability of transactions is feasible (Mukta, 2023). There is a specific transaction patterns analysis (Chang and Svetinovic, 2018) that can be used to identify a user in case of need, such as illegal activities.

A blockchain can be defined as a tamper-proof, shared digital ledger that records transactions in a decentralized peer-to-peer network (Viriyasitavat and Hoonsopon, 2018). The permanent recording of transactions in the blockchain stores the history of asset exchanges between the peers in the network. An important feature is that blockchains can be designed as permissioned or permission-less networks, giving the flexibility to developers to choose the appropriate structure according to the business use case (Lineros, 2020).

The following sections examine potential use cases in various industries and the governmental sector. The development of the BRI may be proven helpful for the decision-making by parties involved in these use cases, such as participants of the finance, banking, and private business sectors and governmental authorities.

1.1.2 Blockchain from the Financial and Business Perspective

Bitcoin is the first decentralized network built on blockchain (Rao, Kanagalakshmi, and Ramya, 2015). The technology is fundamentally developed to assist with executing the transfer of monetary value. However, it has expanded with additional functionalities and diverse, decentralized applications which touch upon various industries and business practices (Attaran and Gunasekaran, 2019). The expansion of blockchain technology toward industries beyond finance has been primarily feasible after the evolvement of the Ethereum blockchain and the concept of smart contracts (Buterin, 2014).

This section demonstrates use cases from the banking/finance sector and other industries where multiple blockchain-based solutions have been built or are in the pilot phase aiming to disrupt traditional processes. This type of use case indicates blockchain technology's disruptive nature and potential. It compels the study's purpose to develop the BRI, which could potentially affect the decision-making by these solution makers.

1.1.2.1 Blockchain Use Cases in Finance and Private Industry

Bitcoin has set the paradigm as the first decentralized cryptocurrency (Chowdhury, 2019). It allows participants to exchange monetary value without the involvement of intermediaries such as banks, clearinghouses, and other financial institutions. Besides eliminating third-party involvement, the other advantages to the end-user come in transaction settlement time, transaction cost, and transparent transaction history to all parties (Sathya and Elngar, 2020). The legal definition and treatment of cryptocurrencies affect operational decisions for business activities in both the public and private sectors (Finck, 2018). Therefore the BRI attempts to clarify which countries embrace the use of blockchain and cryptocurrencies as a means of payment and recording and transferring value.

Besides competing and overachieving in many aspects against the banking system (Trautman and Harrell, 2016), cryptocurrencies like Bitcoin have significant advantages over remittance companies such as Western Union and MoneyGram. Table 1.1 compares transaction fees, execution time, and transaction value limits between cryptocurrencies and prominent remittance companies, as derived from the researcher's personal experience. Since Western Union and MoneyGram rely on intermediaries to execute, further delays or restrictions might apply at any given time.

Table 1.1: Bitcoin vs. Remittance limits

	Bitcoin	**Western Union**	**MoneyGram**
Execution Time	Approximately 10 minutes	Minutes to 5 Days	Minutes to 2 Days
Transaction Fees	It varies between a few USD cents to a few USD when the network is busy[1]	Up to 6%	A minimum fee of 4.99 USD, increases exponentially
Limit in the transaction amount	Unlimited	Limited depending on the country	10,000 USD

It is noteworthy that Bitcoin is considered one of the most expensive and inefficient cryptocurrencies in terms of transaction fees (Tsang and Yang, 2021), as other blockchain networks can operate free of fees or with much lower transactions costs depending on the consensus algorithm adopted (Laurent, Brotcorne and Fortz, 2022).

Blockchain use can be expanded beyond the transfer of digital funds. Securitization of real-world assets can evolve through blockchain tokenization (Li *et al.*, 2019), where blockchain

[1] https://www.blockchain.com/charts/fees-usd-per-transaction

tokens representing securities are issued and represent tradeable assets. These tokens were mainly created through Initial Coin Offerings, later known as Security Token Offerings (Momtaz, Rennertseder, and Schröder, 2019). This definition was fundamentally and legally distinguished from other types of tokens created for utility and payment purposes. The tokenization of these securities can be implemented by platforms like Polymath (Dossa, 2020) and can represent share ownership, while tokens can be traded on a secondary market as well. Token holders gain the advantages of the blockchain network, which involves less friction, faster and cheaper transactions and increased transparency of token history. Tokenization and trading of digital assets is now mostly occurring through non-fungible tokens (NFTs) (Russell, 2022). The value of the NFT industry reached approximately $17B, a value that was not experienced before in similar blockchain use cases (Baytaş, Cappellaro, and Fernaeus, 2022). In 2020, the NFT industry was significantly smaller, hosting activities of approximately $82M (NonFungible, 2021). The BRI aims to distinguish in which countries such activities gather engagement and can operate within the non-hostile legal treatment of such tokens and where the interest for tokenization of assets exists.

In the medical sector, blockchain can assist patients have complete control of their medical history and can choose when to share it with different doctors and medical institutions rather than relying on costly, time-consuming current processes (Liu, 2016). MedRec (Ekblaw *et al.,* 2016) is one of the first blockchain start-ups built to facilitate a decentralized medical records network. Permissioned blockchains probably have an adequate structure to maintain such a network due to minimal costs and the need for data privacy (Karkeraa, 2020).

Blockchain may also achieve operational efficiencies within industries like supply chain shipping and insurance (Alshamsi, 2022). Proof of ownership and quality of goods shipped during delivery is monitored via the combination of these technologies as piloted by projects like IBM and Maersk (Jovic *et al.,* 2019). The insurance industry may also be a step closer to mass blockchain adoption (Maduri and Sen, 2022) as smart contracts can gather information from IoT devices (such as rainfall level) and automatically trigger payments to insured parties (such as a farmer experiencing damages from weather conditions).

The Bitcoin blockchain is not only used for the digital transfer of funds but also for authentication and revocation of academic certificates. A solution developed by researchers at the University of Nicosia (Karasavvas, 2018) allows a secondary party, such as an employer, to verify the authenticity of a digital academic diploma presented by a potential employee without relying on a third-party party's justification, i.e., university alumni office. This solution allows universities to issue and disseminate blockchain-based proofs of academic diplomas to their graduates. If a university is unresponsive or ceases to exist, the graduate can still prove to the employer the academic qualifications gained from studying by referencing a specific blockchain transaction. This is a solution that has been adopted in both permission-less blockchain networks, i.e., Ethereum (Budhiraja and Rani, 2020), and permissioned blockchain networks, i.e., Hyperledger (Castro-Iragorri, 2020).

All the above use cases are built on either permissioned or permissionless blockchain networks. The success of such operations depends on several pillars, which the BRI assesses on a country basis; regulation, local users' engagement, technological advancements, and blockchain industry presence.

1.1.2.2 Uses of Blockchain Technology by Governmental Authorities

The efficiency of governmental authorities in terms of costs and duration of procedures is questionable due to the paperwork involved (Weiss, 1989). The progress of exponential technologies like blockchain allows authorities to re-evaluate specific procedures that can potentially be automated and secured. A report by the Joint Research Centre (Allessie *et al.*, 2019), the European Commission's science and knowledge service, provides an assessment of relevant use cases and scientific support to note the importance of blockchain in governmental digitalization to the European policy-making process.

The blockchain industry has received attention for the recording and general management of land titles (Ekemode *et al.*, 2019). Recording and transferring property titles can be facilitated through a blockchain network with faster and less costly procedures. Some of the initial pilot solutions tested were the prototype blockchain title registry system in Davidson County (Spielman, 2016), Georgia (Korepanova *et al.*, 2019), and Sweden (Kempe, 2016). The immediate settlement and reduction of uncertainty in multiparty transactions are some of the main issues that can be resolved with blockchain technology. Even though these proposed solutions could provide integrity, immutability, and transparency regarding the management of land records, such a solution would need to be embraced by the local government by implementing a regulatory framework and/or issuing guidelines which legalise the treatment of these records via the use of blockchain technology (Ghanpathi *et al.*, 2022). An example of a governmental act that would allow this model to develop is the legalisation of digital signatures (Veuger, 2020).

The Swiss Blockchain start-up, uPort, developed a decentralized identity project in Zug Municipality (Panait, Olimid, and Stefanescu, 2020), which allows citizens to create and manage their blockchain-based identity independently from the government. This decentralized identity only needs to be attested once by the authorities and utilizes smart contracts technology to control the sharing of personal data. This is another example of a blockchain solution that requires local governments' embracement, as proper regulatory frameworks and a centralized governmental attestation system must be in place for the concept to advance.

A blockchain redistribution system for allocating social benefits and grants was built in Groningen, Netherlands. The Stadjerspas smart voucher system (Wang *et al.*, 2018) facilitates the decentralized distribution of social benefits to low-income citizens. Smart contracts, or programmable money as is the term used in this case, allow the setting of rules that govern the authorization, transfer, and settlement of transactions.

A decentralized pension administration system has also been developed in the Netherlands to automate payments to pension holders. The Pension Infrastructure Project (Bennon, Monk, and Nowacki, 2015) aims to deal with complex challenges, such as the large volume of transactions that need to be processed using smart contracts.

Blockchain can be utilized for the digital recording and transfer of assets and certificates and to evade fraud. Specifically, billions are lost annually in value-added tax fraud (Frunza, 2018). This amount of loss is an issue that could be attempted to be resolved by developing tools that require taxpayers to upload digital invoices into a country's blockchain-based reporting system (Ainsworth and Shact, 2016).

Considering the aforementioned use cases, governments seem to struggle to keep up with technological advancements that could revolutionize current processes, transforming current systems into sophisticated deployments. The BRI aims to assess such advancements by considering certain indicators that measure the readiness of countries in specific areas of technological and blockchain-related development. All pillars and indicators which comprise the BRI are outlined in Chapter 3.

1.2 Problems

The problems identified and justified further in the following chapter, is the lack of a blockchain readiness index that is able to simultaneously:

(a) Consider an unlimited range of countries, by developing a technique to estimate values of missing indicators
(b) Justify and consider a range of indicators according to the importance set by qualified individuals in the field

(c) Develop a technique to estimate in numerical terms the regulatory stance per country, instead of manual judgment
(d) Develop techniques to produce dy versions of the BRI, such as a version allocating indicators' weights set by the community and a version allowing users to adjust indicators' weights according to their customised needs

1.2.1 Motivation

The knowledge gap identified involves the absence of a numerical index which is based on subjective data to identified blockchain readiness per country. There is a lack of blockchain industry knowledge (Lakhan *et al.*, 2022) among relevant parties like blockchain start-ups, private organizations, and individual investors. This gap leads to regulatory and operational uncertainty before certain decision-making actions (Cumming, Johan, and Pant, 2019) regarding which countries are suitable to host their blockchain-based operations and establish further industry collaborations. Governmental authorities may often not identify the most empowering conditions for deciding which actions must be taken to position their country as a blockchain hub (Carullo, 2021). Countries with a low score in specific indicators may use the results and adopt policies of top-ranked countries to initiate developments that will address their areas of improvement.

My motivation is to develop a readiness index that is able to assist in the engagement and activities of the relevant parties operating in the blockchain ecosystem. Defining the readiness of a disruptive technology like blockchain is challenging due its rapid and dynamic development (Angelis and Ribeiro da Silva, 2019).

The rapid growth of DLT with the realization of blockchains is leading the forefront of technological developments. It has been disrupting a plethora of human activities ranging from financial and social interactions, business-to-business interchange, legislation, the public sector, and many more (Fahmideh *et al.*, 2021). With this evolution of human activities led by blockchain technology, it is hard to monitor how different countries are reacting to this change. Under this new state of affairs, countries are faced with the challenge of catching up with the trend and harnessing this technological innovation while at the same time seeking a balance by mitigating potential risks that are likely to arise from the consequences of applying a premature, emerging technology.

Blockchain technology is still a nascent field, but it is becoming a promising technology for the next generation of future internet systems and applications (Makridakis and Christodoulou, 2019) (Marchesi *et al.*, 2022). Even though blockchain is expected to impact the Internet by enabling decentralized transactions, smart contracts, and virtual countries and being used as a driver for other emerging technologies (e.g., Artificial Intelligence), the treatment of the technology has proved challenging for countries worldwide (Fahmideh *et al.*, 2022). Currently, legislation and rules for using the technology and treating crypto-assets vary by country or even do not exist (Dumchikov *et al.*, 2020). Similarly, the industry is emerging at different degrees of technological maturity within each region. Local blockchain engagement and technological advancement differ per country, while start-ups consider several countries to operate (Karisma and Moslemzadeh Tehrani, 2022).

The main aim of industrial readiness indexes is to provide a single numerical representation of how engaged an examined item is - such as a country, region, or entity - towards a specific subject or sector (Tan, Brewer, and Liesch, 2008). Several readiness indexes are constructed to assess technological innovations, some of which are assessed through the literature review in Chapter 2.

Little scientific work has been done to establish a global blockchain readiness index. More specifically, the estimation of country-by-country blockchain readiness on a worldwide scale is absent from the industry; therefore, this research aims to add value by filling the knowledge gap and providing a standard that the community can look up to and take into consideration before decision-making actions. The gap refers to the presence of a blockchain readiness index which reflects subjective numerical data and its scoring components can be dynamically adjusted according to the preferences of the user.

1.3 Aim and Objectives

The proposed BRI is constructed to identify non-hostile countries where blockchain-based conditions can enable businesses and investors to operate. The index is used as a tool for countries to assess their level of readiness in blockchain technology and shape their digital strategies, influencing the country's socioeconomic growth (Hellmich, 2015).

1.3.1 Research Aim

The aim of this research is to develop numerical techniques towards estimating the level of blockchain readiness per country.

This research follows a quantitative approach to achieve the aim of this research. The BRI aims to consist of understandable and valuable features for the user to comprehend. Ideally, this index shall be valuable for users, including executives, individual investors, consultants, policymakers, and regulators engaged in blockchain technology.

1.3.2 Research Objectives

Setting realistic and achievable objectives is essential, given the limited numerical resources that may be available at this time for each country. At the same time, the index shall be designed to provide a fair estimation of each country, regardless of the amount of data available.

The research objectives provide the context in which the research methods are structured. To achieve the above aim, the following are envisaged:

O1. Identify the adequate indicators which a BRI shall include.

Research question: which techniques can be used to understand the adequate BRI indicators that reflect an estimation of blockchain readiness?

The impact of first research objective is to determine the importance of the suggested indicators. These indicators were gathered based on their co-occurrence on previously established scientific and blockchain-related indexes. The survey enabled the weighting of these indicators by a group of academically certified individuals, where the weighted average was calculated per indicator to provide a reasonable finalized set of indicators to be included in the BRI.

O2. Investigate a way of understanding the blockchain regulatory ecosystem per country in a numerical format

Research question: how can the regulatory ecosystem be translated in a numerical format?

According to the literature review, previous attempts to define regulation numerically were conducted via manual matrix compositions. One of the objectives of this research is to propose a new model for deriving a blockchain regulatory stance per country, which is based on web mining and considerations of “positive” and “negative” words within the text. The impact of this approach was to initiate a proposed model for assessing blockchain regulatory stance per country, which was then justified with experts’ assessment for justification and accuracy purposes.

O3. Design an index that allows a dynamic estimation of blockchain readiness per country

Research question: which techniques will enable the dynamic adjustment of indicators' weights, in order to reflect an estimation of readiness based on users' preferences?

Identifying adequate BRI indicators and weights through the completion of O1 may not be considered valuable for potential BRI users. This is because there may be variations of approaches and opinions on which indicators are of high importance among various parties and industries operating within the blockchain field. The third objective of this research is to enable the end users to adjust the weights of indicators according to their own needs. This introduces a feature that was not patterned in previously examined indexes, therefore enhanced flexibility tools may allow dynamic assessment of blockchain readiness, which was not previously introduced.

1.4 Significance of Research

The quantitative character of this research achieves the aim initially set, which is to propose a technique that produces a numerical estimation of blockchain readiness per country. The elimination of subjective practices to derive country rankings is set out as one of the main challenges of this research. The variations of the BRI versions due to the flexibility of indicators' weights, are deployed in order for the BRI to become useful for a wider range of potential end users with different needs. These components contribute toward the practical contribution to knowledge.

The academic contribution to the existing literature of established scientific indexes mainly relate to the technique for estimating missing indicators as well as the web mining technique for estimating the regulatory stance of countries; based on the idea that the co-occurrence of regulation-related cues implies the country's tendency towards a positive/negative stance. As examined in Chapter 2, the majority of technological and blockchain-related indexes involved human assumptions regarding the weights and scores of certain indicators. In the contrary, the proposed BRI is based on an objective approach for quantifying the engagement per country on cryptocurrencies and blockchain while it is a generic approach that can be parameterized (e.g., weighting strategy, missing indicators estimation, and query types for the set of lexical entries to be used for the Web mining queries).

Initial results from running the proposed BRI index is the finding that countries like *Singapore*, *Sweden*, *Malta*, the *USA*, and *Ireland* remain highly scored with several variations of the BRI. Variations of scores are mostly possible when adopting the BRI Weights-Adjustment Version as observed in section 6.2.3 – "BRI 2021 Weights-Adjustment Version – Results & Discussion". Section 6.2.3.1 – "Random Weighting" indicates that there is a difference in scores derived from potential real-life scenarios compared to scores derived from random weighting.

1.5 Overview of Thesis Structure

- **Chapter 1 Introduction**

Chapter 1 outlines the importance of the research gap regarding this topic and the need for a technique to evolve which is able to act as the standard of measurement of blockchain engagement per country. The central argument, research aim, and objectives prepare the reader for the following chapters dedicated to literature review and methodology.

- **Chapter 2 - Literature Review**

Chapter 2 analyses the present literature review on the topic. The literature review is divided into two components:

1. Review of indexes indicating readiness of countries and/or regions engaged in technological advancements
2. Review of indexes indicating readiness of countries and/or regions engaged in technologies associated with the 4th Industrial Evolution (Industry 4.0)
3. Review of indexes assessing the readiness of blockchain technology worldwide

- **Chapter 3 – Conceptual Framework**

Chapter 3 describes the initial conceptual framework and the broad philosophical underpinning of the research methods, including a description of the quantitative approach applied to this thesis. This approach was first discussed in the initial publication in 2019 (Vlachos, Christodoulou and Iosif, 2019). The research justifies the selection of this approach by linking it with the literature and the scope of the research.

- **Chapter 4 – Data Analysis**

This chapter outlines how the aim and objectives of the research are attempted to be achieved. More specifically, the survey structure, which is conducted to identify the index indicators, is evaluated in terms of sample selection and what actions are taken to ensure that the findings are relevant. Similarly, the scientific equation that is used to conduct country scores is analysed. The additional features of weight adjustment through user customization and community voting are identified but not yet finalized in rankings.

- **Chapter 5 - Estimating Blockchain Regulation via Web Mining**

Chapter 5 describes the assessment method to estimate the regulatory landscape of each country. Chapter 5 is related to the methodological approach outlined in a previous paper. (Iosif, Christodoulou and Vlachos, 2020). The implementation challenges that led to the decision to adopt this method are initially discussed. Similar approaches to identifying blockchain regulation readiness are evaluated as the literature review component. The focuses on the technique used to obtain substantial findings based on the experiment, and the ground truth experiment which justifies the experiment's results.

- **Chapter 6 – The Blockchain Readiness Index for Public and Private Use**

Chapter 6 discusses the importance of the BRI tool and how an estimation of blockchain readiness can affect decision-making in the public and private sectors. The finalized methodology is discussed, including the technique toward measuring blockchain regulatory readiness. In addition, the variations of BRI versions that can be customized according to professional decision-making requirements are finalized and presented in the form of rankings. The final ground truth experiment is conducted, where the BRI rankings are assessed and compared against the rankings set by industry academics.

- **Chapter 7 – Concluding Remarks**

Chapter 7 provides a brief summary of key findings related to the initial expectations and also includes the conclusions drawn from the research. This research states the importance of the study to the blockchain community and fellow researchers. The contributions of the research toward academia and the blockchain industry are discussed as well as future work that includes evaluation practices from blockchain organizations. The limitations are assessed to define the drawbacks and establish procedures that will improve the BRI in the future.

1.6 Summary

Chapter 1 introduces the reader to the field of study and its potential implications. Society needs to appreciate the disruptions that may benefit business activities worldwide. There was an assessment of the impact of blockchain technology in various business dimensions by demonstrating a number of use cases implemented in the public and private sectors.

The development of the BRI is expected to produce a technique able to capture the propensity of countries to adapt to Blockchain technology and exploit the benefits of this emerging area (Informat, 2022), contributing to the knowledge around this innovative concept. The chapter relates the development of the index with the motivation and aim of the study, thereby indicating the path to which the three main research objectives are identified and planned to be implemented; a) Surveying the community to identify the relevant index indicators, b) Define a precise numerical estimation of the blockchain regulatory landscape per country and c) Propose a methodology on developing techniques to produce a dynamic index. The chapter concludes with an overview of the thesis structure.

There are two key methodological frameworks developed in this research. The first one is discussed in Chapter 3 and aims to establish the BRI structure in terms of identifying pillars and indicators, estimating values of missing indicators, and suggesting a mathematical formula that scores countries in terms of blockchain readiness. Upon implementing and evaluating the preliminary BRI scores for 2020, more work is needed as some aspects are still not developed, such as the estimation of blockchain regulation via an algorithmic procedure.

The methodology developed to numerically estimate the blockchain regulatory landscape per country is discussed in Chapter 5. Upon implementing the two methodological frameworks, the research unifies the two methodologies in Chapter 6. There is a combination of the findings of the two methodological frameworks and, by updating indicators' values where needed, produces the three finalized BRI versions for 2021.

CHAPTER 2 LITERATURE REVIEW

2.0 Introduction

This chapter delves into the critical body of literature surrounding readiness indexes, with a particular focus on the complexities involved in creating an index to assess the country's blockchain readiness. The literature review is structured into three key assessment areas.

Firstly, the chapter explores the significance of indexes to decision-making procedures and strategies (Purva, Kumar and Marijn, 2019). As discussed in the Chapter 1, the primary motivation of this research is to construct dynamic versions of the BRI which can demonstrate a fair assessment of the blockchain readiness per country and assist in the relevant decision-making of associated parties in the field. Therefore, examining the evolvement of readiness indexes and the impact triggered by recently published indexes on decision-making processes seems necessary. Analyzing the relationship and current status of established technological indexes and aligning them with the strategies implemented in the business and governmental sectors, a belief is developed that an adequately structured BRI may be an equivalent useful index within the blockchain industry.

National readiness is described as the quality of a country's information communication technology, technical infrastructure and the human ability towards an examined sector (Rao, 2003). Most of the technological indexes examined in this chapter include indicators belonging in the above pillars. However, blockchain-related indexes currently seem less inclusive in terms of indicators assessed, Therefore, it is assumed that an index estimating the blockchain ecosystem shall be addressing the readiness of a given country and shall include the components outlined in (Rao, 2003). Regarding the literature on establishing a framework to estimate readiness, the following contributions are examined: (a) “A framework for measuring national e-readiness” (Bui, Sankaran, and Sebastian, 2003) and (b) the evolution of the “e-Government Readiness Index” (Potnis and Pardo, 2008).

The second part of this chapter focuses on the analysis of other technological indexes such as the “Network Readiness Index” (Soumitra and Bruno, 2020) and the “Autonomous Vehicles Readiness Index” (KPMG, 2020). These indexes are designed to assess the readiness level of countries toward technological advancements that relate to the Fourth Industrial Revolution (aka Industry 4.0) (Xu, David, and Kim, 2018). The assessment of exponential technologies utilized for this cause is the topic of examination of these indexes. Similar to blockchain (and DLTs in particular), such technologies disrupt operations and product lifecycles of processes and consequently achieve increased productivity through automation and advanced intelligence.

Examining the methodologies of these indexes, we gain insight into the types of frameworks designed to rank countries based on technologies categorized under Industry 4.0, including blockchain. For the purpose of this research, I have chosen to review indexes that assess and compare readiness between countries, rather than those focusing on readiness in a local environment. For instance, the "Smart Industry Readiness Index" (Singapore Economic Development Board, 2020), which is specific to Singapore, falls outside the scope of this review.

To the best of our knowledge current research on assessing the readiness of a country in cryptocurrencies and blockchain as a technology is limited. Chapter 3 proposes a methodology for constructing an index that considers signals from various indicators to rank nations according to their stance in blockchain/DLTs and cryptocurrencies. In brief, the methodology, is consolidating signals (the so-called "indicators") that are likely to influence their adoption and user-friendliness and encourage industrial and individual businesses to use them.

Furthermore, the chapter delves into the methodologies of indexes designed to estimate national readiness for blockchain technology. These include the "Distributed Ledger Technology and Cryptocurrency Market Potential Index" (Nguyen and Jeong-Hun, 2020) and the "Crypto-Ready Index (CRI)" (Crypto Head, 2021). These studies represent preliminary research efforts in the development of blockchain-related indexes, aiming to present a country-based ranking similar to the BRI.

Examining the methodology follows by the aforementioned indexes, conclusions arise regarding which factors shall be taken into consideration while developing a scientific index in this field. Additionally, the work presented in "Bitcoin Market Potential Index" (Hileman, 2015), is discussed. This paper attempts to assess the potential utility of Bitcoin globally. Even though the terms "Blockchain" and "Bitcoin" may have different implications and use rates per country, by reviewing the methodology used in this index, there is a need to understand the dimensions, and the factors that are relevant to be considered as part of the assessment process of blockchain-based indexes.

The factors (aka "signals") considered to the construction of the proposed BRI are classified into pillars, indicators, and additional functionalities on top of existing methodologies used in previous studies (refer to Chapter 3). The chapter concludes by explaining how the review of the existing literature has assisted the decision-making in which dimensions are adopted in this research and its dynamic, scalable design.

2.1 The Evolvement of e-readiness Indexes

It is essential to examine the nature and purpose of existing readiness assessment models. Readiness indexes which are associated with the ability to pursue value creation opportunities facilitated by the use of the internet, are often launched via the term "e-readiness index" (Choucri, Maugis, and Madnick, 2003). The official term is a matter of interpretation as a number of indexes evaluated in this chapter are referred to as "readiness index." The general term "e-readiness" is used for consistency purposes in sections 2.1, 2.1.1, 2.1.2, and 2.1.3, as most of the initially developed indexes used this terminology. When referring to similar studies, exceptions include the BRI and other indexes whose establishment included the term "readiness" instead of "e-readiness." From section 2.2 onwards, the term "readiness" is used, as recently launched indexes mainly refer to this term.

As society and technology evolve in parallel, questions and assumptions arise as to which parties remain competitive in various sectors of the economy. These parties can be classified both at the industrial and national levels. Therefore, the evolution of e-readiness indexes often represents a technique or a methodology through which industrial and governmental initiatives are assessed (Mutula, 2010).

A number of e-readiness assessment models were initially developed in 1998 (The Economist Intelligence Unit, 2006), while the concept of e-readiness started to become relevant during the first years of the 21st century (Dada, 2006). Dada (2006) explained that the increased adoption of Information and Communications Technology (ICT) has been pushing towards e-readiness assessments, while affecting the decision-making of companies and even policy-making decisions at the country level. This resulted in the emergence of a positive socio-economic environment for countries with a more positive stance such as increased market competition, business opportunities, employment, and better quality of products and services (Dada, 2006).

Similarly to the proposed structure for BRI, e-readiness indexes evolved to consider numerous indices and indicators to compare the e-readiness of countries in different dimensions (Dutta *et al.*, 2019). Interchangeably in this thesis I am referring to such indicators as "signals" classifying them into several pillars as described in Chapter 3.

Several definitions have been used to define e-readiness, as related assessments may enhance diversity in order to provide different uses and interpretation in different contexts. (Musa, 2010).

The Economist Intelligence Unit interprets e-readiness as the degree to which a society is prepared for e-commerce and e-business evolvement (The Economist Intelligence Unit, 2009). In contrast, the United Nations Department of Economic and Social Affairs considers e-Government readiness as the crucial measure of e-readiness (Ojo, Janowski, and Estevez, 2005).

According to the United Nations University, "e-readiness measures how well a society is positioned to utilize the opportunities provided by ICT, where ICT infrastructure, human capital, regulations, policies, and internet penetration are all crucial components of e-readiness" (Ojo, Janowski and Estevez, 2005).

The Asian Pacific Economic Cooperation defines e-readiness as “the degree to which an economy or community is prepared to participate in the digital economy” (Asian Pacific Economic Cooperation, 2000). Furthermore, per Harvard University, e-readiness examines the preparedness of a community to participate in the networked world, considering its relative ICT adoption and advancement (Alaaraj and Ibrahim, 2014). An additional publicized definition of e-readiness is the "state of play of a country's ICT infrastructure and the ability of its consumer, businesses, and governments to use ICT to their benefit" (The Economist Intelligence Unit, 2006).

The common denominator of the definitions above is the ability of countries/regions/communities to adopt ICT to maximize the digital economy's potential, taking into account human competencies and economic performance. Consequently, the proposed BRI is developed as a country-specific index, assessing the readiness of blockchain technology to maximize the industry's potential within examined regions.

In many cases, “e-readiness” emerged as a point of discussion among governments, organizations, and the public (Zhao, Fan and Yan, 2016). It can facilitate socio-economic development by modernizing traditional processes in e-commerce, e-Government, ICT diffusion and attracting external attention to investors (Alaaraj and Ibrahim, 2014). Several governmental and corporate organizations have developed e-readiness assessment models on a global scale to boost national economic and social development and escalate citizens’ capabilities to utilize new technologies (The Economist Intelligence Unit, 2006). The quantity and quality of information derived from such e-readiness assessments have been a fundamental block of global socio-economic development. They increased the use of ICT in many industries (Zarimpas, Grouztidou, and Anastasiadou, 2009).

The critical factors to facilitating the digital transformation of society rely on establishing scientific decision-making indexes. These indexes shall enable industry participants to understand the needs and identify the most critical variables that influence outcomes based on implications derived from accessible information (Babcock, 2005). Businesses and nations can exploit e-readiness assessments to gain a competitive advantage within the networked economy (Molla *et al.*, 2008). Such assessments can help developing countries overcome development obstacles and interconnectivity on a national level, thus enabling them to tackle issues derived from a physical location (Janom and Zakaria, 2008).

The micro-level benefits of assessing e-readiness are outlined (Mutula and Brakel, 2006) below:

- Save time
- Improve quality
- Improve speed of the delivery of goods and services
- Reduce human requirements for specific tasks
- Increase cost-effectiveness
- Enhance adequate product selection
- Reduce procurements costs
- Through ICT, improve the general skills and competencies of employees
- Through ICT, facilitate better identification, access, organizations, dissemination, and application of information

An additional benefit from the socio-political perspective is that e-readiness can give individuals the confidence and ability to contribute to the policy-making activities of their community, even if they have been previously excluded from such occasions (Lanvin and Qiang, 2004).

2.1.1 Overview of e-readiness Assessments on a National Level

An e-readiness estimation can help create standards for international comparison via available market data, contributing to national planning (IMD, 2019). The estimations established in the field are different in terms of methodology and objectives; therefore, hardly any model is probable to provide rankings considering the whole set of available and relevant information. (Zaied *et al.*, 2007)

Organizing, structuring, and strategizing the implementation of e-readiness assessments vary according to the scope of each research (Mutula, 2010). The role of e-readiness indicators in terms of the socio-economic perspective is discussed by Luyt (2006), specifically their importance in defining policy problems. ICT development can address social issues like social inclusion, individual property rights and population concentration, and economic issues by integrating ICT into business environments. Countries and regions could use ICT to advance their development activities (Luyt, 2006).

Some of the first quantitative assessment models established to measure the e-readiness of countries and their economies are presented in Table 2.1 as derived from a relevant study (Alaaraj and Ibrahim, 2014). These types of assessment models include different types of methodologies, such as surveys and statistical data (Hourali *et al.*, 2008).

Table 2.1: Quantitative e-readiness assessment models

Organization Name	Assessment	Year	Methodology
Economist Intelligence Unit	E-Business Readiness Ranking	2003	Quantitative
Centre for International Development Harvard University	Networked Readiness Index	2002-2003	Quantitative
IDC	Information Society Index	2000-2002	Quantitative
United Nations Development Programme	Technology Achievement Index	2001	Quantitative
United Nations Conference on Trade and Development	ICT Development Indices	2001	Quantitative
International Telecommunication Union	Digital Access Index	1998	Quantitative
Asia-Pacific Economic Cooperation	APEC Readiness Initiative	1999	Quantitative

Several assumptions may be interpreted from observing e-readiness assessments. The e-readiness assessments developed during the late 1990s and early 2000s tend to consider indicators related to technological advancements, ICT, human development skills, accessibility to services, and connectivity (Zaied *et al.*, 2007). As outlined in (Rao, 2003), models assessing e-readiness, examines aspects like information communication technology, technical infrastructure and the human ability. This finding might be a sign that blockchain related indexes shall follow a similar paradigm. The quantitative nature of such methodologies demonstrate the importance of focusing on numerical sources in order to estimate e-readiness of industries in a country-based format.

Furthermore, there has also been a case for assessing the 8Cs - connectivity, content, community, commerce, capacity, culture, corporation, and capital - as the pillars to assess the ability of a country to be engaged in e-readiness in order to enhance efficiency within the business sector (Rao, 2003).

Proper assessment of e-readiness can be proven helpful in implementing e-Governmental services. On certain occasions, e-readiness indicators have been categorized under the pillars of e-commerce and e-Government. A more general pillar includes indicators measuring ICT's capacity and internet diffusion (Ojo, Janowski, and Estevez, 2005).

Table 2.2 provides an overview of the indicators assessed by a number of organizations that have examined e-readiness on a national level (Zaied *et al.*, 2007).

Table 2.2: Overview of e-readiness indicators according to organizations

Organisation/Author(s) Name & Year of Assessment	**Indicators proposed for the assessment of e-readiness**
Asia-Pacific Economic Cooperation (2000)	• Basic infrastructure and technology (access and functionality of basic infrastructure; price, speed, reliability, availability of terminal equipment, market conditions, and interconnectivity) • Access to necessary services (Internet service providers, non-IT services, and distribution channels) • Current level and type of Internet use • Promotion and facilitation activities

	• Human skills and development • Positioning for the digital economy
Bridges.org (2001)	• Number of users or computers • Access to infrastructure • Affordability • Training • Poverty • IT sector (geography, race, age, religion, gender, and disability)
Economist Intelligence Unit (2002)	• Business environment • Consumer and business adoption • Social and cultural infrastructure • Legal and policy environment • Connectivity and technology infrastructure • Supporting e-Services
United Nations Economic Commission for Europe (2002)	• Network access • Networked society • Network policy • Media • Networked economy • Networked learning • Intellectual capital • Labour force • Research and development • Education
Applied Research and Communications (2002)	• Network access • e-education • e-society • e-economy
Centre for International Development at Harvard University (2002)	• Network access • Networking learning • Networked society

	• Networked economy • Network policy

Table 2.3 provides an overview of the indicators assessed by a number of researchers who have assessed e-readiness on a national level (Zaied *et al.*, 2007).

Table 2.3: Overview of e-readiness indicators according to researchers

C. L. Brown (2002)	• Policy discourse culture • Legal culture • Democratisation culture • Diversity culture • Trust culture • Communications culture
Andre Krull (2003)	• Networked society • Network access • Networked learning • Networked economy • Networked government (ICT in public administration)
Vincent Maugis, Nazli Choucri, Stuart E. Madnick, Michael L. Best (2003)	• Access (infrastructure and services) • Capacity (social factors, economic factors, and policy factors) • Opportunities (specific application and opportunity penetration)
Akram Najjar, Salam Yamout, Kamal Siblini (2003)	• Access and infrastructure (network infrastructure, access, affordability, reliability and speed, and international connections) • Government leadership (national ICT strategy, ICT policies and regulations, central bank initiatives, partnerships, and funding for ICT and e-Government and organizational efficiency)

	• Human capacity (ICT as formal education, ICT as informal education, and the ICT brain drain) • E-business and economic environment (economic climate, ICT as a production sector, and e-commerce • Social environment and public awareness (usage of ICT in everyday life and the internet society)
Saad Haj Bakry (2004)	• Strategy (ICT leadership and ICT future development plans) • Technology (ICT basic infrastructure, ICT e-Services infrastructure, ICT provisioning, and ICT support) • Organization (ICT regulations: government, ICT cooperation, and ICT management) • People (ICT awareness, ICT education and training, ICT qualifications and jobs, and management of ICT skills) • Environment (knowledge, resources and economy, organization and general infrastructure)
Princely Ifinedo (2005)	• Demand forces (culture, understanding and effectiveness, knowledgeable citizens) • Measuring the supply forces (industry competitiveness, skilled workforce, and investments) • Societal infrastructure (cost of living and pricing, advanced infrastructure, and macro-economic environment)
Teresa Peters (2005)	• Legal and regulatory environment for ICT use • Appropriateness of ICT • Affordability of ICT in the local context • ICT capacity and training • Availability of locally relevant content and services • Use of ICT in business • Integration of ICT into peoples' lives

	• Physical access to ICT • Socio-cultural factors that affect ICT use • Security and peoples' trust in ICT • Macroeconomic environment affecting ICT use • Government's role in driving e-Readiness

The range of indicators outlined in Table 2.2, validate the view that ICT, human development and infrastructure (Rao, 2003) are important towards the estimation of readiness in a given sector. Several studies involve the strategical, organizational, human and technological context of ICT applications. Affordability, availability and use of ICT and network infrastructure is assessed in most of the studies displayed in Table 2.2. Another interesting finding is the assessment of the role of governments in driving e-Readiness and drafting ICT strategies and regulatory frameworks for use in public sectors. The link with the human factor is conducted by indicators assessing ICT-related education, physical access, network opportunities and trust towards technological advancements.

By overviewing some of the initially launched country-based e-readiness models, there is a conclusion that a significant level of attention is given to accessible infrastructure, technological advancement, human development, and connectivity.

2.1.2 A Framework for Measuring National e-Readiness

The BRI aims to assess blockchain readiness per country by developing a scientific index that considers indicators (also referred to as "measures") on a normalized scale. Similarly, one of the first comprehensive frameworks developed to measure national e-readiness, published as "A framework for measuring national e-readiness," approached the challenge of scoring countries with an identical method (Bui, Sankaran, and Sebastian, 2003). The authors used data published by various world organizations to structure the framework into 52 indicators, which were then classified into pillars (referred to as "factors"). The scope of this framework was to assist national strategic decisions. Table 2.4 illustrates the structure of the proposed framework (Bui, Sankaran, and Sebastian, 2003).

Table 2.4: Factors and Measures for measuring national e-readiness

Pillars (or "Factors")	Indicators (or "Measures")

Knowledgeable Citizens	• Adult literacy rate • Secondary enrolment • Tertiary enrolment • 8th Grade achievement in science • MGMT education available in first-class Business Schools • The flexibility of people to adapt to new challenges
Access to Skilled Workforce	• Public spending on education as % of GDP • University education • % of well-educated people who do not emigrate • The extent of staff training • Research collaboration companies/universities • Number of technical papers per 1 million people
Macro Economy	• Trade as % of GDP • Adequate regulation & supervision of financial institutions • Protection of Property Rights Tariff & Non-tariff Barriers • Soundness of banks • Local competition • Regulatory framework • Government effectiveness • Political stability • Press freedom • Rule of Law • Control of corruption
Digital Infrastructure	• Telephone per 1,000 people • Mobile phones per 1,000 people • Computers per 1,000 people • Internet hosts per 10,000 people • Cost of a call to the USA • Investment in telecom as % of GDP

	• Computer processing power (% worldwide MIPS) • e-Government • ICT expenditure as % of GDP • Freedom on the internet
Industry Competitiveness	• Technology Achievement Index • Gross tertiary science & Engineering Enrolment Ratio • Administration burden for start-ups • Patent applications granted by USPTO • Private sector spending on R&D • Total expenditure for R&D as % of GNI • High-tech exports (% of manufactured exports)
Culture	• National culture open to foreign influence • English language literacy • Percentage of urban population • Percentage of the population 65 years or older
Ability and Willingness to Invest	• Composite ICRG Risk rating • Availability of Venture Capital • Entrepreneurship among managers • Foreign Direct Investment as % of GDP
Cost of Living and Pricing	• International cost of living based on the US $100 • Inflation Rate-CPI in % • GDP per Capita (PPP) in US$

Examining the proposed indicators (summarised in Table 2.4) reveals that this framework takes into account aspects of human interest, capabilities, and skills, as well as industrial presence and infrastructure significant for measuring national e-readiness. Similarly to the blockchain industry nowadays, at the time of this research, e-commerce was still in its early stages; therefore, assessing the factors that would lead to broader adoption and derive country rankings in this aspect was a matter of discussion within the community (Sharma, 2003). The researchers of this work (Bui, Sankaran, and Sebastian, 2003) are computing e-readiness for a given country using a methodology as described below:

For the countries which are to be compared:

1. *Choose one factor along with its measures*
2. *Examine the first measure of the chosen factor. Identify the smallest and the largest values; determine the range by subtracting the smaller value from the larger*
3. *Create a normalized scale for the measure:*
    a. *Divide the range into four equal intervals*
    b. *Assign 1 to the smallest number*
    c. *Assign 5 to the largest number*
    d. *Assign 2, 3, and 4 corresponding to the interval data created*
4. *Compare each country's value for the measure against the normalized scale in step 3*
5. *Assign the closest normalized values for each country*
6. *Repeat steps 2 – 5 for all measures of the examined factor*
7. *Compute the weighted average of the values in step 5 to compute the e-readiness value for the given factor*
8. *Repeat steps 1 – 7 for all factors*
9. *Averaging the value of all factors computed gives the e-readiness index for each country*

2.1.3 E-Government Development Index (eGDI)

The United Nations developed the eGDI in order to assess the capacity and willingness of Member States to assess their e-Government initiatives (Potnis and Pardo, 2008). The first iterations are assessed (Years 2002-2008), which were then considering relatively new technological areas. The reason for this decision is to compare the effect that those estimations had on the technologies they assessed with the effect that the BRI might have on the blockchain industry during the upcoming years, where increased adoption of this emerging technology is expected (Welfare, 2019). Those publications were able to structure the framework of the index methodology, which is still followed precisely until the most recent version (United Nations, 2020b), whose methodology is reviewed at the end of this section.

eGDI assesses comparative indicators of the UN's Member States to demonstrate patterns of Member States' recent e-Government performance by tracking more than 50,000 online features and services in 178 member states by 2008 (Ayanso, Chatterjee, and Cho, 2011).

This comparison is implemented in a Country vs. Country context and in a Current Year vs. Previous Year context to compare the status of a country itself with respect to the past years. eGDI has been developing on a yearly basis until today, with Denmark, Korea, and Estonia heading the 2020 UN e-government rankings, which now rank 193 countries (United Nations, 2020b).

The feedback derived from e-readiness assessments has assisted in shifting the focus of policymakers toward the degree of identifying efficient ways of offering effective e-Governance and keeping up with the global digitization regimes (Potnis and Pardo, 2008). Since its launch, eGDI has been used effectively by the Member States for social and economic assessment and, consequently, uplifting citizens through ICT. On the other hand, findings of the eGDI are often "context" dependent, whereas taking into account assessments such as the trust index (Carroll, 2016) and the citizen satisfaction index (Zenker, Petersen, and Aholt, 2013) could enhance some possible methods to assess e-readiness index in the future better. However, the "inclusion for all" principle, which was developed as an outcome of the index, was able to offer a robust guiding framework for the Member States to design related policies and deploy technological projects (Potnis and Pardo, 2008).

The contribution of the eGDI is identical to the desired contribution of the BRI to government policymakers and other participants within the blockchain industry. According to Potnis and Pardo (2008), United Nations has defined "e-Government" as the governmental use and application of ICT for the provision of information and essential public services to people; therefore, country rankings portray emerging performance patterns and are proposed as a resource to design further ICT initiatives. These contributions may come from the research community, the industry, national authorities, and other interested parties that consider the eGDI rankings a relative indicator of e-Government implementation (Potnis and Pardo, 2008).

The eGDI is evidence of a scientifically constructed index used by policymakers, project implementers, and global funding agencies to assess the relative landscape and inform strategic technological decision-making, even though some noteworthy index limitations have been identified (Potnis and Pardo, 2008).

The United Nations have implemented a series of surveys over a span of years to achieve an identical effect on the eGDI. Annual surveys and reports were conducted to improve the index every year. The summarised yearly updates on the index, resulting from the United Nations' global e-Governments efforts, are the following:

- The “2003 UN Global E-government Survey” includes an assessment of human resource contribution, technical abilities, and web presence of several governments worldwide. Features addressed include the size of countries, their capabilities to invest in technology infrastructure, and the rate at which technology can penetrate society according to the level of the population’s education and skills. The 2003 version attempts to assess the impact and efficiency of innovative technologies via their integration into government and related business processes. The efforts were directed to assess “how citizens can be enabled to receive e-Governance.” The findings highlighted the need for the UN to address global connectivity through significant investments in ICT. (United Nations, 2003)
- The “2004 Global e-Government Readiness Report” focuses on the factors that have led to the challenge of assessing the socio-economic opportunities offered by ICT, with the income of citizens being one of the main obstacles. If this technology is used efficiently, countries could offer better socio-economic opportunities to their citizens. This could lead to the evolution of more skilled and knowledgeable societies where people could exchange information via e-Democracy. The 2004 survey brought these issues to the surface, thereby assisting the United Nations to conclude on the decision to “re-engineer the development strategies designed and implemented by the Member States” (United Nations, 2004).
- The 2005 survey focused on the concept of e-inclusion by measuring readiness both via (a) assessing technological development leading to innovative solutions and (b) social and democratic effects that support people’s active engagement. This addition enhanced democratic practices and government services offered to citizens. The findings were shared with developing countries to highlight the importance of investing in new technology to create information and knowledge-sharing opportunities for the population (United Nations, 2005).
- In 2006, United Nations followed a different, reflective approach by providing an analytical report with findings and observations from past years’ surveys. This approach enabled the United Nations in identifying e-Government projects as a part of a global transformation plan. Strategic partnerships among various participants related to e-Government initiatives were encouraged (United Nations, 2006).

- The "UN e-Government Survey 2008: From e-Government to Connected Governance" assesses the efficiency of e-Government projects by examining the governmental methods of processing information integration. E-Government efficiency is defined as "the means to achieve maximum cost savings and improved service delivery." The outcome of this survey is to encourage public sector efficiency by cutting down financial costs and transaction time (United Nations, 2008).

This sequence of improvements derived from reports and surveys indicates the willingness of the United Nations to continuously improve and develop the eGDI through the years, thereby providing a fair and accurate assessment of e-Government readiness per country on an annual basis.

The digitalization of the economy started changing society and the economy during the late 1990s and early 2000s (Mesenbourg and Bureau, 2001). Some key observations can be derived from evaluating the eGDI index, which is historically one of the first assessment models of e-readiness in the global digital economy, as discussed in section 2.1.1. These observations can guide the path towards structuring specific aspects of the BRI, a similar technique, as to how eGDI was positioned during the 2000s. This is because blockchain technology seems to be positioned within a similar phase of the innovation curve in certain aspects (Purva, Kumar, and Marijn, 2019) as ICT technology was when the eGDI was initially evolving.

The takeaways from the initial versions of the eGDI evaluation, which can be assessed and taken into consideration when structuring the BRI, are outlined in the following dimensions:

1. **Annual improvement of the index**: The significance of the continuous refinement of the eGDI has been discussed in this section. Since blockchain is a relatively emerging topic, the refinement of the indicators and data sources for providing relevant and updated information should be taken into consideration by the proposed BRI.
2. **Acknowledgment of limitations**: Key limitations of the methodology employed to generate the annual eGDI rankings are thoroughly discussed in (Potnis and Pardo, 2008).
    a. The surveys from which eGDI rankings are defined assess the capacity and willingness of governments to create "inclusion for all" but do not address the interest of local communities to an equivalent extent. By acknowledging this limitation, an indication is provided that readiness indexes should not

only emphasize the governmental practices to adopt blockchain technology but also the readiness of the blockchain industry, the technological presence in a country, and the willingness and ability of local populations to understand and use blockchain technology. In order to take advantage of e-Government initiatives, citizens are required to be skilled and knowledgeable in terms of technical competence to a certain extent. As it is mentioned in (Potnis and Pardo, 2008) the inclusion of sub-indicators may not precisely reflect citizens' ability to access e-government services.

b. Exploring the idea of measuring citizens' satisfaction levels regarding e-Government initiatives is proposed to understand the degree of success of such initiatives from the citizens' point of view and expectations for the government. The evaluation aspect could include feedback from a spectrum of active blockchain participants, including industry professionals, associations, and communities.

c. Various administrative officers, researchers, and social scientists have implemented data collection, gathering, and processing through surveys and questionnaires. This variation and method collection level may ultimately disrupt the procedures and lead to errors or misjudgements, affecting the final product and the project's overall aim. Alternatively, a readiness could be based on numerical indices derived from relevant and accessible sources, thereby eliminating the need for judgment, interpretation, and speculation.

The surveys used to derive eGDI rankings nowadays, i.e., 2020, implement precisely an identical methodological framework developed during the previous decade. The three dimensions examined are: (a) the competence of the telecommunication infrastructure, (b) the capabilities of human resources (with improved measurement processes), and (c) the use of ICT and access to online services, as displayed in Table 2.5 (United Nations, 2020b).

Table 2.5: eGDI pillars (or "dimensions") and indicators

Pillars (or "Dimensions")	**Indicators**
Telecommunication Infrastructure Index (TII)	• Estimated internet users per 100 people in the last three months • Number of mobile subscribers per 100 people in the last three months • Active mobile-broadband subscription

	• Number of fixed broadband subscriptions per 100 people
Human Capital Index (HCI)	• Adult literacy rate (weighs as to the 1/3 of the overall pillar weighting) • Combined primary, secondary and tertiary gross enrolment ratio • Expected years of schooling • Average years of schooling
Online Service Index (OSI)	• Examination of whether e-Government online services include certain features like: o Information about laws, policies, regulations, expenditures like public transportation, education policies, national budgeting, equal access to education, electricity outage, housing support, health policies, personal data protection, programs for vulnerable groups, road safety, government scholarships, etc. o Existence of tools like mobile apps to provide e-Government services, national portals, online digital government strategies, e-participation policies, FAQs, sitemaps, live support functionalities, search engine effectiveness, support for digital IDs, tutorials on using the portals, etc. o Ability to access/modify own data, apply for birth certificates, apply for business/patents licenses, apply for a visa, apply for land registration title, apply for marriage certificates, apply for building

	permits, apply to enroll online for education, apply to register a vehicle, apply to pay for utilities, etc.

The *TII* pillar has sustained a similar structure since 2002. Metrics regarding internet users and mobile-cellular phone subscriptions have been considered since the initial releases of the index. Given recent developments and the availability of relevant data, the "Online population" has recently been replaced with "Number of fixed broadband subscriptions per 100 people," and the "Number of television sets" in 2008 has been removed. Another change throughout the years is the replacement of "Personal computer users" with "Fixed Internet subscriptions" in 2012. Due to the advancements in communication technologies, "Fixed-telephone subscriptions" was removed in 2020. It is not an accurate representation of telecommunication infrastructure capacity since web-based alternatives are emerging nowadays.

Indicators with different weights are also something that the BRI should take into consideration. As an example, the indicator "Adult literacy rate" is weighted with a higher percentage (33.3%) compared to the other three indicators (22.2% each), which comprise the *HCI* pillar. It seems that the United Nations research team values this indicator of higher importance than others; however, a scientific justification is not provided for this action. The proposed BRI is configurable with alternative scoring mechanisms, such as weight adjustments according to blockchain community voting and user preferences, as presented in Chapter 6. The indicators considering years of schooling have been added from the 2014 version of the index onwards, while the first two indicators have been included since the initial editions.

The *OSI* score is determined by a list of questions, answerable in a binary format by staff members, volunteers, and researchers. The *OSI* score is calculated by subtracting the lowest total country score from the total score of a country and dividing the outcome by the range of total score values of all countries. For example, if Germany has a score of 118, and the lowest score of any country is 0, and the highest score is 155, then the *OSI* score for Germany is calculated as: $\frac{112-0}{155-0}$= 0.7226

There are specific challenges in reviewing a country's online presence, such as selecting the appropriate site at the national level, dealing with integrated portals, enhancing multiple websites, being able to comprehend information from various languages, and ensuring data quality. Such challenges further confirm our decision to adopt a quantitative approach towards the treatment of indicators considered by the proposed BRI. Before normalizing the three eGDI pillars, the Z-score standardization procedure is implemented for each component indicator as follows:

$$eGDI\ Indicators\ Standardisation\ Formula = \frac{score\ to\ be\ standardized - mean\ of\ the\ population}{standard\ deviation\ of\ the\ population}$$

Source: Adapted from United Nations (2020)

The eGDI score per country is then calculated by equally weighting the normalized scores of the three pillars. The figures are normalized within the (0-1) range, and country scoring is derived from the arithmetic average of the three pillars. It shall be noted that the regulatory aspect is also assessed as a part of the three dimensions in recent versions, which was not included initially.

2.2 Readiness Indexes associated with technologies embracing the 4th Industrial Revolution (Industry 4.0)

The 4th Industrial Revolution comes with several implications that can transform people's role in production, economy, and life, thereby yielding profits and efficiencies for the economy (Nina and Oksana, 2017). The recent technological progress involving exponential technologies may maximize the benefits for countries and society. National and industrial strategic decisions can be affected by the evolution of technological innovation, as discussed during two of the recent World Economic Forum annual meetings, which were named “Mastering the Fourth Industrial Revolution (World Economic Forum, 2016) and “Globalisation 4.0: Shaping a Global Architecture in the Age of the Fourth Industrial Revolution” (World Economic Forum, 2019a).

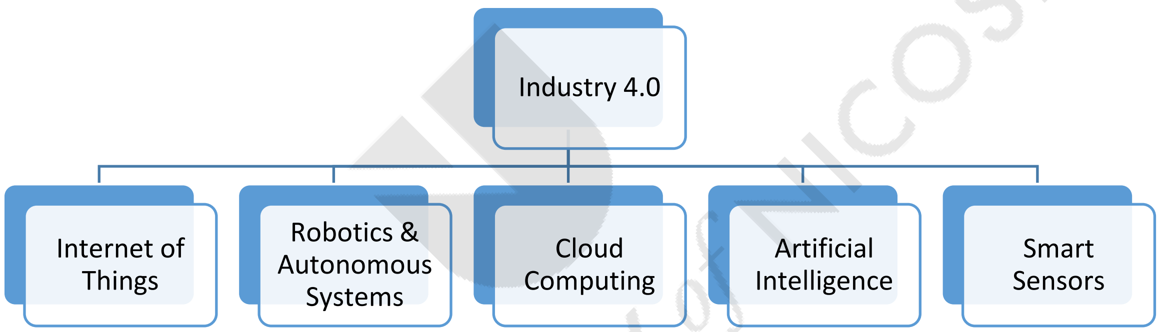
Industry 4.0 is enhancing connectivity and interaction among humans and machines, facilitating high levels of production efficiency and improvements in the quality of products, services, living standards, and environmental outcomes (Capgemini, 2018). Like the fundamentals of blockchain technology, established processes on Industry 4.0 networks can remove the need for intermediaries and aid in the digitization and automation of processes.

The combination of blockchain with Industry 4.0 technologies can be categorized as follows (Mushtaq and Haq, 2019):

- To facilitate process optimization in terms of logistics and product life cycle improvisation
- To provide a time-stamped, tamperproof platform for transaction recording purposes
- To enhance security when dealing with authentication, authorization, and identity management

Figure 2.1 indicates the potential of integrating blockchain as a decentralized network of storing and transferring data with prominent Industry 4.0 platforms such as the IoT, robotics and autonomous systems, cloud computing, artificial intelligence, and smart sensors.

Figure 2.1: Industry 4.0 technologies



Blockchain has the capability to act as the means for recording, storing, and transferring value facilitated through Industry 4.0 technologies (Carayannis *et al.*, 2021). The interaction and interconnectivity of blockchain with these technologies demonstrate its importance as a technological platform to support the applications and new business models driven by Industry 4.0. While the internet, social networking, and e-commerce were the fundamental pillars of the third industrial revolution, technologies like blockchain, artificial intelligence, and IoT are driving the disruption of Industry 4.0 applications (Capgemini, 2018).

A real-life example of a blockchain and Industry 4.0 integration originated within the supply chain industry. Supply chain management can be pretty complex as links involving various geographical locations may be included in a supply chain process, with different types of stages and payments associated with each one of them (Mushtaq and Haq, 2019). Issues related to transparency on the quality of goods supplied arise. IBM delivered a solution using blockchain combined with smart meters to monitor and record the geographic flow of shipment, product conditions under different temperatures, industry certifications, and possible delays involved in a supply chain process. In case of a malfunction, such as a delay or worsening of the product's condition, blockchain is able to facilitate remediation actions like price adjustments and/or penalties to faulty parties accordingly (IBM, 2018).

It is assumed that the association of blockchain with several Industry 4.0 technologies indicates the necessity to examine related readiness indexes deployed, which assess and compare the relevant technological engagement on a country basis. The methodological frameworks used to assess these technologies' readiness may assist in concluding certain aspects of the BRI structure.

2.2.1 The "Network Readiness Index (NRI)"

NRI assesses the preparedness of countries for the networked world in an attempt to accelerate digital transformation. The researchers of this work attempt to measure the propensity of 134 countries to exploit the opportunities offered by ICT developments to assist governments, businesses, analysts, and individual citizens in adopting the right strategies (Soumitra and Bruno, 2020).

The NRI 2020 version is the second edition of an initial model published in 2019 (Dutta *et al.*, 2019). This updated version assesses network readiness under four pillars: (a) Technology, (b) Human Development, (c) Governance and (d) Impact. The pillars consist of three sub-pillars, and each sub-pillar consists of a certain number of indicators.

The index is directly associated with the evolution of Industry 4.0, as it examines issues related to exponential technologies like artificial intelligence and IoT. Some of the critical messages portrayed in the NRI 2020 report are the attempt to contribute toward the digital transformation in a post-COVID global economy and that trust, security, and human skill are essential for digital transformation (Soumitra and Bruno, 2020).

Countries ranked in the Top 10 of the NRI (Table 2.6) are identically advanced in ICT but somewhat different in adopting Industry 4.0 technologies.

Table 2.6: NRI ranking of top 10 countries in 2020

Country	NRI Rank	NRI Score	Technology Rank	People Rank	Governance Rank	Impact Rank

Sweden	1	82.75	2	4	4	3
Denmark	2	82.19	5	1	2	5
Singapore	3	81.39	10	5	13	1
Netherlands	4	81.37	3	9	3	4
Switzerland	5	80.41	1	13	10	2
Finland	6	80.16	9	3	5	9
Norway	7	79.39	11	8	1	6
U.S.A	8	78.91	4	7	8	14
Germany	9	77.48	7	12	12	7
U.K	10	76.27	8	14	14	10

Source: Adopted from Soumitra and Bruno (2020)

Similar to other indexes examined in this chapter, the NRI pillars demonstrate the importance of assessing technological advancement, human development, governmental behaviour, and industry impact.

The team reviewing the NRI index is working annually to improve the index by including updated and/or new indicators, demonstrating the importance of obtaining relevant data to construct an index related to exponential technologies. The NRI 2020 pillars are summarised below (Soumitra and Bruno, 2020):

Pillar 1: Technology

The level of technological advancement is considered essential for a country's participation in the global economy. The following three sub-pillars have been identified for that purpose:

a) Access: The ICT level of each country, including assessment of communications infrastructure and affordability
b) Content: The type of digital technology in each country, including the applications that are developed locally
c) Future Technologies: The extent to which countries are prepared for new technology trends such as artificial intelligence and IoT

Pillar 2: People

The degree of familiarity and access to technology is considered an important pillar, as the use of ICT by the population is broken down as follows:

a) Individuals: The ways that the population uses technology and the level of skills developed to participate in the network economy
b) Businesses: The ways that businesses use technology and the level of skills developed to participate in the network economy
c) Governments: The ways that governments use and invest in ICT to improve the standards of living of the local population

Pillar 3: Governance

A country's network readiness depends on the national landscape and established processes concerning the following three sub-pillars:

a) Trust: The degree of safety to which businesses and individuals operate in the context of the network economy
b) Regulation: The degree to which a country's government provides a non-hostile regulatory environment to participate in the network economy
c) Inclusion: The gap between people that have access to the internet and those who do not have access and whether governance can be based on gender, disabilities, and socioeconomic status

Pillar 4: Impact

This pillar seeks to assess the socioeconomic and human impact of participation in the network economy within a country by dividing the assessment into three sub-pillars as follows:

a) Economy: The economic impact of participating in the network economy
b) Quality of Life: The social impact for citizens of participating in the network economy

c) Contribution towards Sustainable Development Goals: The impact of these goals can set a better future for a local society. Such goals affect the future of education, health, and the environmental landscape

NRI follows a slightly different structure than previously examined readiness indexes. The four main pillars are divided into three sub-pillars, each of which includes a number of indicators.

The indicators considered by NRI infer quantitative data values from 30 single value sources, 13 index/composite indicator sources, and 17 survey/ qualitative sources. Tables 2.7, 2.8, 2.9, and 2.10 associate each NRI sub-pillar with its indicators as derived from the relevant report (Soumitra and Bruno, 2020).

Table 2.7: "Technology" sub-pillars and indicators

Sub-pillars	Indicators
Access	• Mobile tariffs sub-index • Cost of cheapest Internet-enabled device (% of monthly GDP per capita) • The estimated proportion of households with Internet access at home (%) • Population covered by at least an LTE/WiMAX mobile network (%) • Fixed-broadband subscriptions that are equal to or above 10 Mbit/s (% of total subscriptions) • International Internet bandwidth per Internet user • The proportion of primary schools with access to the Internet for pedagogical purposes (%)
Content	• GitHub commits per 1,000 population • Wikipedia yearly page edits (per million population 15-69 years old) • Generic top-level domains (gTLDs) and country-code top-level domains (ccTLDs) per person • Number of active mobile applications developed per person

Future Technologies	• The average answer to survey questions concerning the extent to which companies adopt five types of emerging technology (Likert scale from 1 to 7) • The average answer to the question: In your country, to what extent do companies invest in emerging technologies (Likert scale from 1 to 7) • Number of applications for information and communication technology-related patents filed under the Patent Cooperation Treaty (PCT) (per million population) • Total computer software spending (% of GDP) • Number of robots in operation per 10,000 employees in the manufacturing industry

The technological advancements focused on network and internet access, mobile subscriptions and applications, and interest in new technologies shape the first pillar. Even though the methodology structure is slightly different than other methodologies reviewed in this chapter, the content of technological indicators is similar.

Table 2.8: "People" sub-pillars and indicators

Sub-pillars	Indicators
Individuals	• Individuals using the Internet (%) • Active mobile-broadband subscriptions (per 100 inhabitants) • Number of active social media users (% of the population) • Gross enrolment ratio, tertiary education (%) • Adult literacy rate (%) • The average answer to the question: In your country, to what extent does the active population

	possess sufficient digital skills (Likert scale from 1 to 7)
Businesses	• Firms with a website (% of total) • Ease of doing business index • Professionals (%) • Technicians and associate professionals (%) • The average answer to the question: In your country, to what extent do businesses make good use of the latest digital tools to sell their goods and services (e-commerce, digital payment, mobile web stores, social media stores)? (Likert scale from 1 to 7) • Gross domestic expenditure on R&D performed by the business enterprise (% of GDP)
Governments	• Government Online Service Index (one of the three components of the eGDI) • Open Data Barometer • The average answer to survey questions concerning the extent to which governments foster investment in five types of emerging technology • Gross domestic expenditure on R&D performed by government and higher education institutions (% of GDP)

The second sub-pillar attempts to measure human development from the perspective of individuals, businesses, and governments. Some indicators are identical to indicators under the first sub-pillar such as "Individuals using the Internet (%)" ("People" sub-pillar) and

"Estimated proportion of households with Internet access at home (%)" ("Technology" sub-pillar). The attention of reviewing this index is mainly dedicated to the indicators themselves rather than their categorization under sub-pillars. Similar to other indexes reviewed, the focus is also adjusted to human development competencies and skills. An important aspect to notice is the inclusion of other established indexes like the Government Online Service Index (United Nations, 2020b) and the Ease of Doing Business Index (Mundial, 2020) as indicators that contribute to the NRI rankings. Consequently, if such already established indexes can contribute content-wise to the BRI rankings, they may be included as individual indicators themselves under certain pillars.

Table 2.9: "Governance" sub-pillars and indicators

Sub-pillars	Indicators
Trust	• Secure Internet servers (per million population) • Global Cybersecurity Index • People who used a mobile phone or the Internet to access a financial institution account in the past year (% with a financial institution account, age 15+) • People who used the Internet to buy something online in the past year (%)
Regulation	• Regulatory quality indicator • ICT Regulatory Tracker • The average answer to survey questions concerning the extent to which the legal framework is adapting to five types of emerging technology (Likert scale from 1 to 7) • Global Cyberlaw Tracker • The average answer to the question: What is the legal framework to protect Internet users' privacy and data stipulate? (Likert scale from 0 to 7)
Inclusion	• E-Participation Index

	• Difference between rich and poor income groups that made or received digital payments in the past year (% age 15+) • The average answer to the question: In your country, to what extent are Internet content and services tailored to the local population (e.g., in the local language, meeting local demand)? (Likert scale from 1 to 7) • Difference between the female and male population in using the Internet • Difference between the rural population and the total population that made or received digital payments in the past year (% age 15+)

The indicators of the third sub-pillar involve regulatory assessment and financial inclusion statistics, mainly sourced from World Bank studies (Demirguc-Kunt et al., 2017). Examples of these indicators are "Secure Internet servers (per million population)," "Regulatory Quality Indicator," and "Difference between rich and poor income groups that made or received digital payments in the past year (% age 15+)". The gathering of sources is implemented via statistical data and surveys that are converted into numerical indices.

Table 2.10: "Impact" sub-pillars and indicators

Sub-pillars	**Indicators**
Economy	• The proportion of medium- and high-tech industry value added in total value-added • High-technology manufactured exports (% of total exports of manufactured goods) • Number of applications filed under the Patent Cooperation Treaty (PCT) (per million population) • Labour productivity per person employed (2019 US$)

	• The average answer to the question: To what extent is the online gig economy prevalent in your country? (Likert scale from 1 to 7)
Quality of life	• "Happiness score" (from "The Gallup World Poll" (Helliwell *et al.*, 2020)) • "Freedom to make life choices" score (from "The Gallup World Poll" (Helliwell *et al.*, 2020)) • Gini index for income inequality • Healthy life expectancy at birth (years)
Sustainable Development Goals contribution	• Universal health coverage Index • PISA average scores in mathematics • Gender Development Index • Energy intensity • Urban safety and sustainability

The timing of gathered information can be critical in obtaining a fair assessment of countries; therefore, some potentially outdated indicators like "Energy Intensity" and "Urban safety and sustainability," which represent statistics from 2016, are excluded from the BRI assessment.

The NRI 2020 report (Soumitra and Bruno, 2020), besides from the final country rankings, also involves other analytical rankings which can be helpful toward strategy implementation, such as:

- Country rankings for each pillar
- Country rankings for each sub-pillar
- Country rankings for each indicator
- Rankings of each continent (pillar-level performances)
- Analytical country profiles

These data may assist in drawing conclusions and assessing several topics that ultimately define network readiness per country.

An indicator is considered for the NRI rankings if it provides information for at least half of all countries included in the final NRI list of countries. For a country to qualify for the final NRI list, availability of information is needed for at least:

a) 70% of all indicators
b) 40% for each sub-pillar

Missing values are not taken into consideration when computing the country scores. Certain outliers are identified and removed before normalization occurs, where skewness more significant than two and kurtosis greater than 3.5 is found in more than four outliers (Groeneveld and Meeden, 1984).

A min-max normalization approach within the (0-100) range is applied in order to make indicators comparable for data aggregation. A higher score represents a higher value of a country's network readiness. The Positive Normalisation Formula is used for indicators representing a positive outcome if values are high, which applies to most indicators.

$$Positive\ Normalisation\ Formula = 100 * (value - \min)/(max - \min)$$

The Reverse Normalisation Formula displays the formula used for indicators that represent a positive outcome if values are low, which applies to two indicators; 1) "Income Inequality" and 2) "Urban Safety and Sustainability" (using variables on pollution and road safety to derive a score).

$$Reverse\ Normalisation\ Formula = \mathbf{100} * (\boldsymbol{max} - \boldsymbol{value})/(\boldsymbol{max} - \boldsymbol{min})$$

Source: (Soumitra and Bruno, 2020)

The computation of the NRI country score is based on the arithmetic mean of indicators, sub-pillars, and pillars. Weight adjustments are not taken into consideration. This may imply a reasonably simple but not sophisticated method of obtaining an accurate scoring mechanism of a country's network readiness. As mentioned in section 2.1.2, which describes the methodology portrayed in the "A Framework for Measuring National e-Readiness" study (Bui, Sankaran, and Sebastian, 2003), the scientific formula is structured to compare two entities that can be used for measuring readiness in a national level.

Prof. Bruno Lanvin, who is among the contributors to the NRI research, outlines in the "Preface" section of the annual report (Soumitra and Bruno, 2020) that the critical and central issue addressed by NRI is the following: "How will the various relevant stakeholders (governments, business, and citizens) cooperate (and/ or compete) to fully leverage the possibilities offered by technological innovation to tackle current and upcoming challenges?". The contributor's view is that information derived from evidence about the network readiness of countries can lead to the identification of opportunities and threads, thereby assisting toward successful and sustainable global digital transformation.

The evaluation of the NRI structure and methodology in regard to obtaining assumptions for this research is summarised via the following points:

1. **Pillars and sub-pillars structure**: The NRI is structured on three levels due to the multi-dimensional concept of network readiness. The first level consists of four fundamental pillars representing the dimensions of network readiness: Technology, People, Governance, and Impact. The second level is formed when these four pillars are divided into three sub-pillars. The individual indicators are disseminated among these sub-pillars to form the final level of the NRI structure. The concept of examining network readiness per country has been evolving since the early 2000s (Kirkman, Osorio, and Sachs, 2002).
2. **Focus on indicators**: The review of the NRI study is implemented both to assess the structure as well as the indicators used to obtain the rankings. Specific indicators focusing on regulatory, human development, technological advancement, and industry engagement are included in NRI, and other similar indexes examined. Likewise, some previously established indexes act as indicators for NRI rankings.
3. **Acknowledgment of limitations**: The main areas of improvement are the following:
    a. NRI is not achieving the standard of establishing a scientific equation to derive NRI rankings, as it focuses on aggregating the arithmetic mean of pillars, sub-pillars, and indicators. The need to use a scientific formula to compare many entities has been highlighted in the paper evaluated in section 2.1.2, "A Framework for Measuring National e-Readiness" (Bui, Sankaran, and Sebastian, 2003).
    b. As explained, the NRI research team has applied specific qualification threshold criteria for countries to be included in the NRI rankings. The assumption is that a global index of any kind shall attempt to include as many countries as possible to assist in the decision-making and awareness of the related field worldwide. It has been proven that indexes examining exponential technologies, like the Government AI Readiness Index 2020 (Oxford Insights, 2020), can provide rankings for more than 170 countries worldwide.

2.2.2 The "Autonomous Vehicles Readiness Index (AVRI)"

AVRI is proposed for assessing the level of preparedness of countries and cities to adopt autonomous vehicles (e.g., cars, buses, and trucks). The index is considering data from 28 indicators referred to as "measures." According to the AVRI report, the index findings are addressed to assist in the decision-making of public and private sector organizations operating in road transport and infrastructure. The report includes an assessment and profile presentation of 30 countries and five cities, whereas rankings are displayed only at a country level.

The term "Autonomous Vehicles" is defined in the report as the technology used by vehicles to operate without human intervention in a "self-driving" condition for the driver, who ultimately becomes the passenger. Both blockchain technology and autonomous vehicle technology are considered integral innovations within Industry 4.0 (Capgemini, 2018). Evaluating an index which considers a recent technology that belongs to the same industrial revolution era as blockchain technology, may lead to valuable conclusions as to what aspects shall be considered to construct the final version of the BRI.

Several use cases and publications indicate the relationship between blockchain and autonomous vehicles on a technological level. Blockchains like Ethereum can settle contracts and transactions within the transportation ecosystem and integrate an algorithm that can guarantee energy recharges' execution (Ranchal-Pedrosa and Pau, 2018). As autonomous vehicles may rely on smart devices to obtain and process information to execute specific actions, such as driving within the speed limit, blockchain may be the platform to provide security from malicious parties trying to compromise smart devices and issue fake requests (Rathee *et al.*, 2019). Additionally, a proposal of a consortium blockchain consisting of autonomous vehicle manufacturers/distributors is assessed to provide authenticity and integrity of firmware updates by operating within a credit reputation blockchain reward system (Baza *et al.*, 2018). Participants within a permissioned blockchain can enter into a liability attribution model. According to data derived from the embedded sensors, a collision event may be settled automatically between auto manufacturers, service technicians, and the vehicle owner (Oham *et al.*, 2018). Combining the two technologies can also assess real-time traffic information and ensure faster transportation to users (Saranti, Chondrogianni, and Karatzas, 2018).

Considering the close relationship between the fundamentals of blockchain and autonomous vehicles, the period of development maturity and implementation challenges seem like the common current path for both technologies. Like other technological and Industry 4.0 indexes, the AVRI ranks countries like Singapore, Netherlands, U.S.A, and Norway at the top of the readiness list. A review of AVRI focuses on the indicators taken into consideration and the ranking mechanism used.

Countries and cities are assessed via 28 indicators categorized under four pillars: (a) Policy and Legislation, (b) Technology and Innovation, (c) Infrastructure, and (d) Consumer Acceptance. These four pillars are identical in nature and notion to the pillars used in other indexes reviewed in this chapter. Regulation, technological advancement, human involvement, and industry infrastructure are main focus areas.

It is conceivable that the repetitive indication of pillar structuring in various technological indexes signals this research's framework when structuring readiness indexes. Indicator scores are sourced from publicly available data sources e.g., statistics, press releases, and media reports. Detailed scores of pillars and indicators are displayed within the AVRI report. The theme of pillar structuring is guiding the framework for this research for the proposed BRI.

Table 2.11 demonstrates the association of pillars and indicators of the AVRI (KPMG, 2020).

Table 2.11: AVRI pillars and indicators (or "measures")

Pillars	Indicators (or "Measures")
Policy and Legislation	• AV Regulations (Likert scale from 1 to 7) • Government-funded AV Pilots (Likert scale from 1 to 7) • AV-focused agency (Likert scale from 1 to 7) • The future orientation of government • The efficiency of the legal system in challenging regulations • Government readiness for change • Data-sharing environment
Technology and Innovation	• Industry partnerships • AV technology firm headquarters • AV-related patents

	• Industry investments in AV • Availability of the latest technologies • Innovation capability • Cybersecurity • Assessment of cloud computing, AI, and IoT • Market share of electric cars
Infrastructure	• Electric vehicle charging stations • 4G coverage • Quality of roads • Technology infrastructure change readiness • Mobile connection speed • Broadband
Consumer Acceptance	• Population living near test areas • Civil society technology use • Consumer ICT adoption • Digital skills • Individual readiness • Online ride-hailing market penetration

The "Policy and Legislation" pillar includes an assessment of seven (7) equally weighted indicators examining governmental measures, actions, and plans to adopt the technology. According to the report, setting up the appropriate regulatory landscape is a significant tool for allowing technology development. The three (3) indicators assessed via the Likert scale are scored according to a review of government regulations, press releases, and media articles. For example, countries like Australia, Singapore, and the Netherlands receive high scores because of enhancing supportive autonomous vehicle regulation with minimal restrictions. The opposite occurs in countries with regulatory restrictions, such as India and Mexico. The same approach occurs when a government provides technological guidance through a single knowledgeable point of contact. Countries like Singapore and Hungary that adopt this method score higher than countries that do not prioritize technology. The "Government readiness for change" indicator has been sourced from the "Change Readiness Index" (KPMG, 2019b). The World Economic Forum's "Global Competitiveness Index" (World Economic Forum, 2019) is the source for the indicators "Future orientation of government" and "Efficiency of the legal system in challenging regulations," while the Open Data Barometer 4th Edition (Open Data Barometer, 2017) is included for the "Data-sharing environment" indicator. The method of using established indexes as indicators has been applied in previously reviewed indexes like the NRI (Soumitra and Bruno, 2020).

The "Technology and Innovation" pillar consists of nine (9) indicators, among which some of them assess the advancement of Industry 4.0 technologies like artificial intelligence and cloud computing. Sources indicating market trends and statistics (Topio Networks, 2020) (Crunchbase Pro, 2020) are used to score indicators related to headquarters, investments, and patents per country. Specific indicators like "Availability of the latest technologies" and "Cybersecurity" are adopted from previously published indexes, specifically the Global Competitiveness Index (World Economic Forum, 2019) and the Global Cybersecurity Index (ITU, 2019). "Market share of electric cars" is sourced from an online source conducting relevant research (EVVolumes.com, 2020). Such types of sources can be used to derive blockchain-related data, including locations of Bitcoin and Crypto ATMs.

The third pillar assesses infrastructure and access to autonomous vehicles via six indicators. Out of the six indicators, two of them ("Mobile Connection Speed" and "Broadband") carry half the weighting of the other four without providing a scientific explanation for this adjustment. An added value of the BRI compared to prior established indexes is that weights can be adjusted accordingly to the interests of the user.

Human experience and adoption are considered equally. Measurements are adjusted to reflect a country's population proportions to enhance fairness in the index. The inclusion of ICT and technological knowledge is a feature that is found in several indexes reviewed in this chapter. This observation signals the importance of technological knowledge when engaging with Industry 4.0 technologies.

The ranking mechanism works similarly to the ranking mechanism proposed by the NRI. More specifically, the min-max method is used to normalize indicator scores in the range of 0-1 (whereas the range of 0-100 is used in NRI). The minimum value is subtracted and divided by the range of the indicator values, as shown by the AVRI Normalisation Formula. The highest the score, the higher the readiness of each country in terms of autonomous vehicle engagement.

$$AVRI\ Normalisation\ Formula = (value - min)/(max - min)$$

Each indicator is weighted equally to derive an aggregate score for each pillar. The only exception is the indicators “Mobile Connection Speed” and “Broadband,” which carry half of the weight of the other 26 indicators. Each pillar is weighted equally; therefore, the scores of each of the four pillars are combined to derive the aggregate score of the country.

Source: (KPMG, 2020)

AVRI’s assessment of the autonomous vehicles landscape resembles, to a decent extent, the depth to which the BRI can currently dive and assess the blockchain ecosystem, since both technologies are considered exponential and a part of the 4th Industrial Revolution (Mushtaq and Haq, 2019). Autonomous vehicles and blockchain technology are two technologies that belong to the Industry 4.0 evolution and experience a similar maturity lifecycle (Capgemini, 2018). The additional takeaways derived from reviewing AVRI’s methodology can be summarised as follows:

1. **Assessments of cities**: Many notable developments in the autonomous vehicle's ecosystem occur at a local level, i.e., in cities and states. AVRI displays the technological advances in 5 local regions; Beijing, Detroit, Helsinki, Pittsburgh, and Seoul. Even though these cities are not scored or ranked like countries included in this index, this feature might indicate that future developments in Industry 4.0 technologies could occur at a municipal or state level on top of the national level advancements we are currently witnessing.
2. **Acknowledgment of limitations**: The areas of improvement mainly relate to the methodology used to derive country rankings and the treatment of regulatory indicators.
    a. Converting regulatory data into numerical indices might pose one of the biggest challenges in constructing a technological index like AVRI and the BRI. AVRI approaches this challenge by scoring regulatory indicators like “AV regulations” and “Government-funded AV pilots” on a Likert scale by reviewing press releases, regulations, and media articles. It is assumed that these methods might better assess regulatory scoring rather than producing the scores.
    b. The strategy for assigning weights on indicators is also a challenge to consider when developing a readiness index. While most indexes consider indicators with equal weights, any adjustment like the one implemented in the AVRI (half weighting of two “Infrastructure” indicators) must be justified accordingly.

c. Unlike eGDI and NRI, which consider most countries, AVRI considers a set of 30 countries in the rankings. This is due to the lack of available information for the indicators that relate to Industry 4.0 technologies. It is assumed that the development of a global index shall address the majority of the countries worldwide.

2.2.3 The "Automation Readiness Index (ARI)"

The likelihood of intelligent technologies like machine learning, artificial intelligence, and robotics automating tasks and procedures currently performed by humans is becoming more probable with Industry 4.0 (Dalenogare et al., 2018). ARI measures and compares the preparedness of 25 countries for the age of intelligent automation, as a number of them are in the race to integrate automation into their local operations both in the public and private sectors (EIU and The Economist Intelligence Unit, 2018). According to the ARI report, the expected acceleration of the technology in the coming years signals the need for governments to adopt adequate policies to assist local parties in grasping the opportunities this technology provides. Such policies may also diminish the negative impacts of automation advancement, which is expected to cause workforce displacement and unemployment in some industries (Schulte and Howard, 2019).

ARI uses 52 indicators to provide rankings and insights for the future of the automation landscape to highlight the need for governmental policies to develop in the context of innovation, education, and human development. Similar to the blockchain landscape, there has not been evidence of the satisfactory level of policies imposed globally, according to the ARI report (EIU and The Economist Intelligence Unit, 2018). The report's findings outline that even top-rated countries like Germany, South Korea, and Singapore are not sufficiently ready for the automation age. Only few countries have been assessing the impact of this technology and prepare the workforce for the future working environment. Some countries have implemented projects in areas such as lifelong learning, training, and workplace adoption to new circumstances. It may be probable that the development of the ARI through the years could assist governments and the industry in the identical way that the BRI aims to do, focusing on the establishment of policies and strategic decision-making.

The term "automation" possess a vital part of Industry 4.0 processes. Industry 4.0 facilitates the automation of processes to achieve the ideal optimization of value chains in various industries (Kolberg and Zühlke, 2015). Blockchain networks can assist in the optimization of value chains and form an integral part of the overall process in the era of digitalization (Babkin *et al.*, 2018). “Automation” and “Blockchain” are closely related fields and interdependent in many use cases involving property (Devi *et al.*, 2020), IT processes (Mohammad, 2020), and the finance industry (Jaheezuddin *et al.*, 2020). Therefore, the assessment of ARI might add value to this thesis's literature review aspect.

The countries assessed include G20 countries and five more countries representing different development levels, namely *Estonia, Singapore, Vietnam, Colombia*, and *the UAE*. The assessment emphasizes the efforts to endorse technological processes, the emergence of the relevant industry, and human development. The indicators structure is associated with three pillars (referred to as “categories”) as follows (EIU and The Economist Intelligence Unit, 2018):

Pillar 1: Innovation Environment

a) Research and Innovation: Research and development on Industry 4.0 technologies, governmental support, and regulatory environment
b) Infrastructure: Policies to address connectivity and access to the technology
c) Ethics and Safety: Technology ethics and safety initiatives, processes, and cybersecurity

Pillar 2: Education Policies

a) Primary education: Early education programs, skills, and data literacy
b) Post-compulsory education: Technology education programs and access to education policies
c) Continuous education: Lifelong learning, career guidance programs, and employment skills development
d) Learning environment: Use of artificial intelligence in education, innovative schools models such as school autonomy, and social interaction between instructors and the industry

Pillar 3: Labour Market Policies

a) Knowledge of automation: Government-driven research and sharing of information regarding relevant opportunities with the public

b) Workforce transition programs: Programmes for the development of jobs on automation and adoption of technology in the public and private sector

The three pillars are divided into sub-pillars (referred to as “sub-categories”), with each one of them containing a number of indicators. The structure of the ARI pillars, sub-pillars, and indicators is identical to the respective structure reviewed of the NRI, reviewed in section 2.2.1. It seems that when a relatively high number of indicators are considered to derive country scores, a middle-level of sub-pillars (or sub-categories in this case) is added to support categorization. The focus should shift towards achieving indicators' relevancy and accuracy rather than quantity when constructing a readiness index(Choucri, Maugis and Madnick, 2003). As a result, the mid-level sub-pillar component does not seem essential to be included within the structure. The purpose of reviewing ARI is shifted toward the content of the indicators and the features examined.

The 52 ARI indicators, which industry experts determined, are mainly obtained from publicly available sources. Tables 2.12, 2.13, and 2.14 associate each ARI sub-pillar (sub-category) with its indicators that were adopted from the related report (EIU and The Economist Intelligence Unit, 2018). “Innovation Environment” and “Education Policies” pillars are weighted at 40% each, while the “Labour Market Policies” pillar is weighted at 20% towards the overall ARI rankings.

Table 2.12: “Innovation Environment” sub-pillars and indicators (40% weight on ARI rankings)

Sub-pillars (or “sub-categories”)	Indicators
Financing (10%)	• Public funds dedicated to research and development on robotics, automation, and artificial intelligence (25%) • Research and development spending (as % of GDP) (50%) • Government policies to facilitate private investment in research and development (25%)
Policies and Regulation (10%)	• Initiatives encouraging entrepreneurship (25%) • The average number of days to start a business (25%)

	• Quality of insolvency network (25%) • The extent to which the cultural and social landscape is encouraging entrepreneurship (25%)
Knowledge Transfer (10%)	• Research and innovation platforms (50%) • National schemes dedicated to attracting international experts to the fields of science, technology, engineering, and mathematics (50%)
Technology Adoption (10%)	• Policies supporting technology adoption by SMEs (25%) • Policies supporting technology adoption by the government (25%) • E-Government Development Index (50%)
Start-up Support (10%)	• National start-up support programs (50%) • Public funds to support start-ups (50%)
Broadband (10%)	• National strategies supporting internet use (33.3%) • Internet usage over the last five years (33.3%) • National strategies to increase internet speed (33.3%)
Clusters (10%)	• Cluster development programs (33.3%) • The average score of the top three universities according to the QS World University Rankings (66.7%)
Ethics Boards (10%)	• Ethics boards addressing ethics on technology, artificial intelligence, and automation (50%) • Cybersecurity strategies (50%)
Data Protection (10%)	• Data protection laws (50%) • Enforcement of data protection laws (50%)

Use by the Population (10%)	• Campaigns to raise awareness for the safe use of the internet, robotics, and artificial intelligence (100%)

The first ARI pillar aims to capture the prosperity of the automation landscape in terms of national policies, strategies, and regulations established to support adoption and awareness throughout the economy. These actions, which derive from a governmental level, can boost a local ecosystem towards adopting new technology and indicate the competitiveness of the environment. Local participants are often concerned regarding the use of a new disruptive technology in their industry; however, the pillar rankings indicate that some countries like Japan, South Korea, and Germany are starting to adopt Industry 4.0 technologies and plan for future implementations within a dynamic environment, in order to avoid being outpaced by competitors. 3 out of 4 business executives plan to integrate artificial intelligence into their internal processes within three years (Talwar and Koury, 2017).

The indicators included in the first pillar are primarily sourced from surveys conducted with governmental authorities; therefore, it is challenging to produce a scientifically accurate score. Quantitative data obtained are often more precise than data sourced from qualitative research (Winter, 2000).

Table 2.13: "Education Policies" sub-pillars and indicators (40% weight on ARI rankings)

Sub-pillars (or "sub-categories")	**Indicators**
Development of Childhood (5.6%)	• Education and development strategies for children (100%)
Modern Skills and Education (11.1%)	• Strategies focusing on the development of 21st century skills and knowledge in compulsory education (50%) • Inclusion of 21st century skills in the current curriculum (50%)

Technical Skills and Knowledge (5.6%)	• Strategies focusing on the development of digital skills and knowledge in compulsory education (50%) • Inclusion of digital skills in the current curriculum (50%)
Career Counselling (5.6%)	• Career guidance services in secondary education (100%)
Science, Technology, Engineering, and Mathematics (STEM) (11.1%)	• STEM presence in higher education (100%)
Access (5.6%)	• Policies supporting increased access to tertiary education (100%)
Continuous Education (11.1%)	• Programs for lifelong learning (50%) • Financial support towards lifelong learning (50%)
Assessment Reform (11.1%)	• Assessment of 21st century skills and knowledge in compulsory education (100%)
Training of Instructors (11.1%)	• The degree of training instructors have in order to teach future skills (100%)
Use of Technology in Education (5.6%)	• The degree to which technology is used in classrooms in compulsory education (50%) • Use of data and analytics to improve assessment methods in compulsory education (50%)
Innovation in Curriculum (10%)	• The degree to which schools obtain autonomy to design innovative curricula (100%)
Social Dialogue (10%)	• Degree of interaction between the public and private sectors to innovate the education system (100%)

According to the ARI report (EIU and The Economist Intelligence Unit, 2018), *South Korea, Estonia,* and *Singapore* are attempting to innovate training methods and assessment techniques, emphasizing the need to adapt curricula dedicated to soft skills. The second pillar ranks countries, considering their educational strategy and programs implemented to face with the upcoming opportunities and challenges presented by the emergence of automation. Training in technical and digital skills, including the topics of artificial intelligence and robotics, is a significant area of discussion among education stakeholders (Kandlhofer *et al.*, 2019).

This pillar assesses how the human development aspect and governmental strategies embrace and adapt to emerging technologies requirements. This aspect can be a challenge even for the world's most developed countries. A high degree of collaboration between the public and private sectors is needed to exploit the real opportunities emerging from such technologies. It is considered that an identical form of thought shall be adopted to assess the country's blockchain readiness landscape, assessing governmental and industrial blockchain engagement.

Specific qualitative indicators like "Social Dialogue," "Innovation in Curriculum," "Career Counselling" and any other form of assessing successful governmental policies and strategies are very challenging to be assessed and expressed into numerical indices.

Table 2.14: "Labour Market Policies" sub-pillars and indicators (20% weight on ARI rankings)

Sub-pillars (or "sub-categories")	**Indicators**
Research and Policymaking (12.5%)	• Research conducted by the governments to assess the impact of artificial intelligence, automation, and robotics (50%) • Interaction between the government and industry stakeholders on the impact of emerging technologies (50%)
Vocational Training (12.5%)	• Presence of Dual Vocational Education and Training (VET) systems (50%) • Improvements in VET systems (50%)

University to Workforce Transition (12.5%)	• Programs dedicated to engaging university students on work experience and internships (100%)
Retraining of Workforce (12.5%)	• Retraining programs for displaced workers (100%)
Workplace Transitions (12.5%)	• Programs dedicated to human capital development (100%)
Public Employment Services (PES) (12.5%)	• Existence of a PES institution (50%) • Existence of a PES tool indicating occupational trends and job demand to the population (50%)
Cooperation between Academia, Industry, and the Labour (12.5%)	• Existence of platforms for a dialogue between the industry and the labor market (50%) • Existence of platforms for dialogue between universities and the labor market (50%)
Relevant Regulations (12.5%)	• Existence of a national review for new trends in employment and the future of workspace (100%)

The widespread adoption of automation, artificial intelligence, and robotics requires a skilled workforce to perform such tasks. The third ARI pillar assesses the transition from training to new forms of employment. This pillar assesses whether countries host a pool of digitally engaged labor, enabling them to occur a competitive advantage towards embracing the opportunities and facing the challenges incurred by the rise of Industry 4.0 technologies. ARI attempts to examine the local engagement of Industry 4.0 technologies; however, the relevant indicators are split among the last two pillars and often carry varying weights, e.g., the sub-pillars "Training of Instructors" and "Retraining of Workforce." As a result, some indicators are assessing the same area of examination but are included in a separate pillar and are weighted differently, which may seem inappropriate.

The third pillar is half-weighted compared to the first two pillars, without a justifiable explanation that supports this approach. Despite this circumstance, some indicators which may not seem highly significant to the subject are weighted by a substantial proportion. For example, the indicator “Programmes dedicated to engaging university students on work experience and internships” is weighted at a higher overall range than the indicator “Public funds dedicated to research and development on robotics, automation and artificial intelligence,” which seems more relevant to the index concept (2.5% against 1% of the total ARI country scores).

The formula for computing scores in the ARI is similar to the other indexes examined in this chapter, but the indicators' weighting is quite different. To construct the final scores, weighting and combining scores of pillars and indicators are implemented, as outlined in tables 2.12, 2.13, and 2.14. The scores are normalized on a scale of 0-100, similar to the NRI normalization scale.

$$ARI\ Normalisation\ Formula = 100 * (value - \min)/(max - \min)$$

This normalization formula is used for most indexes in the literature.

The ARI sub-pillars and indicator weights are manually assigned according to the researchers’ decisions regarding their relevant importance. No further scientific explanation is provided for this decision based on a formula, literature review, or survey statistics.

According to the ARI report, a number of participants are required to adopt a robust policy response to opportunities and threads of intelligent automation. There is limited engagement in this aspect, mostly from inadequacies in digital skills, expertise, and strategies. The conclusions derived from reviewing the ARI research are the following:

1. **Most indicators are qualitative**: The researchers preferred to examine a high number of indicators rather than focusing on the numerical accuracy of the factors taken into consideration. Fifty-two indicators were scored for the purposes of the ARI, with 45 of them based on qualitative research that attempts to assess areas with limited information previously known on a country basis. The assessment of these qualitative indicators included national policies, programs, and initiatives, based on official and publicly available sources, which can be challenging to be scored precisely within a numerical context. The value of these indications was evaluated by interviews with more than 80 experts, including local parties like academics, entrepreneurs, policymakers, and consultants. ARI included only seven quantitative indicators derived from numerical data, mainly sourced from previous studies by prominent organizations like the United Nations and the World Bank.

2. **Acknowledgment of limitations**: Besides the limitations already discussed within this section, the researchers recognize that the methodology used for constructing the ARI comprises a number of limitations.
    a. The qualitative indicators were mainly based on the assessment of policies and programs adopted by governments. The researchers acknowledge that such a national-level assessment is challenging due to the lack of access to some resources, so the examination was implemented in cities and/or metropolitan areas for a number of indicators. As a result, specific scores may not accurately reflect the landscape on a country level. An example of this limitation is the education-focused indicators that are challenging to assess numerically and on a wide scale.
    b. Qualitative indicators examining the launch of national policies and programs actually represent the government's willingness toward a particular direction. Still, they cannot be considered an index for the measurement and quality of these initiatives.
    c. The researchers acknowledge that the landscape of Industry 4.0 technologies is experiencing continuous developments. Still, the latest examination was implemented during the second half of 2017, with the last index being launched in 2018.
    d. The selection of indicators is a combination effort of literature examination and consultations by experts. Still, it is assumed that not all critical factors related to intelligent automation have been addressed due to the complexity of the landscape.
    e. The quantitative indicators are sourced from the latest available data, which may not derive from an identical time frame.

2.3 Readiness Indexes associated with Blockchain and Distributed Ledger Technology (DLT)

The readiness indexes examined in this chapter are technologically oriented and address the engagement of new technological innovations per country. The methodology used in each index mentioned above is similar in certain aspects, like the normalization methods adopted. Still, they may differ in other aspects, such as the treatment of indicator weights and pillar allocation.

There is a need to shift focus towards indexes oriented within the blockchain and DLT landscape to understand the focus areas of such studies and the methodology to indicate national engagement on a global scale. This need derives from national and regional efforts to establish local blockchain hubs (Papadaki and Karamitsos, 2021). As discussed in Chapter 1, since blockchain is still maturing as a disruptive technology there is limited literature considering blockchain-related indexes. However, sections 2.3.1, 2.3.2, and 2.3.3 discuss initial attempts towards constructing such indexes. As described throughout the literature review, estimating a numerical score for national regulatory stances is among the main challenges. This estimation is usually conducted based on a manual process most that requires consultation of legal experts using some scoring scheme.

One example is the "Distributed Ledger Technology and Cryptocurrency Market Potential Index" (CMPI) (Nguyen and Jeong-Hun, 2020). The terms "Distributed Ledger Technology" and "Blockchain" are often associated, and some researchers assume that the two terms can be used interchangeably (Sok, 2016). In technical terms, DLT is a generic terms used to refer to a distributed architecture enhancing that records data in some data structure (e.g., graph data structure) in a decentralized way, ensuring integrity through consensus-based validation protocols and cryptographic signatures (Rauchs et al., 2018). Blockchain can be considered a type of a DLT were data are stored in a data structure that is based on a chains of blocks, which are cryptographically linked to each other in order to timestamp data. It is argued that the two terms are scientifically and technically related; therefore, indexes including "Distributed Ledger Technology" within their content are considered relevant.

2.3.1 The "Bitcoin Market Potential Index" (BMPI)

The significance and paradigm set by Bitcoin are extensively discussed in Chapter 1, as it represents the first and most popular use-case of blockchain technology (Zhao, Fan, and Yan, 2016). BMPI (Hileman, 2015) is one of the first indexes launched to address the potential use of Bitcoin globally in order to understand which countries are most likely to embrace the adoption of Bitcoin. It is assumed that the direct relationship between the two terms enables the review of the BMPI as a helpful index for identifying areas of prior assessment and its potential gaps in the field.

BMPI utilizes a set of 40 indicators (referred to as "variables") to rank the use and potential of Bitcoin in 178 countries. The indicators are related to the assessment of Bitcoin as a store of value, medium of exchange, and technological platform. Some indicators are divided into "sub-variables," as shown in Table 2.15.

The indicators are allocated into the seven equally weighted pillars (referred to as "sub-indices"): (a) Technology Penetration, (b) International Remittances, (c) Inflation, (d) Informal Economy, (d) Financial Repression, (e) Historical Financial Crises, (g) Bitcoin Penetration. The derivation of the index considers indicators which could be considered relevant to the adoption of Bitcoin globally, using several sources from private organizations, governmental input, academic research, and multinational agencies.

Table 2.15 demonstrates the BMPI framework constructed to categorize pillars and indicators (Hileman, 2015).

Table 2.15: BMPI pillars (sub-indices) and indicators (variables)

Pillars (or "sub-indices")	Indicators (or "variables")
Technology Penetration	• Internet users per 100 people • Mobile subscription per 100 people • Access to fixed broadband internet per 100 people

International Remittances	• Average remittance fee as a receiving country
	• Personal Remittances
	    ○ Received remittances in monetary funds
	    ○ Received remittances as a % of GDP

Inflation	• Inflation in consumer prices (%)
Informal Economy	• The black market as a % of the total economy
Financial Repression	• Controls on the use of domestic economy • Control on the use of foreign exchange among residents • Controls on trade in gold • Local accounts in domestic currency convertible into foreign currency • Controls on exports and imports of banknotes • Surrender requirements for exports • Repatriation requirements on capital transactions

	• Surrender requirements on capital transactions
	• Controls on real estate transactions - Purchase abroad by residents
	• Controls on the number of personal capital transactions
	• Transfer of assets abroad by emigrants
	• Transfer of assets into the country by immigrants
	• Financial sector repression
	  ○ Borrowing abroad
	  ○ Maintenance of accounts abroad
	  ○ Lending locally in foreign exchange
	  ○ Purchase of locally issued securities denominated in foreign exchange
	  ○ Insurance companies - Limits (max.) on investment portfolios held abroad
	  ○ Pension funds – Maximum limit on investment portfolio held abroad
	  ○ Investment firms and collective investment funds – Maximum limit on investment portfolio held abroad

Historical Financial Crises	• Number of years of hyperinflation since 1980
	• Number of years of currency crises since 1980
	• Number of years of inflation since 1980
	• Other crises
	  ○ Number of years of external default since 1980
	  ○ Number of years of domestic default since 1980
	  ○ Number of years of banking crises since 1980

Bitcoin Penetration	• Global Bitcoin nodes
	  ○ Total nodes
	  ○ Nodes per capita

	• Bitcoin software client downloads
	  ○ Total client downloads
	  ○ Client downloads per capita
	• Google search rate for the word "bitcoin."
	• Bitcoin venture capital investments per country

BMPI pillars are equally weighted towards the calculation of the final BMPI score. The indicators are aggregated to provide a score for each pillar. As demonstrated in Table 2.15, there is a certain number of sub-variables that are aggregated to provide the score for a single indicator. Some indicators have been selected which may be outdated, such as the indicators comprising the "Financial Crises" pillar, which is based on sources in 2010 (Reinhart and Rogoff, 2010), and black market percentage, which is based on sources in 2012 (Elgin and Öztunali, 2012).

BMPI values the degree of international remittances and black market activity as compelling use cases for the adoption of Bitcoin. The reasoning is that the Bitcoin network may act as a remittance alternative (Böhme *et al.*, 2015) and has initially gained momentum as a mechanism for illegal activities (Christin, 2012). Relevant factors contributing towards Bitcoin adoption include the indicators allocated in the "Bitcoin Penetration" pillar.

For a blockchain-related index, certain aspects must be additionally included (to be discussed in Chapter 3) which directed towards the readiness of the technology as a whole rather than just the adoption of Bitcoin, which represents a single application of the technology.

BMPI utilizes two methods to derive country scores, with each one of them providing slightly different rankings. The first method involves *standardization*, and the second method is identical to the previously examined *normalization* approaches on a scale from 0 to 1.

$$BMPI\ Standardisation\ Formula = \frac{value - \text{average of all sample data values}}{standard\ deviation\ of\ the\ whole\ sample}$$

$$BMPI\ Normalisation\ Formula = (value - \min)/(max - \min)$$

The top three countries were ranked in the same order via both methods. Argentina, Venezuela, and Zimbabwe were ranked in the top spots of this index (developed in 2015). The recent developments indicate that these countries are not widely considered the top in terms of Bitcoin adoption, as developed regions have been more engaged in the field (Parino, Beiró, and Gauvin, 2018). This misjudgement in the BMPI rankings may be the equal weighting of pillars that may not have equal significance in terms of Bitcoin adoption, such as "Technology Penetration" and "Inflation." Technological advancement can be considered more important as it is included in several technological indexes reviewed. In contrast, according to the literature review, the inflation rate is not considered to such an extent. An additional reason for the misjudgement of country rankings is that regulatory treatment is not assessed by this index, as a number of developing countries have been hostile in terms of embracing the cryptocurrency regulatory landscape compared to developed countries (Cointobuy.io, 2020)

There are some significant ranking differences between the two approaches (i.e., the USA fell from 5th to 72th when data were normalized) due to the method of normalization, which reduces the effects of outliers. Table 2.16 displays the top country rankings with the two methods adopted as derived from the BMPI report (Hileman, 2015).

Table 2.16: BMPI rankings of the top 10 countries with standardized and normalized approaches

Ranking	Country (standardized)	Country (normalized)
1	Argentina	Argentina
2	Venezuela	Venezuela
3	Zimbabwe	Zimbabwe
4	Malawi	Iceland
5	United States	Malawi
6	Belarus	Guinea-Bissau
7	Nigeria	Democratic Republic of Congo
8	Democratic Republic of Congo	Belarus
9	Iceland	Nigeria
10	Iran	Angola

BMPI has been the first index proposed to rank countries according to Bitcoin adoption. Therefore, it resembles a first noteworthy attempt from existing literature. The key takeaways of this index are the following:

1. **Significance of indicators**: BMPI considers several indicators, many of them varying in significance but with equal weighting. There is no broader examination of technological advancements, blockchain industry presence, and regulation.
2. **Assessment methods and weighting**: Assessment methods demonstrated in Table 2.16, are not justified and not adjustable.
3. **Acknowledgment of limitations**: According to the concluding remarks of the BMPI research, certain limitations were outlined:
   a. An improved version of the index can potentially consider adjustment of weights.
   b. Due to the limited availability of sources in 2015, many indicators are not included in the index. The exclusion of the legal aspect results from continuous regulatory evolvement, uncertainty, and questionability as to what Bitcoin regulation signals. As the technology matures, increasing the interest for its adoption the availability of relevant sources is likely to increase.

2.3.2 The "Distributed Ledger Technology and Cryptocurrency Market Potential Index" (CMPI)

CMPI attempts to measure the adoption of DLT as a conceptual framework on a country basis, taking into account the development and implementation attributes (Nguyen and Jeong-Hun, 2020) through the examination of 30 indicators (referred to as "variables") which are categorized under three pillars (referred to as "sub-indexes"). This index examines the landscape in 213 countries, significantly more than the other indexes reviewed in this chapter. The authors use the statistical approach of factor analysis to produce weights and final rankings.

The focus of this research is shifted toward the development of protocols, networks, and the overall maintenance and ecosystem usage of the technology.

The *protocol layer* lays out the consensus rules that govern each decentralized system. The *network layer* refers to the recording and sharing information among participants through processing and validating transactions. The *data layer* includes storing and broadcasting data within a DLT system in an operational context, highlighting the actual use of this data.

Consequently, the authors claim that the selection of indicators is based on the "direct consequences" defined by these three layers. A literature review of the BMPI and the initial release of the BRI methodology paper (Vlachos, Christodoulou, and Iosif, 2019) were conducted before identifying the CMPI indicators.

CMPI indicators are categorized under three pillars; (a) Development, (b) Implementation, and (c) Adoption. Table 2.17 outlines the CMPI pillars and indicators adopted from the relevant report (Nguyen and Jeong-Hun, 2020).

Table 2.17: CMPI pillars (sub-indexes) and indicators (variables)

Pillars (or "sub-indexes")	Indicators (or "variables")
Development (Protocol Layer)	• Blockchain developers per country • Blockchain developers per 100,000 people • Ethereum developers per country • Ethereum developers per 100,000 people • Hyperledger developers per country • Hyperledger developers per 100,000 people • Solidity developers per country • Solidity developers per 100,000 people • The degree to which the national economy enables innovative activities • Knowledge and technology outputs and creative outputs • Attributes and qualities of national economies to efficiently use factors of production (4 indicators derived from the World Economic Forum)
Implementation (Network Layer)	• Mobile subscriptions per 100 people • Internet access (% of the population) • Broadband subscription per 100 people • Bitcoin nodes • Bitcoin nodes per 100,000 people • Ethereum nodes • Ethereum nodes per 100,000 people • Legal status

	○ Absolute Ban: -2 ○ Implicit Ban: -1 ○ No Ban: 0 ○ Tax Law: +1 ○ Anti-money laundering law: +1 ○ Antiterrorism financing law: +1 Scores are added up and ranked
Adoption (Data Layer)	Average annual inflation rates for the period 2009-2018 • Remittances received (% of GDP) • Remittances received • Black market score (BMPI) • Financial crises score (BMPI) • Financial repression score (BMPI) • Economic Freedom Summary Index • Number of Bitcoin Software Downloads from 2008-11-09 to 2019-11-01 • Google search rate for the word "Bitcoin" • Number of Ethereum Software Downloads from 2016-12-16 to 2019-11-11 • Google search rate for the word "Ethereum"

The *protocol layer* covers the origins and fundamentals of blockchain technology, so available indicators demonstrating the active number of the engaged population, such as developers and ground for further innovativeness, are chosen as sources of information. The Dappros 2018 report (Dappros, 2018) obtains relevant developers' population data. The ground for further innovation is assessed by sources derived from the World Economic Forum and World Intellectual Property Organization studies.

The *network layer* addresses internet access and communication aspects, attempting to measure the ability of local populations to use blockchain technologies and, more precisely, a number of cryptocurrencies (Bitcoin and Ethereum). The legal status is also assessed in this pillar; however, the rating scale used by the CMPI is not based on scientific measurement but is instead calculated on a manual scale.

DLT and cryptocurrency adoption is measured and compared within countries via the indicators selected to form the data layer. This layer examines the operational landscape for exchanging financial information and the ground for the adoption of cryptocurrencies in everyday activities. Indicators demonstrating remittances, economic freedom, software downloads, and google searches indicate signs of interest for local populations. The scores of certain BMPI pillars (black market, financial crises, and financial repression) are also adopted as indicators for this index. This decision demonstrates that findings of previously established indexes can be used as the source of information for further improvements of a newly launched tool. This is a technique observed in numerous cases within this chapter.

Rather than equally weighting all the pillars and indicators, CMPI takes a different approach. The total number of indicators is narrowed down to 21, and the weighting for each one is determined through factor analysis. An unobserved common factor component that can provide insights into the three CMPI pillars is generated for this cause. The limit for inclusion of indicators was set at the eigenvalue of greater than one and more than 80% of the variance. This is performed to exclude indicators with uniqueness that may be unrelated to the concept and also in order to assign weights. The initial factor analysis indicated that nine indicators had a uniqueness of over 0.20, which could indicate that they are unrelated to the concept.

The method adopted was referred to reflect the "Kaiser criterion" (Kaiser, 1958) and the "Variance explained criteria" (Fichman, 1999). "Mobile subscriptions," "Legal status," "Inflation," "Black Market score," "Financial Crises score," "Financial Repression score," "Economic Freedom score," "Google search rate for the word "Bitcoin" and "Google search rate for the word "Ethereum," were excluded from the final list of indicators. The degree of success of this method is questionable, as the context of some of these indicators – such as "Legal Status" and "Mobile subscriptions" - have been included and assessed in prior published indexes that measure the preparedness of countries for Industry 4.0 technologies.

CMPI indicates that blockchain engagement and technology implementation is mainly associated with countries with financial ability, human capital, and technical knowledge of blockchain technology. Whereas the global adoption rate has not yet emerged, there are some implementation obstacles regarding infrastructure and access to technology, especially for developing countries. The CMPI is developed as a reference for policymakers and the public and private sectors to improve local financial processes through blockchain and DLT, considering development, implementation, and adoption data.

The key takeaways from reviewing the methodological structure of the CMPI are summarised as follows:

1. **Scientific assessment of scores**: CMPI adopts a scientific assessment of inclusion and weighting of indicators. As previously examined indexes are mostly manually placing the importance on indicators used. However, this assessment has excluded indicators assessing the regulatory and mobile penetration factors within a country; which are considered necessary within other studies assessing the readiness of Industry 4.0 technologies.
2. **Acknowledgment of limitations**: The CMPI paper does not recognize any limitations of the study, but areas for improvement exist in regard to the following:
    a. According to the Dappros 2018 report (Dappros, 2018), the source for most indicators included in the "Development" pillar, is a once-off report that is out of date. It is essential for an index assessing the dynamic blockchain and DLT environment to consider updated data sources to reflect the newest development in the field.
    b. A number of CMPI indicators include the assessment of both raw numeric data (i.e., "Blockchain developers per country" and "Bitcoin nodes per country") and the assessment of these figures proportionately to a country's population (i.e., "Blockchain developer per 100,000 people" and "Bitcoin nodes per 100,000 people"). There is an assumption that there is no need for both of these assessments to be implemented - as to fairly assess a country's engagement regarding a specific technology - the population of the country shall be considered. This is supported by a number of related studies (Phillippo *et al.*, 2020) (Phillippo *et al.*, 2019);.
    c. Besides excluding the regulatory assessment based on the scientific method adopted by CMPI, the "Legal status" indicator is initially measured based on a manually constructed rating scale. This comes in contrast with the general methodology of CMPI that attempts to measure the readiness of countries with an algorithmic approach toward the inclusion and weighting of indicators.

2.3.3 The "Crypto-Ready Index" (CRI)

A recent index for attempting to provide rankings relevant to blockchain and crypto readiness is the CRI (Crypto Head, 2021).

CRI attempts to answer the question of *"which countries present the most opportunity for people to start trading and investing and show the most interest in crypto."* It is assumed that the scope of this index is to showcase readiness for financial trading and investing rather than capturing the broader adoption in multiple industries of the economy.

The methodology focuses on obtaining scores for three pillars. The first pillar measures the number of crypto ATMs in the country and how accessible they are to the general population. The second pillar is each government's legal approach to the ownership of cryptocurrencies and the approach of the banking sector. Finally, the interest in cryptocurrencies is assessed through data of online searches and the increase or decrease of these over the last year. Even though the CRI website[2] states that the scores for these categories were formulated for 200 countries and territories, the final rankings only display scores for 76 countries.

Table 2.18 breaks down the structure adopted by the CRI to conclude the final rankings. CRI uses a limited set of indicators to derive the final rankings.

Table 2.18: CRI Pillars and Indicators

Pillars	Indicators
Adoption of Crypto ATMs	• Number of Crypto ATMs • People per ATM • Square Miles per ATM
Tax and Legislation	• Wikipedia (A point is given to countries if people are allowed to own cryptocurrencies, and an additional point is given if the banking sector is considered friendly)
Crypto Searches	• Google Searches for relevant terms in the last two years

[2] https://cryptohead.com/crypto-ready-index/

	• Percentage change in Google Searches between the first and second year of assessment

The Number of Crypto ATMs can be considered a relevant indicator for local engagement. CRI normalizes the value by taking into account the population of each assessed country. The third indicator of the first pillar, which measures Square Miles per ATM, appears to be a metric whose measurement is not clarified. It is stated as "the average number of square miles per ATM," but no further explanation on how the value was derived and what formula has been used.

CRI examines a limited number of indicators that are fewer in quantity compared to previous readiness indexes. By adopting this limited scope of research, the index may not be sufficient to be considered a tool that can affect users' decision-making. The limited scope can be justified as the creators of this index state that their objective is to identify non-hostile countries for trading and investing activities rather than a broader set of blockchain activities.

The regulation assessment is considered highly speculative and has a degree of unreliability since it derives from a Wikipedia source. Anonymous sources can possibly edit Wikipedia without providing scientific proof for any modifications (West, Kannan, and Lee, 2010). Therefore, the reliability of sources is questionable.

The scoring mechanism for the regulatory indicator has not been justified in CRI, either by a per-country analysis or by a ground truth procedure. A score is given to each country with a maximum of 2.

CRI measures google searches and percentage increases compared to the previous year, but the terms that are measured are not displayed. The website only shares one example of assessed terms, which is stated as: "best crypto exchange Australia." The research does not provide further details on what other terms were assessed. This adds a layer of uncertainty as to what aspects this index measures. Therefore, it is questionable what conclusions can be derived by evaluating the final scores of this pillar. The final CRI rankings of the top 10 countries are outlined in Table 2.19. An interesting finding CRI rankings feature developed countries as highly ranked, while BMPI rankings feature several developing countries.

Table 2.19: CRI Rankings (Top 10 Countries)

Rank	Country	Google Searches per 100,000 People	Google Searches Annual Increase	Number of Crypto ATMs	People per Crypto ATM	Area per Crypto ATM	Tax and Legislation	CRI
1	USA	14796	140%	17436	19023	218	2	7.13
2	Cyprus	33941	139.6%	0	888005	3572	2	6.47
3	Singapore	31324	111%	10	568581	28	2	6.3
4	Hong Kong	10356	102.1%	124	60276	3	2	6.27
5	UK	21154	205.4%	200	333984	468	2	6.06
6	Ireland	24189	140.3%	35	142211	775	2	6.05
7	Slovenia	21849	147.7%	22	95863	356	2	5.96
8	Australia	23080	165.6%	32	806220	92810	2	5.94
9	Germany	2551	112%	53	1569633	2602	2	5.93
10	Canada	20783	213.1%	1464	26265	2633	1	5.86

The following takeaways are derived after reviewing the CRI components:

1. **Assessment methods and weighting**: The assessment methods for all pillars contain a degree of opaqueness and possibly unreliability for the regulation indicator. Therefore, the subjective approach to scoring regulation advancements in each country may affect the final scores to a significant degree, given the limited number of indicators. A notable observation is that the scoring formula for the CRI is not presented. The user may probably consider various assumptions about how the formula is derived. Table 2.19 considers the top-10 countries using CRI. The methodology for deriving the final scoring is not supported by a scientific measurement. There seem to be no weight adjustment capabilities. Therefore, the tool may not be able to accommodate users' customized needs and preferences.

2. **Acknowledgment of Limitations**: There is no acknowledgment of limitations and/or plans for future work. This comes in contrast with similar studies reviewed, which acknowledge areas of improvement, potential pitfalls, and future work to improve the accuracy of an index. Besides the limitations already outlined, a different number of countries is assessed for each indicator. For example, the Google search trends for 110 countries are ranked, but the final CRI rankings only demonstrate scores for 76 countries. Therefore, it seems that there is no mechanism to estimate and/or calculate scores of missing indicators.

2.4 Discussion and Conclusions

This chapter reviews the implications of several indexes from the literature considering various domains from the technological industry. This attempt is crucial to understand the landscape and formation of readiness indexes and identify the knowledge gap to where the BRI is contributing. The readiness indexes have similarities and differences in scope, pillars, indicators, and scoring mechanisms used. The research discussed in this thesis attempts to develop techniques on estimating readiness of blockchain engagement per country, enhancing the aforementioned indexes.

Table 2.20 provides an overview of existing approaches studied focusing on the selection of pillars.

Table 2.20: Pillars examined by the reviewed methodological frameworks

Index / Study	Assist Decision Making	Regulation	Technology	Industry Presence	Local Users	Weights
A Framework for Measuring National e-Readiness	✓	✓	✓	✓	✓	Equal
eGDI	✓	✓	✓	✓	✓	Equal

NRI	✓	✓	✓	✓	✓	Equal
AVRI	✓	✓	✓	✓	✓	Two indicators are half-weighted
ARI	✓	✓	✓	✓	✓	Varying
BMPI			✓	✓	✓	Equal
CMPI	✓		✓	✓	✓	Determined via Mathematical Formula
CRI		✓			✓	Not clarified
BRI	✓	✓	✓	✓	✓	Equal, Adjustable, Determined by Community, Computed via Mathematical Formula

Table 2.20 indicates that indexes related to blockchain and DLT adoption have not yet been developed to examine all key areas commonly evaluated by readiness indexes in numerical form. CMPI incorporated a computational formula to determine indicators’ inclusion and

weights. However, the fact that the signal for the legal/regulatory stance for each stance is not algorithmically derived is a limitation. Evaluating the legal landscape applied to the examined technologies has been a critical component for the majority of reviewed indexes.

A common denominator of all reviewed indexes is that regulation is measured via subjective assessment, which is a limitation considering the manual and labour intensive process that is required for this process. BRI proposes a technique to measure the regulatory stance eliminating any dependencies to manual processes. The proposed model developed to estimate the regulatory stance per country is discussed in Chapter 5.

2.4.1 BRI's structure compared to examined indexes

BRI is proposed as a dynamic and scalable index that adopts three different dimensions to rank countries in terms of blockchain readiness, compared to a more static approach adopted by the reviewed indexes.

Table 2.21: Countries assessed and continuity per each reviewed readiness index

Index / Study	Number of Countries Assessed	Continuity
eGDI	193	2001 - Present
NRI	134	2019 (renewed) - Present
AVRI	30	2020 – One version
ARI	25	2018 – One version
BMPI	178	2015 – One version
CMPI	213	2020 – One version
CRI	76	2021 – One version
BRI	Unlimited	To be updated annually

The research supports developing a readiness index that can regularly assess the global environment in a consistent timeframe. As observed in Table 2.21, most reviewed indexes have either published a single version or have not continuously stated their intentions to develop and update the index.

The landscape of established technological indexes directs to the pillar areas that the BRI shall adopt. The assumption is that a review of technological indexes' content and structure in terms of pillars may indicate the fundamental sources that shall be considered to construct the content of the BRI.

eGDI has been established as a well-known and relevant index due to its longevity (it tends to be updated at least every two years) and depth in terms of global nation assessment (Lněnička, 2015). The contribution of the eGDI is identical to the desired contribution of the BRI to government policymakers and other participants within the blockchain industry. The proposed BRI is positioned in a similar context within the blockchain ecosystem by incorporating certain additional functionalities. More specifically, BRI considers the following design principles:

- Developed to assist in national decision-making procedures for the public and private sector
- Automatically assess the regulatory blockchain environment per country
- Automatically assess the technological advancement per country
- Automatically assess the blockchain industry presence per country
- Automatically assess the local users' blockchain engagement per country
- Automatically assess the blockchain readiness for an unlimited number of countries
- Using updated information to assess blockchain readiness on at-least an annual basis automatically
- Identify BRI indicators and weight mechanisms according to survey results obtained by crypto users
- The ability for end-users to adjust the scoring strategy as follows:
  - Equal weights to all indicators
  - The weighting of indicators according to community voting
  - Adjusting indicators' weights according to the individual preferences of the end-user

The BRI aims to substantially impact the blockchain community and contribute to further implementation and decision-making regarding blockchain technology by attempting to eliminate similar "context-driven" assumptions of the assessment found in eGDI. The focus is on identifying and normalizing numerical indicator indices to achieve an - as accurate as possible - assessment of each country.

The indicators' weights adopted in the BRI can instead identified by the community and/or adjusted according to the users' preferences to avoid eliminating or underweighting potentially significant indicators. Indexes like AVRI assess certain indicators considering different weights, however without justifying the adjustment. The proposed BRI attempts to improve this standard by providing three different weighting mechanisms for the end-users to choose from. The BRI 2021 Standard Version is based on equal weights, the BRI 2021 Community-Driven Version is based on weights voted by the community via a survey and the BRI 2021 Weights-Adjustment Version is based on manual adjustment of weights by the end user. These versions are discussed in Chapter 6. AVRI estimates readiness for 30 countries due to lack of information. BRI proposes an estimate on missing data values for indicators based on data from similar countries in Chapter 4. Furthermore, the user is able to create rankings with only those countries that are out of interest, allowing the estimation of readiness in continents, regions, industries etc.

An additional focus of the BRI is to remain relevant and updated on the latest developments within the blockchain landscape in terms of the sources taken into consideration to form the technique. Although a dynamic update of the data sources taken into consideration is outside the scope of this research, this could be an additional feature of our process to be considered as a future work (refer to Chapter 7).

Choosing a scientific formula that has been used and proven to be scientifically effective when comparing two separate indices is also a main component of the methodology discussed further in the Chapters 3 and 4.

The Pearson and Spearman correlation coefficients are calculated to empirically evaluate the regulation scores after the development of a scoring matrix to rank countries according to human judgment. This method is used as ground truth to justify the scoring mechanism developed for estimating regulatory readiness and is discussed in detail in Chapter 5. Similarly, the Pearson rank correlation coefficient (Samuels and Gilchrist, 2014) between the ground truth (obtained from the blockchain community's opinion) and the auto-computed BRI scores are used as an evaluation method for the preliminary and final BRI country rankings.

Changes are expected to occur within the BRI structure in the following versions as blockchain technology evolves, and updated data sources may provide more relevant information. The set of indicators is likely to change considering similar cases from other indexes. As discussed in subsequent chapters, the proposed BRI is considering a smaller set of indicators compared to other indexes like the NRI (60 indicators). This is attributable to the fact that blockchain technology is still in its infancy, and obtaining accurate information from data sources is often challenging compared to other more mature technological fields (i.e., Internet).

CHAPTER 3 CONCEPTUAL FRAMEWORK

3.0 Introduction

Following from Chapter 2, the proposed BRI has the potential to be established as a numerical blockchain-related country index in the industry, considering technological, legal, business, and user engagement aspects as described in the following three chapters. In addition, there will be no limitation on the number of countries assessed, while the proposed scoring methodology considers an estimation of values for missing indicators. Which means that even with limited data sources the methodology can derive reasonable rankings (refer to section 4.3).

To validate the claims, the proposed BRI has been implemented as a Web app which considers a set of indicators that have been derived by Survey 1 which is presented in Chapter 4. Note here that the methodology for deriving the final rankings is generic and can accept various signals from various numerical indicators.

Due to the increased interest in blockchain technology and cryptocurrencies discussed in the Chapter 1, it is anticipated that the interest in such an index is likely to rise in the future. The BRI can be applied globally without any geographical and political restrictions.

This chapter discusses the methodology for structuring the proposed BRI and for identifying its pillars and indicators. Furthermore, the challenges of constructing a fair and accurate index are discussed. The proposed methodology for deriving the ranking per country, according to blockchain engagement, is discussed. .

3.1 Methodology for the preliminary "Blockchain Readiness Index" (2020 Standard Version)

The 2020 Standard Version of the BRI serves as the basis of the proposed methodology. It involves the identification of pillars with their respective indicators, and preliminary BRI rankings that reflect data from sources gathered up to December 31st, 2020. A ground truth procedure to validate the accuracy of the methodology is performed. Furthermore, this version of the methodology weighs equally all indicators, including a strategy for estimating score for missing indicators based on a cosine similarity of similar countries. More details on the exact methodology are discussed throughout this chapter.

More specifically, this research contributes the following versions of the proposed BRI:

1) BRI 2020 Standard Version (Preliminary results for 2020 are presented in this chapter. Final results for 2021 are presented in Chapter 6, including the regulatory stance from each country)
2) BRI 2021 Weights-Adjustment Version (discussed in section 6.2.3)
3) BRI 2021 Community-Driven Version (discussed in section 6.2.2)

The subsequent sections detail the quantitative methods employed to identify the set of indicators and assign weights to them. All versions of the BRI utilize a shared methodology, which is discussed in this chapter. The approach to assessing scores for missing indicators, a common feature across all versions, is also discussed in this chapter.

The methodology was influenced by the Saunders Onion Model (Saunders and Bristow, 2023). The BRI adopted the following components from the model:

(a) Positivism Philosophy: BRI methodology relies on scientific findings and empirical data.
(b) Inductive Approach: The research begins with specific observations derived from the literature review, and then themes and patterns in the data are assessed.
(c) Surveys, Experiment and Ground Truth: In order to identify and understand the importance of weights, a survey is conducted. Multiple experiments are also essential to derive preliminary BRI rankings as well as rankings of the finalized BRI versions presented in Chapter 6. The findings of BRI rankings and estimation of regulatory stance are tested via ground truth procedures.
(d) Quantitative Approach (Mono Method): Due to the nature of the BRI which requires the methodology to be built on numerical, subjective data, a quantitative approach is selected.
(e) Longitudinal Time Horizon: Even though the versions of the BRI require gathering of information in a given calendar year, the proposed methodology shall be suitable for BRI iterations throughout multiple years.
(f) Data Collection and Analysis: Analysis conducted based on quantitative data which are available at the given stage.

3.1.1 Identification of Pillars and Indicators

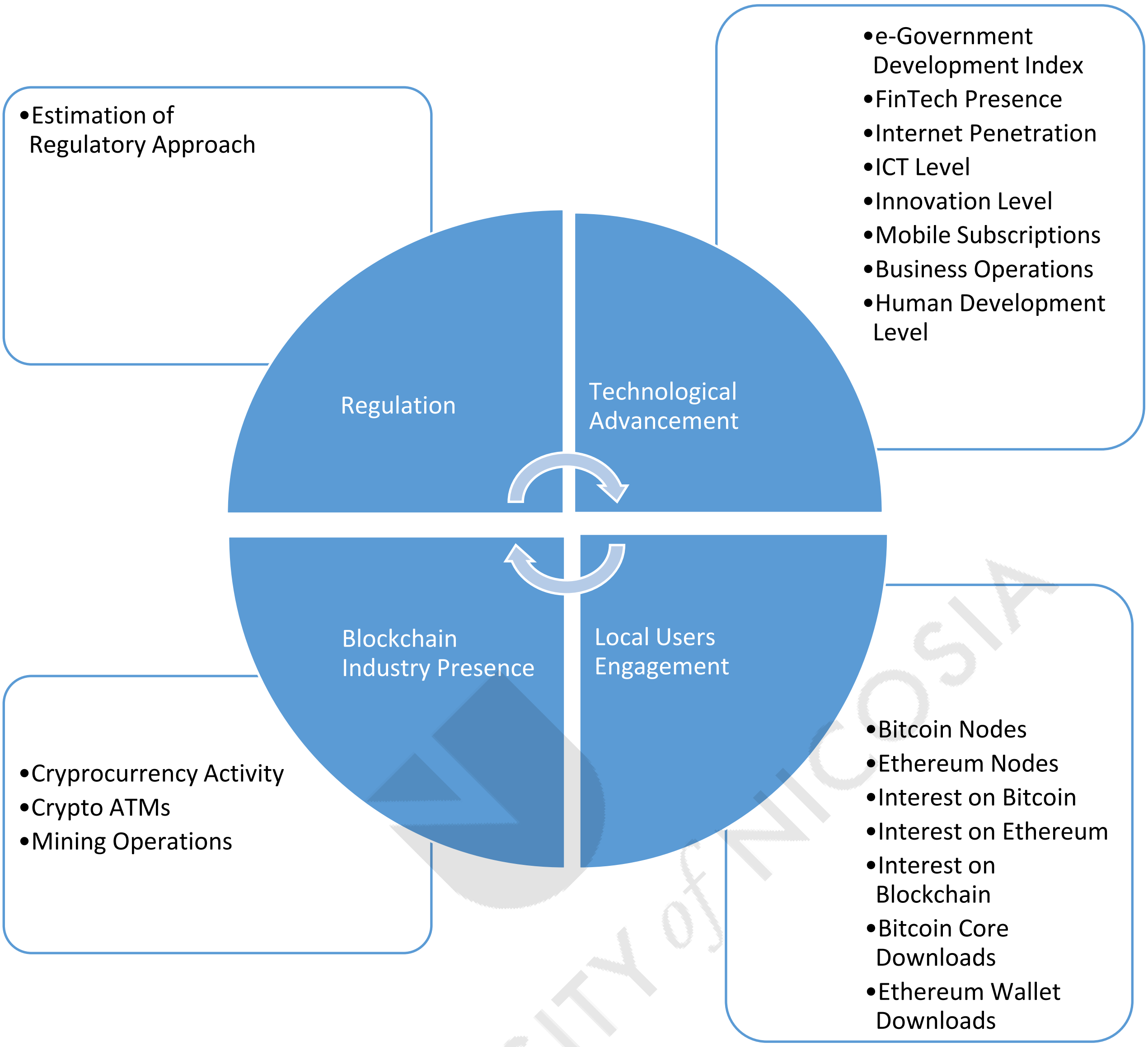
As discussed in Chapter 2 a common challenge for the derivation of indexes is the process for deciding the pillars and indicators among scientific indexes. Pillars consist of a specific number of indicators. Indicators are the sources that provide the numerical scores that collectively used as input data to the derivation of the rankings. Table 2.2 summarizes the findings regarding the context of common pillars used in the indexes examined in Chapter 2. Based on these findings, the research distinguishes the following examined categories as the proposed pillars for BRI: (1) Regulation, (2) Technological Advancement, (3) Blockchain Industry Presence, and (4) Local Users Engagement.

It is noted that the generic nature of the proposed BRI can be adapted to any set of indicators as long as numerical scores are provided. The preliminary selection of pillars and indicators for the BRI is informed by examining selection patterns from indicators used in other technological and blockchain-related indexes. The criteria established for incorporating indicators into the BRI methodology are as follows:

1) Previous direct or indirect inclusion in scientific and/or blockchain-related indexes
2) Ability to gather updated numerical data
3) Relevancy to the scope of the BRI

The indicators that are assumed to satisfy the above criteria to a satisfactory extent are summarized in Figure 3.1 under their respective pillars.

Figure 3.1 Conceptual Framework Model



The 4 main pillars and their indicators are inspired from the literature review, where developments in ICT, technological advancements, regulatory/governmental stance and human development were assessed in scientific indexes.

Some indicators can be allocated under multiple pillars. For example, "Bitcoin Nodes" may indicate both local users' engagement and the presence of the blockchain industry. The same applies to "Mining Operations" which could be placed under the "Blockchain Industry Presence" pillar and the "Technological Advancements Pillar". It is noted that the allocation of indicators to respective pillars is not significant in terms of the BRI scoring mechanisms, therefore justification is focused toward the selection of indicators rather than their categorization under pillars. The individual scoring and weighting mechanisms of the indicators determine the BRI country scores and rankings across all versions.

The selection of the 19 indicators considered by the proposed BRI are justified in terms of meeting the inclusion criteria (previous inclusion in indexes, ability to gather numerical data, relevancy to the scope of BRI) as follows:

1) **Estimation of Regulatory Approach**
    a. Previous Direct/Indirect Inclusion in Indexes
        i. An estimation of the regulatory approach of respective technologies is assessed in all examined indexes (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Nguyen and Jeong-Hun, 2020), (Soumitra and Bruno, 2020), (Crypto Head, 2021) except BMPI. CMPI assesses regulation but excludes it from its final calculations.
    b. Ability to Gather Updated Numerical Data
        i. Cryptocurrency Regulation Analysis (Cointobuy.io, 2020). This is a temporary source that is adopted for the preliminary 2020 BRI Standard version. Chapter 5 discusses the contribution towards deriving the regulatory stance using a Web mining technique. The preliminary regulation analysis considers the "Legality of Bitcoin," "ICOs Restricted," "ICOs Located," "Exchanges Located" and "User Voting" with equal weighting.
    c. Relevancy to the Scope of the BRI
        i. The regulatory stance towards blockchain activities may affect the business operations and decisions of relevant network participants (Cumming, Johan, and Pant, 2019). Several countries are targeting to enhance innovative services by adopting disruptive technologies such as blockchain to further enhance existing governance operations (Ølnes, 2016). This indicator is designed to evaluate the local regulatory landscape for blockchain technologies, which is likely to shape a country's strategy towards becoming a blockchain hub.

2) **E-Government Development Index (eGDI)**
    a. Previous Direct/Indirect Inclusion in Indexes
        i. eGDI is a readiness index assessing government development (Potnis and T. A. Pardo, 2008)

ii. NRI (Soumitra and Bruno, 2020)

b. Ability to Gather Updated Numerical Data

i. UN E-Government Survey (United Nations, 2020). The methodology of this research is discussed in section 2.1.3.

c. Relevancy to the Scope of the BRI

i. eGDI assesses the capacity and willingness of Member States to evaluate their e-Government initiatives (Potnis and Pardo, 2008). Its assessment includes pillars that can be relevant to blockchain adoption, such as human development, ICT literacy, internet penetration, engagement of users and governments with web services, and more.

3) FinTech Presence

a. Previous Direct/Indirect Inclusion in Indexes

i. A combination of financial and technological indicators is assessed in all examined indexes.

b. Ability to Gather Updated Numerical Data

i. The Global FinTech Index (Findexable, 2019). This research's methodology relies on a total score of three "units" of metrics. The scores are divided into the "units" presented below, with relative weights to assess the quantity and quality of companies in the FinTech ecosystem and the region's business environment. Both country-based (more than 65) and city-based scores (more than 230) are calculated. The proposed BRI considers the country-based scores. The respective units are as follows:

1. Quantity of FinTech and Ecosystem Companies, including fintech co-working spaces, accelerators, and fintech industry events and meetups
2. Quality of FinTech and Ecosystem Companies, including fintech co-working spaces, accelerators, and fintech industry events and meetups. Based on the web presence, monthly visits, customer base, and valuation.
3. Doing Business Index (Mundial, 2020). The methodology is discussed below in the description of the indicator "8) Business Operations".

c. Relevancy to the Scope of the BRI

   i. The blockchain FinTech industry, which is rapidly gaining popularity, is poised to have strategic impacts on both public and private sector organizations (Du *et al.*, 2018). FinTech and blockchain are two concepts that are emerging simultaneously, enhancing several mutual operation aspects (Cuibari, 2021).

4) Internet Penetration

a. Previous Direct/Indirect Inclusion in Indexes

   i. The degree of internet access and penetration is assessed in all examined indexes (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Nguyen and Jeong-Hun, 2020), (Soumitra and Bruno, 2020), (Crypto Head, 2021), (Hileman, 2015)

b. Ability to Gather Updated Numerical Data

   i. Internet World Stats (Miniwatts Marketing Group, 2021). Internet penetration per country is derived from the following metrics and organizations: The Nielsen Company, the International Telecommunications Union (ITU), the GfK Group, the CIA Fact Book, local NIC, local ISP, other public like Internet regulating agencies, and information from other research private sources.

c. Relevancy to the Scope of the BRI

   i. Connectivity to the internet is essential for users to access and adopt blockchain technology (Nijhawan, Kumar, and Bhardwaj, 2020). The internet penetration rates demonstrate the potential of blockchain readiness within regions. By assessing country-based penetration statistics, countries with a high penetration rate are better positioned to embrace blockchain technology, even if such information may not be directly relevant to blockchain engagement.

5) **ICT Level**

a. Previous Direct/Indirect Inclusion in Indexes

i. Indicators relevant to the ICT level of countries are included in all examined indexes. (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Nguyen and Jeong-Hun, 2020), (Soumitra and Bruno, 2020), (Crypto Head, 2021), (Hileman, 2015)

b. Ability to Gather Updated Numerical Data

i. ICT Development Index (ITU, 2019). This research combines 11 indicators under the following three pillars to compute the final country scores.

1. ICT Access
2. ICT Use
3. ICT Skills

c. Relevancy to the Scope of the BRI

i. Countries with a developed ICT level are more likely to engage in blockchain activities (Kale, 2019). The ICT Development Index (ITU, 2019) is an index structured by the United Nations International Telecommunication Union that considers globally established ICT indicators. This index combines several indicators intending to assess ICT development per country. The perception is that findings from this index can lead to indications demonstrating areas for innovation toward Blockchain-related activities.

6) **Innovation Level**

a. Previous Direct/Indirect Inclusion in Indexes

i. Indicators relevant to the innovation level of countries are included in all examined technological indexes. (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Soumitra and Bruno, 2020)

b. Ability to Gather Updated Numerical Data

i. Global Innovation Index (World Intellectual Property Organization, 2021). 80 indicators of varying weights were calculated that are categorized under the following seven pillars:

1. Institutions

2. Human Capital and Research
3. Infrastructure
4. Market Sophistication
5. Business Sophistication
6. Knowledge and Technology Outputs
7. Creative Outputs

c. Relevancy to the Scope of the BRI

i. Countries that facilitate innovation practices are more likely to engage in blockchain activities (Potts, Davidson, and Berg, 2020). The comprehensive metrics gathered assess, among other aspects like, the technical infrastructure, education, and political environment that enable the adoption of exponential technologies, as evaluated in the literature review process.

7) Mobile Subscriptions

a. Previous Direct/Indirect Inclusion in Indexes

i. Indicators relevant to mobile access are included in all examined indexes with the exception of the CRI. (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Nguyen and Jeong-Hun, 2020), (Soumitra and Bruno, 2020), (Hileman, 2015)

b. Ability to Gather Updated Numerical Data

i. Mobile Cellular Subscriptions (World Bank, 2021)

c. Relevancy to the Scope of the BRI

i. Users with access to mobile devices are most likely to engage in blockchain activities (Vincent and Evans, 2019). The use of crypto mobile wallets is emerging and is considered one of the most convenient methods for new users to purchase and trade cryptocurrencies (Jaiswal *et al.*, 2022).

8) Business Operations

a. Previous Direct/Indirect Inclusion in Indexes

i. Indicators relevant to facilitating business operations are included in all examined indexes. (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Nguyen and Jeong-Hun, 2020), (Soumitra and Bruno, 2020), (Crypto Head, 2021), (Hileman, 2015)

b. Ability to Gather Updated Numerical Data

   i. Ease of Doing Business Index (Mundial, 2020). This index is also included in the NRI as an indicator. In brief, 81 indicators were calculated that are categorized under ten equally-weighting pillars:

      1. Starting a Business
      2. Dealing with Construction Permits
      3. Getting Electricity
      4. Registering Property
      5. Getting Credit
      6. Protecting Minority Investors
      7. Paying Taxes
      8. Trading Across Borders
      9. Enforcing Contracts
      10. Resolving Insolvency

c. Relevancy to the Scope of the BRI

   i. The BRI aims to provide country rankings that reflect the preparedness of countries to host blockchain business activities in the public and private sectors. The ease of establishing businesses and corporations has been proven to be a factor in the decision to establish headquarters and other operations required for supporting the next generation of blockchain-based businesses (Suri, 2021).

9) Human Development Level

a. Previous Direct/Indirect Inclusion in Indexes

   i. Indicators relevant to human development practices, like literacy and education levels, are included in all examined technological indexes and the CMPI. (KPMG, 2019a), (EIU and The Economist Intelligence Unit, 2018), (Nguyen and Jeong-Hun, 2020), (Soumitra and Bruno, 2020)

b. Ability to Gather Updated Numerical Data

   i. Human Development Index (UNDP, 2020). The Human Development Index measures “Life Expectancy at Birth,” “The average of Expected and Average Years of Schooling,” and “Gross National Income per Capita”. Equal weights are assigned to each.

c. Relevancy to the Scope of the BRI

i. People with a high level of literacy and higher education are most likely to engage in blockchain activities (Bittencourt *et al.*, 2020). The findings of Survey 1 presented in this chapter indicate an increased level of education and expertise for people engaged with blockchain technology.

10) Cryptocurrency Activity

a. Previous Direct/Indirect Inclusion in Indexes

i. Attempts to measure cryptocurrency activity per country are taken in all examined blockchain-related indexes (Nguyen and Jeong-Hun, 2020), (Crypto Head, 2021), (Hileman, 2015)

b. Ability to Gather Updated Numerical Data

i. For this indicator, there is a measurement of the number of Top 100 Cryptocurrency Exchanges per country according to Total Volume (CoinMarketCap, 2020) for the preliminary BRI 2020 Standard Version and the Trust Score (Coingecko, 2020) in other BRI versions. Trust Score assesses liquidity/web traffic, the scale of operations, API technical coverage, cybersecurity, team presence, and past incidents of cryptocurrency exchanges.

c. Relevancy to the Scope of the BRI

i. The presence of top-performing cryptocurrency exchanges mostly takes place in jurisdictions that are non-hostile towards blockchain activities (Belykh, 2020). It is expected that top-ranked countries, regarding this indicator, encompass non-hostile professional environments for cryptocurrency activity.

11) Crypto ATMs

a. Previous Direct/Indirect Inclusion in Indexes

i. Attempts to measure users that are involved in cryptocurrency financial activities are taken in all examined blockchain-related indexes (Nguyen and Jeong-Hun, 2020), (Crypto Head, 2021), (Hileman, 2015). The adoption of crypto ATMs is an indicator of CRI (Crypto Head, 2021).

b. Ability to Gather Updated Numerical Data

i. Coin ATM Radar Data (Coin ATM Radar, 2021) tracks the installation of Crypto ATMs worldwide by considering data provided by the community, like geo-locations, images, and videos of the physical installation sites.

c. Relevancy to the Scope of the BRI

i. The tracking of crypto ATMs is one of the few available sources that provide an indication of the complex scattering of geographical cryptocurrency activities (Serena, Ferretti, and D'Angelo, 2021). Crypto ATMs are a convenient initial method for new users to engage with cryptocurrencies. The installation rates per country indicate the local industry presence rate and the ease for the local population to be introduced to the technology and exchanging cryptocurrencies for fiat currencies.

12) Mining Operations

a. Previous Direct/Indirect Inclusion in Indexes

i. Attempts to measure users that are involved in crypto-related activities are taken in all examined blockchain-related indexes. Mining was not measured as an individual indicator, but the download rates of nodes (a miner must also be a node) are examined in BMPI and CMPI. (Nguyen and Jeong-Hun, 2020), (Hileman, 2015)

b. Ability to Gather Updated Numerical Data

i. Bitcoin Mining costs throughout the world (Elite Fixtures, 2018). This is the initial source adopted for the preliminary BRI 2020 Standard Version due to the absence of an alternative related index. The research was based on average electricity rates according to government and utility/company and reports. This research used the AntMiner S9, the AntMiner S7, and the Avalon 6 as mining rigs.

ii. The Cambridge Bitcoin Electricity Consumption Index (CCAF, 2021) is adopted as a more relevant and updated source in all finalized BRI versions.

c. Relevancy to the Scope of the BRI

i. Bitcoin mining can be more profitable in countries with low electricity costs, as these countries tend to enhance higher levels of mining hash rate per capita (Rawal and Peter, 2021). Mining facilities are expected to operate within countries with high and efficient energy consumption, thereby indicating opportunities for growth in the blockchain industry.

13) Bitcoin Nodes

a. Previous Direct/Indirect Inclusion in Indexes
   i. Measurement of reachable Bitcoin nodes is an indicator in BMPI and CMPI (Nguyen and Jeong-Hun, 2020), (Hileman, 2015).
b. Ability to Gather Updated Numerical Data
   i. Bitnodes Data (BITNODES, 2021). This metric involves sending *getaddr* messages to find reachable nodes in the Bitcoin network, starting from a set of seed nodes.
c. Relevancy to the Scope of the BRI
   i. The presence of cryptocurrency nodes is a metric that indicates the activity and interest of local users (Park *et al.*, 2019).

14) Ethereum Nodes

a. Previous Direct/Indirect Inclusion in Indexes
   i. Measurement of reachable Ethereum nodes is an indicator in CMPI (Nguyen and Jeong-Hun, 2020)
b. Ability to Gather Updated Numerical Data
   i. Ethernodes Data (Ethernodes.org, 2021). A similar methodology is used to extract values as in indicator 13) Bitcoin Nodes.
c. Relevancy to the Scope of the BRI
   i. The presence of cryptocurrency nodes is a metric that indicates the activity and interest of local users (Park *et al.*, 2019). Only Bitcoin and Ethereum networks are considered for the preliminary BRI 2020 Standard Version since these are considered the main decentralized public networks with the most activity since their Genesis block. The BRI methodology can be further extended in considering data from additional data sources from other blockchain networks as well.

15) Interest on Bitcoin

a. Previous Direct/Indirect Inclusion in Indexes

i. Assessing interest per country in key cryptocurrency and blockchain concepts is an indicator in all examined blockchain-related indexes. (Nguyen and Jeong-Hun, 2020), (Crypto Head, 2021), (Hileman, 2015).

b. Ability to Gather Updated Numerical Data

i. Google Trends for the word "Bitcoin"[3]. Google Trends provides a dataset representative of Google searches. Each data point is divided by the total searches of the geography and time range it represents. This is done to compare relative popularity. The values are then scaled within a range of [0-100] based on a topic's proportion to all searches on all topics.

c. Relevancy to the Scope of the BRI

i. By capturing the metrics of Web search keywords that include the term "Bitcoin", interest trends within countries can be estimated. This indicator examines the interest of local populations in Bitcoin as a cryptocurrency and concept.

16) Interest on Blockchain

a. Previous Direct/Indirect Inclusion in Indexes

i. Assessing interest per country in key cryptocurrency and blockchain concepts is an indicator in all examined blockchain-related indexes. (Nguyen and Jeong-Hun, 2020), (Crypto Head, 2021), (Hileman, 2015).

b. Ability to Gather Updated Numerical Data

i. Google Trends for the word "Blockchain."[4]. The same methodology is used to extract values as in indicator 15 - Interest in Bitcoin.

c. Relevancy to the Scope of the BRI

i. A high level of interest in blockchain and cryptocurrency concepts may indicate the local presence of users. This indicator examines the interest of local populations in blockchain as a technology.

17) Interest on Ethereum

a. Previous Direct/Indirect Inclusion in Indexes

[3] https://trends.google.com/trends/explore?date=all&q=bitcoin
[4] https://trends.google.com/trends/explore?date=all&q=blockchain

i. Assessing interest per country in key cryptocurrency and blockchain concepts is an indicator in all examined blockchain-related indexes. (Nguyen and Jeong-Hun, 2020), (Crypto Head, 2021), (Hileman, 2015).

b. Ability to Gather Updated Numerical Data

i. Google Trends for the word "Ethereum"[5]. The same methodology is used to extract values as in indicator 15 - Interest in Bitcoin.

c. Relevancy to the Scope of the BRI

i. Similar to the previous assessments of key blockchain and cryptocurrency concepts, the interest of local populations in Ethereum as a blockchain network may indicate further interest in concepts like decentralized applications and smart contracts.

18) Bitcoin Core Downloads

a. Previous Direct/Indirect Inclusion in Indexes

i. Bitcoin Core Downloads are an indicator in BMPI and CMPI. (Nguyen and Jeong-Hun, 2020), (Hileman, 2015).

b. Ability to Gather Updated Numerical Data

i. Sourceforge Data[6]. Data are extracted from metrics obtained by APIs[7].

c. Relevancy to the Scope of the BRI

i. The Bitcoin Core software enables users to become nodes of the Bitcoin network, generate secure wallets, and interact with the network. Local engagement can be measured by tracking the number of users who have downloaded and used the client in a specific region. Downloading the software requires significant computational capacity and is a time-consuming task (Brakmić, 2019). Users who participate in the validation process may be considered active community members.

19) Ethereum Wallet Downloads

a. Previous Direct/Indirect Inclusion in Indexes

[5] https://trends.google.com/trends/explore?date=all&q=ethereum
[6] https://sourceforge.net/projects/bitcoin/files/stats/map
[7] https://sourceforge.net/p/forge/documentation/Download%20Stats%20API/

i. Bitcoin Core Downloads are an indicator in CMPI. (Nguyen and Jeong-Hun, 2020)

b. Ability to Gather Updated Numerical Data

i. Sourceforge Data[8]. The same methodology is used to extract values as in indicator 18) Bitcoin Core Downloads.

c. Relevancy to the Scope of the BRI

i. Ethereum regularly maintains its position as the second biggest cryptocurrency in market capitalization and is the platform for building decentralized applications that disrupt multiple industries (Bhardwaj, Chandra, and Sagar, 2021). Downloading the Ethereum Wallet does not involve the requirements of validating blockchain transactions but can be considered an indication of active Ethereum users.

The sources identified are selected with the anticipation that they will be updated regularly in order to maintain a regular pool of relevant information. The scientific indexes that are chosen as indicators shall ideally be studies that are published annually. The BRI is structured with indicators that can possibly be updated or revised annually in case other more reliable sources emerge. The proposed BRI describes a methodology, which may consider any set of indicators as long as these indicators are numeric.

In the process of identifying the indicators used to construct the BRI, this research considers the standard procedures proposed by Rust and Cooil (1994). As per their guidelines, rankings should be based on relevant and reliable indicators that have substantial data availability and are grounded in theory (Rust and Cooil, 1994).

3.2 Challenges

The adoption of blockchain technology and cryptocurrencies is still in progress. While numerous countries are exploring the technology, the nascent nature of the field makes it challenging to identify relevant and up-to-date data sources for the indicators. This often results in a scarcity of accurate data (Alshamsi, Al-Emran, and Shaalan, 2022). The BRI aims to be established as the primary blockchain readiness tool in the industry. Therefore, identifying accurate and updated sources is one of its primary goals. The identification of sources must be relevant to the aim of the index and be appropriate to form BRI as the main

[8] https://sourceforge.net/projects/ethereum-wallet.mirror/files/stats/map

components of the research. . The data sources identified for this research focus on publicly available information published by the nations and accessible over the web (e.g, Human development index, Internet penetration) or by online communities that have be actively participating to the ecosystem (e.g., Bitcoin nodes, cryptocurrency activity). The data sources are provided as footnotes in this chapter. Reliable data is also sourced from academic and industry publications, in addition to surveys conducted with individuals involved in the blockchain industry. Access to sources of index indicators is currently free and available, but this may change with increased adoption. In future work, it is envisioned updating the current methodology to include potential sources discovered algorithmically using web retrieval techniques (see Chapter 7).

One of the challenges in this research involves assessing countries that lack data (i.e., scores) for some of the indicators. I refer to this issue as the "missing indicators challenge". It is anticipated that for the purposes of this research, there may be a lack of enough source data to cover all indicators for all recognized countries (more than 200 countries). This is a common issues that has be discussed in the existing literature review in other indexes. Mainly this challenge has been addressed mainly by eliminating the inclusion of such countries from the derivation of the final ranking. The proposed BRI contributes towards a methodology designed to provide the best possible estimate of scores in cases where indicators are missing.

This version of the BRI considers static numerical data sources that have been preselected to cover the set of indicators. The BRI 2020 instantiation of the scoring formula uses equal weights for each indicator.

According to the literature review (see Chapter 2), providing a reliable numerical index for every country's legal landscape is considered challenging. The technique proposed to solving this challenge is discussed in Chapter 5. For the derivation of the BRI 2020 index I used data from a publicly available data source that provided us with manual assessments of blockchain regulatory readiness per country (Cointobuy.io, 2020). These assessment have been derived by different regulators that have been attempting to provide a number score based on the stance of each country and their professional experience. In Chapter 5, I discuss an approach for deriving numerical scores based on a technique known as "Web mining" (Iosif, Christodoulou and Vlachos, 2020).

The adjustment of weights has been addressed in relevant indexes evaluated in Chapter 2, but this is one of the first attempts to support weights adjustment with scientific justifications.

Surveys are conducted to identify the inclusion and weight of BRI indicators. As discussed in this chapter, a sample of academic participants following blockchain-related courses at the University of Nicosia, were asked to rate the importance of the suggested indicators. As the index aims to offer a global assessment of blockchain engagement, online survey methods may partially address this challenge. However, it's not feasible to conduct surveys in all the 200+ countries that the BRI will assess. There's a risk of biased and unreliable assessments if survey respondents are not geographically diverse. Additionally, respondents must possess a sufficient degree of knowledge about blockchain and cryptocurrencies. For the initial evaluation of the BRI rankings, this research also incorporates expert testimonies as a benchmark for our technique.

Recent DeFi and cryptocurrency hacks and code exploit often shift the attention toward the risks of this technology (Grobys, 2020). Such incidents on blockchain networks may affect public engagement towards blockchain technology and the BRI, which is a research implemented simultaneously with scalability and security debates (Khan, Low, and Hashmani, 2021)

CHAPTER 4 DATA ANALYSIS

4.0 Introduction

This chapter focuses on the techniques used to identify and justify BRI indicators and discusses the findings of the relevant survey addressed by the blockchain community. Following the identification of indicators and recording weights as rated by the community, the BRI Scoring Formula is discussed and the first rankings of a preliminary BRI version (at this stage, sources of indicators are not finalized).

For the empirical evaluation of this research, as well as, the derivation of the initial set of pillars and indicators used for the first instantiation of the BRI I have reached out to Master students and graduates at the University of Nicosia's program in "Blockchain and Digital Currency"[9]. Furthermore, and due to the community building activities of the University I reached out to the blockchain community through the University's communication channels. Therefore, certain findings and assumptions derive from piloting the research towards a sample of participants in the blockchain ecosystem. The University of Nicosia is an established organization in blockchain academia and is well-known for being the frontrunner in blockchain-related education and research (Themistocleous *et al.*, 2020).

Therefore, this research leveraged on the academic expertise of the students and blockchain community members to derive the initial set of pillars and indicators to be used for the BRI setup as well as for validating our intuitions and results from running the methodology

The technique of estimating missing indicators, is also described, and represents an important aspect of this research as it is able to expand the number of assessed countries. A second survey is presented which aims to evaluate the preliminary BRI scores based on the similarity of BRI scores and the manual scoring of countries by participants of the blockchain ecosystem. This represents a contribution to the academic aspect of this research, as previously examined indexes have not presented an evaluation mechanism.

The preliminary BRI 2020 rankings are evaluated, and improvements to the methodology are identified and discussed. These improvement are addressed in subsequent chapters. Specifically, the methodology proposal for estimating blockchain regulatory readiness is presented in Chapter 5. The findings related to blockchain regulatory engagement are considered into the BRI 2021; discussed in Chapter 6, alongside with improvements to the implementation of the technique.

[9] https://www.unic.ac.cy/blockchain/msc-blockchain-and-digital-currency/

4.1 Survey 1 – Justification and Weighting of BRI Indicators

At this stage, the indicators are identified based on the literature review, ability to be derived from numerical sources, and relevance to the scope of the BRI. The assumption is that opinions from a sample of people with experience and academic knowledge of the industry matter to justify the selection of indicators. A survey was sent out to a community of students following a range of the University of Nicosia's blockchain-related academic degrees[10]. Most students who follow this specific academic path do not match the traditional university student profile but mostly include professionals from various industries.

The structure and the survey's answers are discussed in this section. A total of 321 people participated in the survey, with a diverse background in knowledge, professional experience, and geographical location. The response rate was 21% which is considered large enough to produce adequate results from an online survey (Nulty, 2008). An outline of the survey's scope was sent via e-mail in order to obtain a fair assessment from the community as displayed in Appendix I.

Participants could respond to as many questions as they chose. This allowance enabled survey participants to skip questions that were either uncomfortable or unfamiliar to answer. The findings presented in Appendix II indicate the survey participants' diverse geographical locations. A total of 6 more questions were answered and the opinions gathered are summarized as follows:

Table 4.1: Question 1 - What is your Gender?

Answer Choices	Responses	
Female	14.69%	47
Male	85.00%	272
Prefer not to say	0.31%	1
Other (please specify)		0
	Answered	**320**
	Skipped	**1**

The survey participants are primarily male, which is considered an expected outcome, as studies indicated that the women's ratio in the blockchain industry is approximately 14%

[10] https://www.unic.ac.cy/iff/

(Frizzo-Barker, 2020). Our findings justify that the gender ratio of the survey participants seems representative of the blockchain industry as a whole.

Table 4.2: Question 2 – Which of the following best describes your occupation?

Answer Choices	**Responses**	
Management Occupations	9.97%	32
Business and Financial Operations Occupations	21.18%	68
Computer and Mathematical Occupations	16.20%	52
Architecture and Engineering Occupations	2.49%	8
Life, Physical, and Social Science Occupations	0.93%	3
Community and Social Service Occupations	0.62%	2
Legal Occupations	2.49%	8
Education, Training, and Library Occupations	10.90%	35
Arts, Design, Entertainment, Sports, and Media Occupations	4.05%	13
Healthcare Practitioners and Technical Occupations	1.87%	6
Healthcare Support Occupations	1.25%	4
Protective Service Occupations	0.31%	1
Food Preparation and Serving Related Occupations	0.31%	1
Building and Grounds Cleaning and Maintenance Occupations	0.31%	1
Personal Care and Service Occupations	0.31%	1
Sales and Related Occupations	3.43%	11
Office and Administrative Support Occupations	3.12%	10
Farming, Fishing, and Forestry Occupations	0.93%	3
Construction and Extraction Occupations	1.56%	5
Installation, Maintenance, and Repair Occupations	1.87%	6
Production Occupations	0.31%	1
Transportation and Materials Moving Occupations	1.87%	6
Other (please specify)	13.71%	44
	Answered	**321**
	Skipped	**0**

There is an attempt to understand the professional background of the survey participants in order to comprehend the potential end users of the BRI tool. Most respondents indicate business and finance as the industry they operate. This represents the majority of people engaged in blockchain activities, as a big part of the community derives from a financial background. (Zhang *et al.*, 2020).

Table 4.3: Question 3 – What is your position in the company you work for?

Answer Choices	Responses	
Executive	37.22%	99
Manager	25.94%	69
Associate	14.66%	39
Developer	10.53%	28
Researcher	11.65%	31
Other (please specify)		56
	Answered	**266**
	Skipped	**55**

Table 4.4: Question 4 – What is your level of familiarity with blockchain fundamentals?

Answer Choices	Responses	
Very Poor	3.90%	12
Below Average	7.14%	23
Average	22.40%	71
Above Average	46.75%	147
Excellent	19.81%	63
	Answered	**316**
	Skipped	**5**

Survey participants originate from a variety of professional backgrounds, company positions, and levels of blockchain expertise. This enables the research to derive on conclusions based on opinions and indicator assessments from a wide range of industries and knowledge levels. The findings presented in Table 4.4 indicate a weighted average of the sample at 3.74/5 (well within the Above Average threshold), a figure that possibly leads to a reasonable judgment regarding the importance of pillars and indicators for a blockchain-related index. Specifically, the findings in Table 4.4 indicate that 88.93% of the survey participants stated that they own average, above average or excellent familiarity with blockchain fundamentals. If these figures reflect the actual familiarity of participants, the reliability of the final findings is justified to a more positive extent.

Table 4.5: Question 5 – How do you rate the importance of the following pillars as metrics to compose the Blockchain Readiness Index?

	Very Low	Low	Average	High	Very High	**Weighted Average**
Regulation	4.09%	6.92%	12.89%	28.30%	47.80%	**4.09**
Technological Advancement	1.90%	4.75%	14.24%	40.51%	38.61%	**4.09**
Blockchain Industry Presence	3.14%	6.60%	22.33%	37.74%	30.19%	**3.85**
Local Users Engagement	4.98%	8.10%	21.81%	30.22%	34.89%	**3.82**

From the sample of survey participants, there is a general belief that all four pillars of indicators shall be taken into consideration when participants decide to move their blockchain-based operations to a specific country. The question was assessed on a Liker Scale of 1-5, which is an adequate scheme for gathering data in terms of reliability and test information perspective in the scale development process (Arnold, McCroskey and Prichard, 1967). The pillars' weighted average score is identical. The Legislation and Technological Advancement pillars are considered the most critical aspects prior to decision-making as they both score a weighted average of 4.09/5.00 each. This score falls within the "Very High" threshold. The other two pillars, Blockchain Industry Presence (3.85/5.00) and Local Users Engagement (3.82/5.00), also seem substantial enough to be considered prior to decision-making actions, as they fall within the "High" threshold. These findings conclude that indicators from all pillars shall be assessed to construct the BRI.

Table 4.6: Question 6 – How do you rate the importance of the following indicators as metrics to compose the Blockchain Readiness Index?

BRI Indicators	Very Low	Low	Average	High	Very High	**Weighted Average**
Favorable Regulation for Blockchain/Cryptocurrency Activities	3.53%	3.53%	10.90%	30.45%	51.60%	**4.23**
Bitcoin Node Distribution	10.29%	13.18%	28.30%	30.87%	17.36%	**3.32**

Ethereum Node Distribution	12.79%	15.08%	28.20%	28.85%	15.08%	**3.18**
Bitcoin ATMs	21.10%	21.43%	22.40%	19.81%	15.26%	**2.87**
E-Government Development Level	5.81%	9.68%	16.45%	32.58%	35.48%	**3.82**
ICT Development Level	1.97%	10.53%	22.37%	37.50%	27.63%	**3.78**
Internet Penetration	0.97%	1.61%	13.87%	37.42%	46.13%	**4.26**
Innovation Level	0.97%	3.55%	18.06%	44.84%	32.58%	**4.05**
Presence of Top Cryptocurrency Exchanges	9.74%	15.26%	28.25%	25.32%	21.43%	**3.33**
Fintech Ecosystem Level	1.95%	7.79%	23.70%	40.58%	25.97%	**3.81**
Mining Costs	14.98%	15.96%	24.10%	26.38%	18.57%	**3.18**
Ease of Establishing Business Operations	1.31%	4.25%	16.34%	40.20%	37.91%	**4.09**
Public Interest on Bitcoin	6.86%	13.07%	25.49%	28.43%	26.14%	**3.54**
Public Interest on Blockchain	5.18%	9.71%	22.65%	31.72%	30.74%	**3.73**
Public Interest in Ethereum	10.75%	14.66%	27.69%	26.38%	20.52%	**3.31**
Bitcoin Software Downloads	12.26%	20.65%	27.74%	24.84%	14.52%	**3.09**
Ethereum Wallet Downloads	14.66%	18.24%	26.38%	28.01%	12.70%	**3.06**
Human Development Level	2.92%	8.77%	24.35%	40.26%	23.70%	**3.73**
Mobile Subscriptions	5.16%	10.97%	24.84%	35.48%	23.55%	**3.61**

Indicators of all pillars are displayed in the table above as rated by the survey participants based on their importance in composing the Blockchain Readiness Index. The question was assessed on a Liker Scale of 1-5.

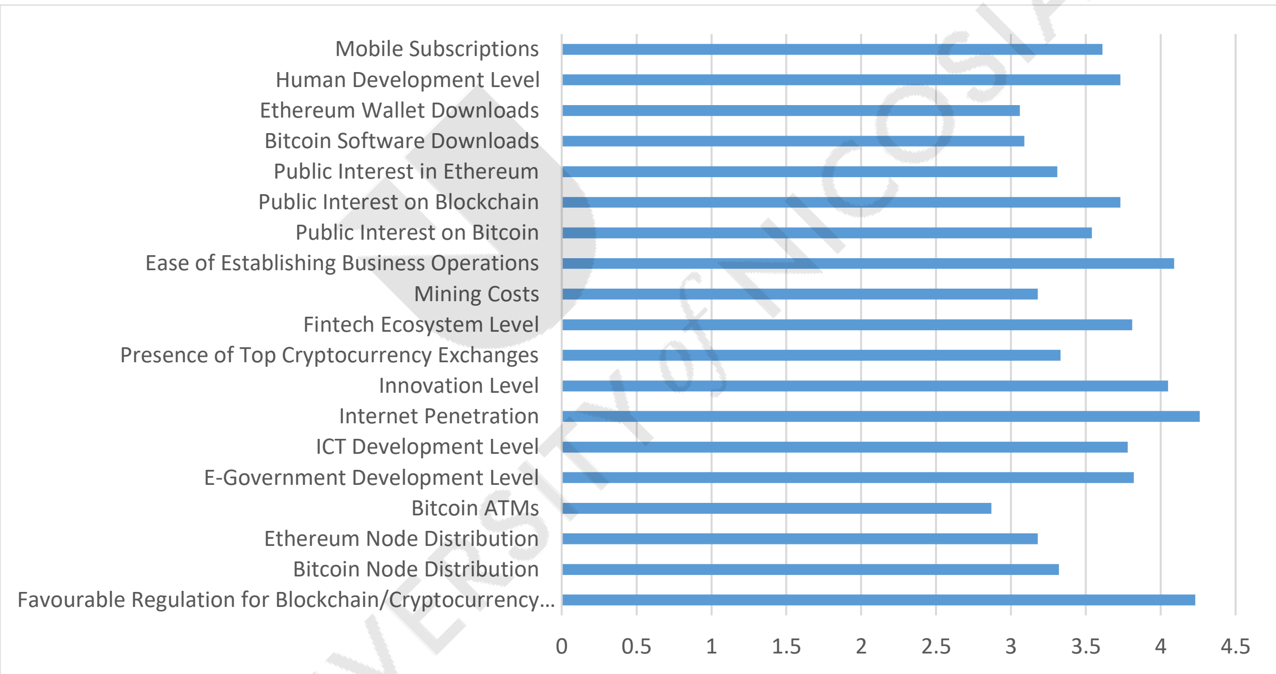
The adjustment of weights methodology is discussed and implemented in Chapter 6. It is applied in two additional versions for the year-end 2021; (a) BRI 2021 Community-Driven Version based on the Weighted Average column in Table 4.6 and (b) BRI 2021 Weights-Adjustment Version based on user's individual preferences. There was no implementation of the additional BRI versions at this stage since the methodology for estimating blockchain regulation via web mining is not enhanced in the respective indicator. Chapter 6 will also assess the BRI Standard Version and enhance equal indicator weights as the "default" version.

4.1.1 Discussion on Survey 1 Findings

The data observations in this section reflect the assessment of people engaged academically with blockchain technology.

It is observed in Figure 4.1 that survey participants recognize the importance of all chosen pillars and indicators, as even the lowest-ranked pillar, "Local Users Engagement," as well as "Bitcoin ATMs," have a relatively high weight. The highest-ranked pillars and indicators fall within the "Very High" threshold, as indicated in Table 4.6.

Figure 4.1: Rating of BRI Indicators



The indicators focusing on regulatory stance, internet penetration, and ease of establishing business operations are the most highly scored. Due to this finding, it is assumed that the community believes that the local infrastructure and the external factors affecting blockchain operations are more important towards readiness than individual interests and technical presence at this stage.

Favourable Regulation for Blockchain/Cryptocurrency Activities has the highest weighted average (4.23/5.00), while Bitcoin ATMs (2.87/5.00) and Ethereum Wallet Downloads (3.06/5.00) have the lowest weighted average. Even these lowest indicators in terms of weighted average scores are within the "Average" or "High" thresholds. Considering this metric, there is an assignment of equal weights for the above indicators as composites of the preliminary BRI 2020 Standard Version, which assesses information for the year-end 2020. The reasons for this decision are: (a) the majority of the participants recognize all suggested indicators as important since they are re-scored within the upper thresholds, and (b) BRI will allow further flexibility in adjusting weights according to the preferences of users.

Due to these findings, the researcher justifies the construction of the three different BRI versions, each reflecting different preferences and potentially targeting users. The versions aim to serve the decision-making procedures of participants within the blockchain industry. Therefore the construction of a flexible service is assumed to be the more ideal and usable in this case.

The BRI Standard Version weighs equally all indicators, similar to technological indexes reviewed, such as the NRI, and designed according to the overall consensus among the survey participants that all chosen indicators are at least rated "Average" or "High" in terms of importance.

The BRI Weights-Adjustment Version allows manual adjustment of any indicator according to the users' business needs and preferences. The adjustment tool will be embedded based on the varying assessment of each indicator in order to satisfy the customized criteria of groups of users that operate under specific circumstances. Varying weights have been adopted in other technological indexes like the AVRI and ARI but were based on the manual adjustments of index creators. The BRI Weights-Adjustment Version allows for flexible adjustment of weights in order to eliminate the possibility of false conclusions due to misjudgement of imposing manual indicator weights.

The understanding of the community's preferences and the corresponding assessment of blockchain readiness will be reflected via the BRI Community-Driven Version. The indicator weights are customized according to the Weighted Average in Table 4.6. This version scientifically supports the allocation of weights from the survey findings and is ideal for users sceptical about relying on their weighting assessment. Some of these users are expected to be new and relatively unfamiliar with the blockchain industry. Thereby the option of trusting the assessment of the engaged community is suitable for them.

4.2 BRI Scoring Formula

The BRI Scoring Formula(Iosif, Christodoulou and Vlachos, 2020) is constructed to be the fundamental mathematical equation determining country scores for all BRI versions. The additional calculations to final values that occur for the Weights-Adjustment Version and the Community-Driven Version are discussed in Chapter 6.

The allocation of equal weights on the preliminary BRI 2020 Standard Version and the BRI 2021 Standard Version is expected to satisfy the needs for some interested users like new blockchain startups and policymakers. This is because scientific indexes examined during the literature review process enhance equal indicator weighting (Ayanso, Chatterjee and Cho, 2011), (Dutta *et al.*, 2019) (Hileman, 2015).

The value for a number of indicators is expected to be unavailable from the sources adapted for a set of countries. A preliminary step is developed to estimate missing indicators' values based on the cosine similarity between closely assessed countries in terms of rankings. The cosine similarity measurement is widely used in multiple scientific areas, including semantic web (Christodoulou, Paton, and Fernandes, 2015) and natural language processing (Iosif and Potamianos, 2013), especially for studies related to unsupervised machine learning.

Estimating the values of missing indicators is a challenge (KPMG, 2019) that must be addressed in order to formulate rankings for a wide range of countries. As observed in Table 2.21, all examined indexes except CMPI (Nguyen and Jeong-Hun, 2020) assess a limited number of countries because of limited available sources. One of the main challenges of the BRI is to establish a procedure where estimations are possible for missing indicators according to patterns of similarly scored countries. The BRI methodology suggests a preliminary step that may be considered an adequate solution to the problem of missing indicators. This step theoretically allows BRI to provide rankings for an unlimited set of countries and indicators. The identification of as many numerical sources as possible is still assumed to be the most precise method to obtain relevant results.

The total number of BRI indicators was set to 19, following the literature review process and the Survey 1 results that justified the selection of those indicators. For the following hypothetical scenario describing the overall procedure of estimating a missing indicator, we assume that the maximum number of indicators equals 3.

- In this hypothetical scenario, assume Cyprus is missing the third indicator while the respective vector of indicators is [0.25, 0.30, 0]. In the case of missing indicators, the respective non-available values are substituted by zeros values representing the unavailability of information. For estimating the value of the missing indicator of Cyprus, the assessed countries that have all indicators available are considered. Assume that Singapore, Malta, and Switzerland are the countries that have all indicators sourced from available information. Let their vectorized indicators be [0.17, 0.20, 0.20], [0.15, 0.18, 0.35], and [0.28, 0.16, 0.30], respectively.

- The next step is to compute the cosine similarity between indicators annotated in Cyprus and indicators annotated in Singapore, Malta, and Switzerland. Applying the cosine similarity yielded the following similarity scores: 0.795, 0.556, and 0.686, respectively. In order to estimate the missing value of Cyprus' indicator, a number of top similar countries are considered. In this case, two countries are considered; Singapore and Switzerland, since they constitute the two most similar countries in terms of indicator values to Cyprus. The online BRI tool[11] allows users to select on how many similar countries the estimation of missing indicators shall be conducted. Assuming the user selects two, the values of the third indicator of Singapore and Switzerland are added and divided by two to derive an average value as follows:

$$\frac{0.20 + 0.30}{2} = 0.25$$

- The zero value that represented the missing indicator of Cyprus is substituted by 0.25. This results in the following set of indicators for Cyprus: [0.25, 0.30, 0.25].

Upon the collection of the numerical values (available and estimated) for each indicator, a score per country is conducted with the following four computational steps:

1. **Data Normalisation**

   All non-normalized values are normalized respective to the population of each country. Non-normalized values are mostly derived from non-index sources such as Bitcoin Core Downloads, Bitcoin Nodes, Ethereum Nodes, and Crypto ATMs per country. Then, all values are normalized to a max-based scheme [0, 1] interval.

2. **Benchmark Level – The Ideal Country**

   The objective of the scoring mechanism is to fairly calculate the country scores based on an accurate benchmark target index. The concept of an "Ideal Country" is introduced to facilitate this cause. The "Ideal Country" is a non-existent country that exhibits the highest-scoring values regarding the considered indicators.

3. **The similarity between the Ideal Country and each Examined Country**

   The computation of similarities between each country and the Ideal Country is implemented by vectoring the indicators' values and calculating the cosine similarity

[11] http://readiness.unic.ac.cy/

between the corresponding vectors. Cosine similarity is commonly used among scientific studies to calculate relevance between values (Gunawan, Sembiring and Budiman, 2018). Where A is the Ideal Country, and B is each Examined Country, we want to calculate its BRI score; the cosine similarity is computed using the following formula to result in the BRI Score for each Examined Country:

$$\boldsymbol{BRI\ Scoring\ Formula = similarity(A, B) = \frac{A \cdot B}{\|A\| \|B\|}}$$

Let's assume that the total number of BRI indicators is 3, where Table 4.7 displays the indicator scores for the Ideal Country and the Examined Country, whose BRI score we aim to compute.

Table 4.7: Ideal Country and Examined Country Hypothetical Indicator Scores

	Indicator 1	Indicator 2	Indicator 3	BRI Score
Ideal Country	0.90	0.85	0.86	1
Examined Country	0.72	0.45	0.68	x

To find x, the following equation is calculated, which represents a detailed breakdown of the BRI Scoring Formula displayed above:

$$x = \frac{(0.90 * 0.72) + (0.85 * 0.45) + (0.86 * 0.68)}{\sqrt{0.90^2 + 0.85^2 + 0.86^2} * \sqrt{0.72^2 + 0.45^2 + 0.68^2}}$$

$$x = 0.9851$$

4. **Country Rankings**

The country scores are expected to be between the range [0, 1], where 1 is the BRI score of the Ideal Country. Countries with high BRI scores (close to 1) are expected to be close to the concept of the Ideal Country, as they reflect the similarity of the respective country with the best possible indicator values. The fewer the number of indicators assessed, the closer is expected that the BRI scores of examined countries will be to 1. Therefore, it is expected that with 19 BRI indicators assessed, the BRI scores of the highest-ranked countries will be lower than the example above (0.9851).

Since 19 BRI indicators are assessed for all countries, it is irrelevant if the range of high BRI country scores is lower than the example above (e.g., ≈ 0.70), as conclusions and comparisons between country scores will be based on the same number of indicators, i.e., 19.

4.3 BRI Rankings and Results of the Preliminary BRI 2020 Standard Version

This section displays a set of results of the preliminary BRI 2020 Standard Version, with data sourced for the year-end 2020. The country rankings are computed based on the methodology discussed, including identifying BRI indicators, estimating missing country indicators, and implementing the BRI scores for all assessed countries.

Table 4.8 displays the results for the Top 10 countries in terms of preliminary BRI scores for the year-end 2020. All indicators are equally weighted.

Table 4.8 Top 10 Countries – Preliminary BRI 2020 Standard Version

Country	BRI Score	Ranking
IDEAL COUNTRY	1	-
SINGAPORE	0.864	1
MALTA	0.814	2
SWITZERLAND	0.801	3
ESTONIA	0.796	4
CANADA	0.783	5
LUXEMBOURG	0.782	6
USA	0.778	7
NETHERLANDS	0.773	8
LITHUANIA	0.761	9
CHINA	0.760	10

The preliminary BRI rankings display some of the most innovative countries that have indicated signs of blockchain readiness, taking the top positions, such as Singapore, Malta, and Switzerland (Almekhlafi and Al-Shaibany, 2021). The list with the complete rankings of the preliminary BRI Standard Version is displayed in Appendix IV for 192 countries.

To evaluate how the BRI score for a given country is computed, Table 4.9 provides the example of the USA and the Ideal Country after the normalization of the non-normalized indicators' scores to a scale of [0-1] is implemented. Decimal places vary depending on the numerical context of the indicator. As presented in Step 2 above, the normalization of scores must take place before calculating the indicator scores of the Ideal Country in order to reflect comparable values. The cosine similarity between the scores of the USA's and Ideal Country's indicators (Step 3) determines the preliminary BRI score of the USA.

Table 4.9 Relationship between Ideal Country and USA Indicator Scores

Preliminary BRI 2020 Indicators	Ideal Country	USA
Cryptocurrency Regulation Analysis 2020	7.9	7.5
e-Government Development Index 2020	0.9758	0.9297
Global FinTech Score 2020	31789	31789
Internet Penetration as a % of Population in 2020	0.996	0.898
ICT Development Level 2017	0.898	0.818
Global Innovation Index 2020	0.6608	0.6056
Mobile Subscriptions per 100 People in 2019	289	124
Doing Business Index 2020	86.8	84
Human Development Index 2020	0.957	0.926
Top 100 Crypto Exchanges in Total Volume in 2020	0.000050840391	0.000000048337
Crypto ATMs in 2020	0.000052454888	0.000034585825
Cost to Mine 1 Bitcoin in 2018	531	4758
Reachable Bitcoin Nodes in 2020	0.000089044551	0.000006021099
Reachable Ethereum Nodes in 2020	0.000090934854	0.000008697815
Google Searches for the word "Bitcoin" in 2020	100	19
Google Searches for the word "Blockchain" in 2020	100	7
Google Searches for the word "Ethereum" in 2020	100	10
Bitcoin Core Downloads in 2020	0.000010211479	0.000000836851
Ethereum Wallet Downloads in 2020	0.000006449783	0.0000014199228
Preliminary BRI 2020 Score	**1**	**0.778139**

The indicators that required normalization because the sources did not divide their numerical values by the respective population of countries are the following:

- Top 100 Crypto Exchanges in Total Volume in 2020
- Crypto ATMs in 2020
- Reachable Bitcoin Nodes in 2020
- Reachable Ethereum Nodes on 2020
- Bitcoin Core Downloads in 2020
- Ethereum Wallet Downloads in 2020

Further normalization was required for the following indicators to address values between the [0 to 1] range.

- Cryptocurrency Regulation Analysis 2020
- Global FinTech Score 2020
- Mobile Subscriptions per 100 People in 2019
- Doing Business Index 2020
- Cost to Mine 1 Bitcoin in 2018
- Google Searches for the word "Bitcoin" in 2020
- Google Searches for the word "Blockchain" in 2020
- Ethereum Wallet Downloads in 2020

When the BRI Scoring Formula is applied, the cosine similarity between the two sets of values is equal to 0.778139, representing the USA's preliminary BRI score. There is an assumption that the preliminary country rankings and results appear to reflect a relatively realistic overview of blockchain engagement per country. Still, the justification of the results requires a ground truth evaluation procedure.

4.3.1 Survey 2 – Evaluation of the Preliminary BRI Country Scores through Community Voting

The evaluation procedure for the preliminary BRI 2020 Standard Version scores is expected to indicate whether the methodology followed can be justified. The preliminary BRI Standard Version scores are evaluated by establishing a ground truth procedure and comparing the preliminary BRI results with scores derived from the community's opinion.

The research adopts an approach to grasp the community's opinion on country scores, similar to the method used to identify BRI indicators and relevant weights. A survey was sent out to a community of students and professionals registered at the University of Nicosia's blockchain-related academic degrees[12]. A total of 64 countries were assessed. The research included the assessment of the community's opinion for a sample rather than for all 200+ world countries. This is done in order to provide survey participants with a limited set of countries that is convenient for them to respond to rather than requiring responses from a big sample.

The survey was sent out in six groups, with 175 responses being the largest amount of responses received for a given country. Response rates varied between 15%-23% which is considered an adequate rate to for estimations in online surveys (Nulty, 2008). The sample included a range of developing and developed countries that were mainly selected according to the most common geographical locations of the University's registered students. The assumption is that this approach enables the participants to provide a relatively precise opinion. Survey participants provided their assessment of country scores via a slider tool. The attempt was to clarify the scope of the survey, by sending the text displayed in Appendix III.

Table 4.10 displays the set of countries assessed and their respective weighted average.

Table 3.10 Country Scores per Community Voting

Country	Weighted Average	Number of Responses
Albania	26.846	175
Argentina	41.531	175
Australia	52.046	175
Bangladesh	27.474	175
Belgium	46.983	175
Bosnia	32.006	175
Brazil	46.378	175
Brunei	28.126	175

[12] https://www.unic.ac.cy/iff/

Cambodia	22.844	122
Canada	59.910	122
China	61.582	122
Colombia	34.090	122
Croatia	40.639	122
Cyprus	58.942	122
Denmark	54.238	122
Estonia	63.861	122
Finland	50.687	100
France	51.212	100
Germany	56.273	100
Greece	43.636	100
Hungary	35.859	100
Iceland	45.192	100
India	47.778	100
Iran	36.222	100
Ireland	46.051	100
Israel	55.000	100
Italy	43.040	100
Japan	65.803	152
Jordan	27.592	152
Latvia	42.632	152
Lithuania	42.526	152
Luxembourg	55.164	152

Malaysia	45.454	152
Malta	62.401	152
Mexico	37.230	152
Montenegro	33.750	152
Nepal	19.433	114
Netherlands	53.566	114
New Zealand	45.504	114
Nigeria	29.982	114
North Macedonia	25.903	114
Norway	49.089	114
Pakistan	26.292	114
Paraguay	25.939	114
Peru	25.204	114
Philippines	35.195	114
Poland	41.212	114
Portugal	38.399	114
Romania	35.351	149
Russia	54.641	149
Saudi Arabia	36.547	149
Serbia	30.108	149
Singapore	64.831	149
Slovenia	41.493	149
South Africa	41.040	149
Spain	48.142	149

Sri Lanka	28.736	149
Sweden	56.46622	149
Switzerland	66.973	149
Uganda	26.601	149
UK	62.142	149
Ukraine	44.736	149
Uruguay	31.574	149
USA	69.831	149

The Pearson rank correlation coefficient commonly used for jointly normally distributed data (Samuels and Gilchrist, 2014) was conducted between the values in Table 4.10 and the preliminary BRI 2020 scores. The coefficient score is 0.742, indicating a positive magnitude of the relationship between BRI's assessment and the community's opinions, where the community consists of academically accredited individuals. These findings tend to satisfy the methodology adopted for the preliminary version of the BRI and therefore support the individual country scores.

No remarkable outliers were found between the preliminary BRI results and the ground truth findings.

4.4 Evaluation of the Preliminary BRI Methodology

The processes of defining the BRI indicators, their weights, and country scores are outlined in this chapter. This preliminary version of the BRI was developed and evaluated to establish a standardized procedure for country scoring and justify that this methodology can be adopted for the finalized BRI versions. The evaluation metrics indicate a high correlation between BRI country scores with opinions from subject matter experts.

There is an identification of the gaps in the preliminary BRI 2020 Standard Version, which are mainly about essential improvements in terms of weights adjustment and a small set of indicator sources. To provide a useful index for the public and private blockchain industry, end-users shall be able to adjust indicator weights according to customized preferences.

Specific indicators may be more significant for a group of users than for another group regarding decision-making procedures.

Besides the manual assignment of weights, findings from Survey 1 are useful for developing an alternative set of assigned weights for indicators that will lead to customized BRI rankings, which reflect the community's judgment. Developments in blockchain technology are mainly facilitated by the community of users (Brody and Couture, 2021); therefore, community judgment is considered an important aspect of the industry. These variations of BRI versions are discussed and implemented in Chapter 6. By providing multiple weighting mechanisms for the end-user, the BRI may be able to assist more groups of users and multiple industries with specific decision-making needs. Upon successful implementation, the BRI attempts to provide an innovative technique to the industry with an enhanced degree of customization, which examined indexes have not delivered.

The challenges to identifying numerical sources were mostly overcome by sourcing information from updated numerical indexes and web-sourced data. At this stage, a challenge is the lack of an accurate estimate of the blockchain regulatory environment per country in numerical form. The source that is used to extract regulatory information[13] for the preliminary BRI 2020 Standard Version adopts a methodology that is considered highly speculative. The related indicators are considered either irrelevant to the regulation context (e.g., ICOs Located, Exchanges Located, User Voting) or derived from Wikipedia sources (e.g., Legality of Bitcoin). This initial source was used in the preliminary BRI 2020 Standard Version because it was identified as the only global country-based numerical ranking attempting to indicate regulatory stance. The need to establish a method that enables the measurement of the regulatory stance of countries through web mining seems to be the solution for a more realistic evaluation of the ecosystem.

The context of certain indicators of the preliminary BRI 2020 Standard Version is considered doubtful; therefore, there is an expectation to replace some sources with updated or more relevant alternatives for the finalized BRI versions. For example, "Cryptocurrency Activity" will be scored according to the location of the top 100 exchanges in Trust Score, which is a metric that measures multiple factors rather than only total volume. Indicators sourced from periodically published indexes are expected to be updated for the finalized BRI versions and, consequently, for the next years' versions.

[13] https://cointobuy.io/countries

Among the indicators considered, there is a degree of overlap. This implies that some metrics, like the Doing Business Index, are considered more than once. It is assumed that if an index is used as an indicator for another scientific index, it does not create a significant overlapping effect. Each index's country rankings are mostly derived from several indicators; therefore, the final scores are not affected significantly in the case of overlapping one indicator.

Any kind of modification to the current list of indicator sources is possible. However, the assumption is that the nature of these indicators is not subject to significant changes in the near future. These indicators are expected to remain relevant as far as their contribution to developing the finalized BRI versions.

The aim of the research is to use indicators that reflect updated information for each BRI version corresponding to the calendar year. Currently, sources like the ICT Development Index (ITU, 2019) reflect information applicable to previous years due to the absence of updated studies. Some indicators are measured according to all-time values (e.g., Total Volume of Exchanges), and others are measured according to values for the given calendar year (e.g., Bitcoin interest). Chapter 6 provides a more detailed analysis of the extracted indicator values, where the finalized BRI versions are presented along with the finalized indicator sources.

4.5 Discussion

The challenges of implementing a dynamic index that measures blockchain engagement per country have been identified. The initial attempt to resolve these challenges seems to have yielded promising results. The preliminary BRI 2020 Standard Version results provide a precise overview of blockchain engagement per country in 2020, as assessed by obtaining opinions from blockchain industry participants.

The implemented methodology is not finalized at this stage but has addressed the key challenges of identifying BRI indicators and estimating the values of missing indicators.

The identification of BRI indicators is based on their inclusion in previously examined indexes, numerical context, and relevance to the scope of the BRI. The 19 indicators identified derive from numerical sources, allowing the research to avoid manual or subjective scoring. This feature enables the automation of scores on an annual basis, given that the sources are available and updated regularly.

BRI is an index that can assess an unlimited range of countries because of the additional computational step that estimates the values of missing indicators. The estimation of missing indicators may be considered a competitive feature that is suitable to be adopted by future technological indexes. Consequently, the BRI may add value beyond its scope as a technique to estimate blockchain readiness, by setting the paradigm for future indexes with a limited range of examined countries and/or regions.

The samples of the two surveys conducted reflects opinions from participants with academic engagement with blockchain-related courses offered by the University of Nicosia. It is assumed that these samples provide a relatively truthful judgment toward the scope of the BRI. Due to the emergence of COVID-19 during this research, the survey method was identified as the ideal to reach a number of blockchain industry participants.

Through the data gathered from Survey 1, the research bases the fundamental structure of the BRI 2021 Community-Driven Version that is discussed in Chapter 6. The blockchain community evaluates each selected indicator by suggesting the importance of each one in constructing the BRI. Upon the calculation of country scores based on updated sources and the assessment of regulation through web mining, the BRI 2021 Community-Driven Version and the BRI 2021 Weights-Adjustment Version are implemented in Chapter 6.

In implementing the preliminary BRI Standard Version for 2020, initial results (Appendix IV) appear to be reliable according to findings derived from Survey 2 (Table 4.10). Equal weights were applied to all 19 indicators, with the community's voting assessment achieving a high correlation score with preliminary rankings. If the three finalized BRI versions to be implemented and discussed in Chapter 6 achieve a higher correlation score with the community's assessment, in that case, it is assumed that an improvement in the methodology compared to the preliminary experiment will occur.

There is no extensive analysis of findings for each indicator in this chapter. The scope of the preliminary BRI 2020 Standard Version is to identify indicators, apply the mathematical equation that computes the preliminary rankings, and establish a ground truth procedure to verify the reliability of the methodology. Since the correlation of the country rankings with the community's assessment is high, the assumption is that an extensive analysis of indicator scores is not required at this stage, but it is essential upon the finalization of all BRI versions.

This chapter concludes with an evaluation of the preliminary BRI methodology and the planned work that must be implemented to achieve reliable finalized BRI rankings. The methodology adopted in this chapter is fundamental for the upcoming work. The focus for the remaining part of this research shifts to establishing an automated scoring mechanism for domestic regulations and identifying potentially updated sources annually.

CHAPTER 5 ESTIMATING BLOCKCHAIN REGULATION VIA WEB MINING

5.0 Introduction

One of the objectives of this research is to address the challenge of assigning a numerical value to the legal treatment of blockchain activities. As revealed during the literature review, previous attempts relied on subjective judgment and manually implemented scoring mechanisms.

The regulatory framework of blockchain and cryptocurrencies varies depending on national jurisdiction, while it is considered a grey area in many countries (Subramanian *et al.*, 2020). In countries with established states like the U.S.A., the legal environment regarding blockchain operations varies according to state jurisdictions (Chohan, 2018). Such a diversification of legal jurisdictions and guidelines demonstrates the importance of the industry on assessing a country's regulatory landscape before making business decisions. Such decisions may include business activities like investments, company registrations, mining operations, etc. The industry participants involved in these decisions include, among others, company executives, governmental authorities and policymakers, individual investors, and industry professionals. The proposed methodology for measuring legal engagement per country computational model aims to provide an alternative to manual and subjective assessment of the regulatory landscape by focusing on numerical findings. Manual assessment of the blockchain regulatory environment can be costly and time-consuming, requiring specific expertise that is not widely found (Kubiak-Cyrul and Szostek, 2021). The subjective approach of such a process may lead to inaccurate estimations affecting the decision-making procedures of interested parties.

Subsequent sections discuss the computational model proposed for quantifying the regulatory stance per country (including the governmental stance) in relation to blockchain and cryptocurrencies. Our computational model is based on a Web mining technique that leverages on the results returned from web search engines (Iosif, Christodoulou and Vlachos, 2020) (Alasadi *et al.*, 2017).

Web mining is a technique from information retrieval which leverages results from web search engines, and extends techniques used in natural language processing (Iosif *et al.*, 2017) to discover useful information and/or patterns from data.

The proposed technique estimates the regulatory tendency per country in a numerical score, which represents the degree of local "non-hostility" (Iosif, Christodoulou and Vlachos, 2021).

The primary contribution of this methodology is the creation of an automated recommendation and evaluation mechanism for policymakers. This tool can assist relevant policymakers in assessing country paradigms that could be adopted to foster local regulatory hubs within their jurisdictions. These paradigms can serve as a guide for future blockchain-related regulatory guidelines and frameworks developed to regulate exponential technologies, which often evolve faster than the implementation of corresponding laws (Fenwick, Kaal, and Vermeulen, 2016).

Establishing regulatory frameworks for emerging technologies is considered a significant aspect years before the emergence of the blockchain industry (Aranson *et al.*, 1990). The findings from observing the structure of technological indexes indicate that the regulation aspect is considered mainly through manual assessment. A regulatory framework can drive key decisions in the respective business areas of each industry (Asquer, 2018).

The proposed technique is experimentally validated to analyze the derived estimations. A validation dataset has been constructed and used as ground truth for evaluating the accuracy of the results. Examining potential outlier values is essential to understand areas of improvement and possible future modifications of the proposed methodology.

5.1 Challenges

Identifying a methodology that would enable an estimation of the blockchain regulatory landscape per country, worldwide, is probably the most challenging objective of this research. There are multiple challenges to achieving this objective, with a vital one being the insufficient or unclear governmental attempts to regulate the blockchain industry (Kim and Kang, 2020). Gathering information about the regulatory stance of all individual countries appears to be a heavy task that can probably yield unreliable findings due to the absence of enough information. Furthermore a significant challenge lies in the rapid pace at which regulations in the blockchain industry are evolving. Keeping up with these changes and accurately reflecting them in the assessment is a challenging task.

The proposed BRI aims to be established as a tool for users worldwide, where useful findings may assist blockchain parties in decision-making procedures. Therefore, the BRI cannot afford to exclude the regulatory assessment of countries, even though limited online information may be available at this stage. In additional, the community rated the suggested indicator “Favourable Regulation for Blockchain/Cryptocurrency Activities” with a weighted average of 4.23/5, which is the second-highest score for any suggested BRI indicator assessed (see Table 4.6). This implies the importance of developing a methodology that reliably assesses the regulatory aspect of each country.

Identifying sources and gathering a large amount of information is not enough, as the BRI structure requires indicators to be numerically assessed. A manual assessment of the legal landscape of countries does not satisfy the scope of the BRI; which is a dynamic methodology for deriving the rankings.

Combining accuracy, quantity, and automation in the blockchain regulatory assessment of countries worldwide is a challenge that previously established indexes have not addressed, according to the findings in Chapter 2. The indicators that assess the regulatory landscape of blockchain and other exponential technologies are based on a manual gathering of information and subjective scoring schemes.

Our methodology relies on a methodology that considers positive and negative cues and pragmatic constraints in the form of words or phrases. While the methodology will be detailed later in this chapter, two additional challenges emerge. The first one is identifying and categorizing the cues and constraints and the second one is adopting an appropriate mathematical formula that fairly scores countries according to the collected data.

Identifying a legal expert or several legal experts that have the knowledge to assess and compare country rankings with their actual blockchain and cryptocurrency regulatory landscape is a cumbersome task. Most legal experts in the blockchain industry are professionally engaged with an individual country rather than having an expert opinion on a wide range of regulatory frameworks (Bylinkina, 2020). Therefore, the evaluation procedure requires careful consideration to ensure a relatively accurate assessment of the blockchain regulatory stance. Certain outlier values are expected to occur, but the assumption is that the methodology used can be technically and fundamentally improved alongside the blockchain industry's readiness.

5.2 Regulatory Landscape in Scientific Indexes

A favourable regulatory environment governing the treatment of blockchain operations and cryptocurrency activity might be able to boost adoption by local industries and governments, thereby attracting regional and foreign investments. At this stage, regulation is considered one of the biggest obstacles to global blockchain adoption for investment funds (Crypto Fund Research, 2020).

The estimation of regulatory assessment by the scientific indexes examined in Chapter 2 is based on surveys and manual assessment of legal systems, and online resources. The reliability of the resources used are often questionable, as among the sources adopted is Wikipedia (Aibar *et al*>, 2015). The scientific indexes based on these types of assessments include the Autonomous Vehicles Readiness Index (KPMG, 2020), the Network Readiness Index (Dutta *et al.*, 2019), which assesses digital transformation, and the Automation Readiness Index (EIU and The Economist Intelligence Unit, 2018) which assesses automation procedures.

Similarly, the assessment of blockchain regulation and the legal environment around cryptocurrencies is limited at this stage, since the regulatory landscape is still evolving (Cumming, Johan and Pant, 2019). To the best of our knowledge no numerical framework was adopted to capture the regulatory stance of a country based on Web harvesting techniques, considering the above indexes. Some formal and informal sources have been published that provide an indication of the regulatory environment in some countries (e.g., see (Yeoh, 2017), (Cumming, Johan, and Pant, 2019), (Library Law of Congress, 2020) and (Global Legal Insights, 2021)). Current developments indicate a gap in the blockchain industry for a numerical model that captures a global regulatory signal and numerically assesses regulation on a global scale. This knowledge gap persists because existing reports and studies do not employ a clear quantitative method, such as a score-based assessment, which could significantly reduce the time required for assessment.

Examined indexes in Chapter 2 attempt to assess the regulatory landscape of the respective technology with the limitations explained. The remaining of this chapter examines and evaluates the methodologies adopted to measure the regulation-related indicators of technological and blockchain-related indexes.

Furthermore, the web harvesting approach proposed by the BRI is also discussed. In brief, our methodology is based on the Regulatory Stance Hypothesis (RSH). This hypothesis is built on the idea that the co-occurrence of positive/negative regulation-related cues with references to a country, lies within a coherent linguistic space. Analysing this space we can imply the country's tendency towards a positive/negative stance. The proposed model uses lexical information harvested from the WWW using search engines to estimate the regulatory stance of a given country with respect to cryptocurrencies and blockchain. The regulatory stance for the countries of interest is assumed to be reflected in the web documents indexed by the search engines (e.g., Google Search).

5.2.1 Assessment of Regulation in the NRI

The regulatory aspect of network readiness is considered a sub-pillar in the NRI and measured by assessing the following indicators, as presented in Table 2.6:

1. **Regulatory Quality:** An indicator sourced from The World Bank[14] that measures *"the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development*". It assesses 204 countries, and scores are standardized on a scale from -2.5 to 2.5.

2. **ICT Regulatory Tracker:** The ICT Regulatory Tracker[15] is a composed metric of 50 indicators and is established as a tool to help decision-makers and regulators understand the advancement of ICT regulation. This tool tracks the regulatory changes in the ICT industry and identifies legal and regulatory ICT trends in 192 countries. The ICT Regulatory Tracker focuses on recording the existence and features of regulatory frameworks rather than measuring the quality of the implementation. As its name may suggest, it aims to track the progress and activity of ICT regulation in countries. Scores are standardized on a scale from 0 to 2.

3. **The average answer to survey questions concerning how the legal framework adapts to five types of emerging technology:** This indicator derives from findings of The World Economic Forum's Executive Opinion Survey (EOS) (McLennan and Group, 2022). The questions are answered on a Likert scale from 1 to 7. This survey is addressed to business executives annually. The aim is to gather information from experts on topics where data are insufficient or non-existent. The mean of the average answers to a question of how adequately the legal framework adapts to 5 emerging technologies: (1) Artificial intelligence, (2) Robotics, (3) App and web-enabled markets, (4) Big data analytics, and (5) Cloud computing.

[14] https://govdata360.worldbank.org/indicators/h5083f593?indicator=394&viz=line_chart&years=1996,2020#table-link

[15] https://app.gen5.digital/tracker/about

4. **Global Cyberlaw Tracker:** The Global Cyberlaw Tracker[16] measures countries' engagement with e-commerce legislation. It is used as an indicator that provides information on whether a country has implemented or drafted relevant legislation (or has a draft law pending adoption) in four areas: electronic transactions, consumer protection, privacy, and data protection, and cybercrime. Scores are standardized on a scale from 0 to 4.

5. **The average answer to the question concerning how the legal framework protects Internet users' privacy and data stipulates:** The answers have been aggregated, and a probability distribution has been calculated for each year on a standardized interval scale from 0 to 4. The median values of these distributions are the score estimates.

The NRI adopts several indicators to measure the regulatory environment, deriving both from numerical sources and survey findings. These indicators are equally-weighted to form the regulation pillar. This index does not individually score regulation but relies on several indicators to form the regulation pillar. The inclusion of indexes to serve as the pillar indicator displays the reliance on numerical indexes. However, there is a degree of subjective measurement as several of the indicators included are scored based on variable Likert scales.

There is no specific explanation given for the use of variable Likert scales. The BRI aims to eliminate subjective judgments as much as possible and attempts to rely on a numerical methodology that utilizes web harvesting techniques.

5.2.2 Assessment of Regulation in the AVRI

The AVRI adopts a similar approach to NRI to assess the industry's regulatory environment for 30 countries by positioning the seven indicators under the "Policy and Legislation" pillar, as presented in Table 2.11. The first three indicators are scored on a Likert scale from 1 to 7 based on a review of governmental press releases, media articles, and imposed regulations.

1. **AV Regulations:** Countries like Canada and Singapore, which have published supportive regulations for the AV industry, receive a high score for this indicator. This indicator also favors countries that have placed minimum regulatory restrictions

[16] https://unctad.org/page/cyberlaw-tracker-country-detail

regarding AVs' application, methods, and testing compared to countries that have imposed more strict guidelines.

2. **Government-funded AV Pilots:** A similar assessment method with the first indicator is adopted to score government-funded AV pilots' local activity. The findings indicate that the same group of countries is scored in the upper (Canada, Singapore, Czech Republic) and lower tiers (India, Brazil, Mexico) as the first indicator.

3. **AV-focused Agency:** Countries are awarded low scores on this indicator if their local governments spread tasks and responsibilities regarding AV activities across a wide range of governmental entities. This scoring scheme suggests that the AVRI supports the notion of having a common and understandable regulatory approach and a central point of contact to address users' needs. Countries that assign AV-related responsibilities to existing government departments achieve middling scores. Countries like Hungary that have established innovative agencies responsible for governing AV-related activities achieve the highest scores.

4. **The Future Orientation of Government:** This is a numerical indicator adopted from the previously established World Economic Forum's Global Competitiveness Index 2019 (World Economic Forum, 2019). This indicator assesses policy stability, the responsiveness and adaptability of the governments' frameworks to change, and their long-term vision. The average of these findings is used to produce the final country scores.

5. **The Efficiency of the Legal System in Challenging Regulations:** This is a numerical indicator derived by the opinions of business executives and specifically sourced from the World Economic Forum's Global Competitiveness Index 2019 (World Economic Forum, 2019). The index assesses how regulations can be challenged within a country's legal system to measure the capabilities of the AV industry to challenge hostile government rules.

6. **Government Readiness for Change:** Derived from the KPMG International's 2019 Change Readiness index (KPMG, 2019b), this index assesses the preparedness level of a country's government, people, private organizations, and civil society to manage

and react to *"change and cultivate opportunity"*. This study assesses 140 countries by scoring 30 equally divided and weighted indicators under the enterprise, government, people and civil capabilities pillars.

7. **Data-sharing Environment:** This index is based on data sourced from the World Wide Web Foundation's Open Data Barometer 2016 [17] and was also used in the NRI. It assesses the ability of 29 countries on adopting to open and shared data approaches that enable efficient collaboration between public and private sectors to encourage AV development.

The "Policy and Legislation" pillar is calculated from seven equally weighted measures. "The Future Orientation of Government" is a new indicator adopted in the 2020 edition.

The first three regulation-related indicators are based solely on human judgment of reviewing a set of text-related information. The process is not automized and relies on human judgments; specifically, the review of the researchers and a sample of official and unofficial documents. The researchers attempt to assess and score each country according to the findings of their reviews on a Likert scale. The main limitation is that human judgment has several boundaries in terms of the amount of information to process, especially when considering dynamic indexes. The proposed BRI methodology builds on a numerical methodology to estimate blockchain readiness. The regulatory stance is also derived based on web mining techniques.

5.2.3 Assessment of Regulation in the ARI

The ARI follows a different approach to scoring the regulation-related indicators than NRI and AVRI. The ARI methodology indicates that the regulatory assessment is divided across sub-pillars of the "Innovation Environment" (Table 2.12) and "Labour Market Policies" (Table 2.14) pillars.

The "Policies and Regulation" sub-pillar that belongs to the "Innovation Environment" pillar includes four indicators. This sub-pillar counts as 4% of the total ARI country scores, with each indicator equally weighted, which translates to 1% of the total ARI country scores for each indicator.

[17] https://opendatabarometer.org/?_year=2016&indicator=ODB

1. **Initiatives encouraging entrepreneurship:** The existence of initiatives that encourage a positive stance towards entrepreneurship as derived from the Economy Intelligence Unit [18].
2. **The average number of days to start a business:** The number of days required to start a business from the Doing Business Index (Mundial, 2020).
3. **Quality of insolvency network:** The assessment of insolvency laws between debtors, creditors, and the court from the relevant indicator developed by the World Bank[19].
4. **The extent to which the cultural and social landscape encourages entrepreneurship:** The degree to which the society and culture of countries inspire the creation of new business activities and methodology that could provide increased levels of income as derived from the annual Global Entrepreneurship Monitor report (GEM, 2022).

The publicly available report (EIU and The Economist Intelligence Unit, 2018) provides a summarized view on the assessment of regulating innovation. This assessment may also include other indicators that belong to other sub-pillars since there are multiple indicators across many sub-pillars that may indicate regulation-related assessment.

The objective of this sub-pillar is to understand which economies facilitate innovation through their regulatory approach. For example, restrictive visa requirements impose an obstacle for local organizations to employ the best possible talent. Countries with programs seeking to attract a skilled workforce and professionals, like the French Tech Visa[20], are considered more innovative toward automation technologies.

The ease of starting a business and the support to tech startups are assessed as they are considered a regulation-related obstacles for technology professionals to engage within jurisdictions.

The "Labour Market Policies" pillar includes the "Review of regulations for new forms of employment" indicator that counts toward 1.6% of the total ARI country scores. The existence of a relevant national review regarding new forms of employment is assessed by

[18] https://www.eiu.com/landing/regulatory-affairs
[19] https://tcdata360.worldbank.org/indicators/d944bdfc
[20] https://lafrenchtech.com/en/how-france-helps-startups/french-tech-visa/#:~:text=The%20French%20Tech%20Visa%20is,a%20residence%20permit%20for%20France.

examining the Mapping Report by the Economist Intelligence Unit (Economist Intelligence Unit, 2016).

The assessment of regulation in the ARI is scattered across various pillars and sub-pillars, methodology is not transparent and in some cases not easy to understand and comprehend. This scattering of regulatory assessment is not found to this extent on other indexes reviewed for this research. The indicators are applied to different weights across sub-pillars and are mostly sourced from numerical sources that add a degree of automation to the process. The BRI aims to enhance automation for retrieving regulatory scores per country. Furthermore, our technique allows the implementation of different weighting strategies when considering the values from the indicators.

5.2.4 Assessment of Regulation in the CMPI

The regulation assessment has been implemented but not included in the final CMPI rankings, as it has been eliminated according to the methodology of the specific index.

A manual scoring scheme was designed to assess regulation per country, as shown in Table 2.17. The assessment was based on text written by legal experts, which is available online (Library Law of Congress, 2020).

Countries with restrictive measures like an absolute ban (-2) or an implicit ban (-1) were negatively scored. Countries that do not impose bans were assumed to have a “non-hostile” regulatory approach with no negative points granted. Countries with imposed blockchain and/or cryptocurrency-related regulations and/or guidelines have been awarded positive points as follows:

1. Tax Law (+1)
2. Anti-money laundering Law (+1)
3. Antiterrorism financing law Cryptocurrency Ownership Law (+1)

All negative and positive scores are aggregated, and countries are ranked according to the total aggregated score.

The assessment procedure is not automated and relies heavily on humans examining online information and ranking countries according to a randomly chosen scoring scheme. The scoring scheme is not justified. This implies a relatively highly subjective approach that may apply to a limited number of countries if the information from the specific source is missing for some jurisdictions.

The CMPI report does not provide the regulation scores or rankings per country (Nguyen and Jeong-Hun, 2020), and this also applies to the other indicators used to construct the CMPI. This adds a degree of non-transparency to the research, as only the final CMPI scores are displayed for all assessed countries.

The premise is that scores for each indicator should be transparently presented on scientific indices, such as the BRI, enabling users to critically evaluate the methodology and derivation of the results.

5.2.5 Assessment of Regulation in the CRI

The estimation of regulatory stance in the CRI is based on a Wikipedia source[21]. Wikipedia editors have named the Wikipedia page where the information is sourced as "Legality of cryptocurrency by country or territory".

The assessment of countries is in the form of text that covers the majority of recognized countries in the world. The countries are categorized under their respective regions, e.g., North America, North Africa, Western Africa, etc.

The description of the blockchain regulatory landscape per country is mostly comprehensive. It consists of one sentence for relatively small countries (e.g., Namibia) or a few sentences for bigger countries (e.g., the USA). This implies that readers can probably not assess the regulatory approach of each country to a scientific extent, as a lot of information regarding official frameworks and guidelines is missing.

The reliability of Wikipedia sources is questionable, as they are maintained by a community of volunteer editors (Wong, Redi, and Saez-Trumper, 2021). As per Wong, Redi, and Saez-Trumper, there is a lack of large-scale data to support the development of machine learning and information retrieval algorithms that could improve the reliability of sources. Therefore, the current structure of Wikipedia implies that information retrieved from its sources cannot be considered perfectly accurate and reliable.

The information for some countries seems outdated, while the status of other countries reflects the current year's developments. For example, the most updated blockchain regulatory status for North Macedonia is regarding a press release in 2016, France in 2014, and Luxembourg in 2015.

[21] https://en.wikipedia.org/wiki/Legality_of_cryptocurrency_by_country_or_territory

Similar to CMPI's methodology, the regulation scoring scheme of CRI is randomly chosen without any scientific explanation provided. . Countries are awarded a point if the ownership of cryptocurrencies is permitted, and they receive an additional point if their banking sector is deemed "non-hostile" towards cryptocurrencies. However, not all countries evaluated are assessed on both these aspects - ownership and banking sector attitude

The specific Wikipedia source may contain many inconsistencies and outdated information. The BRI aims to assess the regulatory stance of each country by considering their stance from the early initiatives until the same calendar date, to establish consistency in rankings.

5.2.6 Cryptocurrency Regulation Analysis

The preliminary BRI 2020 Standard Version considers regulatory scores from a blockchain-oriented study, which is noted as one of the initial attempts to score 249 countries according to their cryptocurrency regulatory environment (Cointobuy.io, 2020). The numerical scores of countries were based on five indicators summarized as follows:

1. **The Legality of Cryptocurrencies:** This indicator examines whether cryptocurrencies are considered legal, within a grey area, or banned by local governments. The sources that determine the scores of each country are not displayed, but it is assumed they are derived from text-driven content. The countries that have not placed an outright ban on blockchain and cryptocurrency activities are outlined as "dangerous".

2. **ICOs Restrictions:** The second indicator aims to assess local restrictions of ICOs. These may include outright bans and "hostile" regulatory guidelines that could affect the investors' investment ability. It is assumed that such restrictions could provide challenges for team members to develop and launch their DeFi projects. Such a restriction is placed in the USA, where coin offerings are classified under securities laws; this classification forced many projects to register abroad (Henderson and Raskin, 2018). The sources used to derive this information are not referenced.

3. **ICOs Locations:** The sources to derive this information are not referenced. It is questionable if the scores also reflect the number of DeFi projects since the concept of ICOs may be considered outdated (Lyandres, Palazzo, and Rabetti, 2022).

4. **Exchanges Locations:** The location of cryptocurrency exchanges is a similar indicator adopted as the relevant one used in the BRI. This indicator examines the availability of cryptocurrency exchanges for traders and investors, as the crypto–to–fiat and fiat-to-crypto ramps are still a convenient way for new users to get on-boarded into the ecosystem. The regulation of cryptocurrency exchanges determines the locations in many instances, such as in the case of Binance relocation due to the hostility of the regulatory environment (Disli *et al.*, 2022). The methodology does not clarify whether this indicator reflects the number of company registration of exchanges per country or the ease of users registering in cryptocurrency exchanges per country.

5. **User Opinions:** This indicator relies on the opinion of users. The users who access the website are asked to vote for the countries they believe have the friendliest blockchain-related regulations. The professional background and expertise of the voters are unknown, while the number of votes is low, i.e., Malta which is ranked first in the rankings, has one positive vote and zero negative votes[22].

The inefficiencies of the methodology mostly apply to the unknown origins of sources. Countries are scored based on their "Safety Rank" which is a combination of the five indicators' scores. There is no justification on how the score of each indicator was derived.

Some indicators' relevance to each country's regulatory stance may be questionable. The concept of ICOs, which is the main examination point for the second and third indicators, may be outdated. User opinions are also subjective and could be used as an evaluation method rather than as an index indicator.

There is a level of non-transparency in the procedure of calculating the final country scores. The scoring formula is not displayed. Therefore, the weights of each indicator are also unknown.

The BRI's approach of obtaining web-harvested information could drive a relatively reliable and automated procedure that can substitute manual approaches.

Table 5.1: Top 10 Countries of the Cryptocurrency Regulation Analysis

Rank	Country	Safety Rank	ICOs Located	Exchanges Located

[22] https://cointobuy.io/countries/malta

1	Malta	7.9	0	2
2	Netherlands	7.9	0	1
3	France	7.8	1	1
4	Slovenia	7.6	0	0
5	USA	7.6	1474	15
6	Cyprus	7.4	0	1
7	Czech Republic	7.4	0	1
8	Bulgaria	7.4	0	1
9	Romania	7.3	0	0
10	Ireland	7.3	1	0

Table 5.1 outlines the detailed score of the top-10 countries based on their "Safety Rank".

Some data presented in Table 5.1 may be inaccurate. For example, Slovenia is presented as having zero ICOs located, where official Slovenian government sources stated that ICO investments received around 49% of the financing of startups[23].

The common assumption that derives from examining how country-based regulatory stance is assessed in blockchain-related indexes, is that there is a degree of reliance on speculative or untrustworthy sources. There is no complete transparency on how scores were derived since text-based sources are adopted, complicating the scoring schemes. The timeframe to which countries are assessed is relatively unknown. The BRI aims to address the above challenges using a well-structured numerical technique.

5.3 BRI Methodology to Estimate Blockchain Regulatory Stance

This section presents the computational model used to measure the regulatory stance of a country towards blockchain activities (Iosif, Christodoulou and Vlachos, 2021). This model uses search engines and assesses lexical data sourced from the WWW. The research assumes

[23] https://www.gov.si/en/news/slovenia-launches-national-test-blockchain-infrastructure-and-slovenian-blockchain-partnership/

that the blockchain regulatory stance of assessed countries is reflected in the web sources indexed by the used search engines.

This section describes the aspects of the proposed model i.e., (i) the underlying hypothesis, (ii) the model parameters, including the needed web search queries, and (iii) a technique that ranks the blockchain regulatory stance of countries according to query data

The Regulatory Stance Hypothesis (RSH) is a key component of the proposed computational model. It is based on the idea that the co-occurrence of positive/negative regulation-related cues with a country's references within a coherent linguistic environment implies the country's tendency towards a positive/negative stance.

For example, and given a country, e.g., *Cyprus*, the co-occurrence of positive and negative regulation-related cues (or actions) with *Cyprus'* references within a coherent linguistic environment demonstrates *Cyprus'* tendency toward the local blockchain regulatory stance. The research assumes that if *Cyprus* maintains a hostile stance towards blockchain regulation, this stance will be indicated by the findings from publicly available online sources on the WWW.

The distributional hypothesis of meaning (DHM) (Harris, 1954) is the basis for the fundamentals of the RSH adopted in this research. DHM is one of the core components of distributional semantic models (DSM), a framework that suggests that context similarity indicates the similarity of meaning (Iosif and Potamianos, 2013). It is commonly used in natural language processing and information retrieval. This approach uses lexical semantics to estimate the semantic similarity between words and multi-word terms. Per Iosif and Potamianos, DHM considers the co-occurrence of words to obtain similarity measurements, that can assess the semantic similarity of the corresponding words (Iosif and Potamianos, 2010).

Our research proposes a new approach based on the RSH model, driven by the hypothesis that the largest source of lexical data is available on the WWW. Our new approach is based on a "contrast" aspect and differentiates this model from previous DSM-based approaches used to estimate semantic similarity. The positive and negative lexical cues (or actions) are computed to implement a "contrast measurement" that identifies the regulatory stance hypothesis per country.

The regulatory stance of each country is calculated based on the "contrast measurement" between positive and negative findings. The proposed RSH model also takes as input a single argument, e.g., *Cyprus*, compared to DHM and DSM models that consider pairs of words.

In the example of *Cyprus*, the blockchain regulatory stance is a numerical score, R_c that estimates *Cyprus'* legal tendency towards a positive or negative stance. The R_c score is calculated by measuring the co-occurrence of *Cyprus* references alongside positive and/or negative lexical cues (or actions). The positive and negative cues are derived from the textual content of online web sources and are also referred to as the "number of results" or "number of hits". The linguistic environment where the co-occurrence is considered is the textual context of web documents (Iosif, Christodoulou and Vlachos, 2021).

For a given country *c*, the R_c score is derived as follows:

$$R_c = \frac{p_c - n_c}{max[p_c, n_c]}$$

where,

- p_c is the total number of web documents in which country "c" co-occurs with positive cues

and,

- n_c is the total number of web documents in which country "c" co-occurs with negative cues

The regulatory stance of *Cyprus* is computed by subtracting the total negative cues from the total positive cues and dividing the result by the maximum value of positive or negative cues. This formula is implemented for normalization purposes in order to derive an R_c score within the range of [-1 to 1]. Based on this formula, the expected results for a given country are summarized as follows:

- If $p_c > n_c$, then $R_c \approx$ [0 to 1]. If the number of positive cues exceeds the number of negative cues, it is assumed that a given country has a ***positive*** stance toward blockchain regulation.
- If $n_c > p_c$, then $R_c \approx$ [0 to -1]. If the number of negative cues exceeds the number of positive cues, it is assumed that a given country has a ***negative*** stance toward blockchain regulation.

- If $p_c \approx n_c$, then $R_c \approx 0$. If the number of positive cues is approximately the same as the number of negative cues, it is assumed that a given country has a ***neutral*** stance toward blockchain regulation.

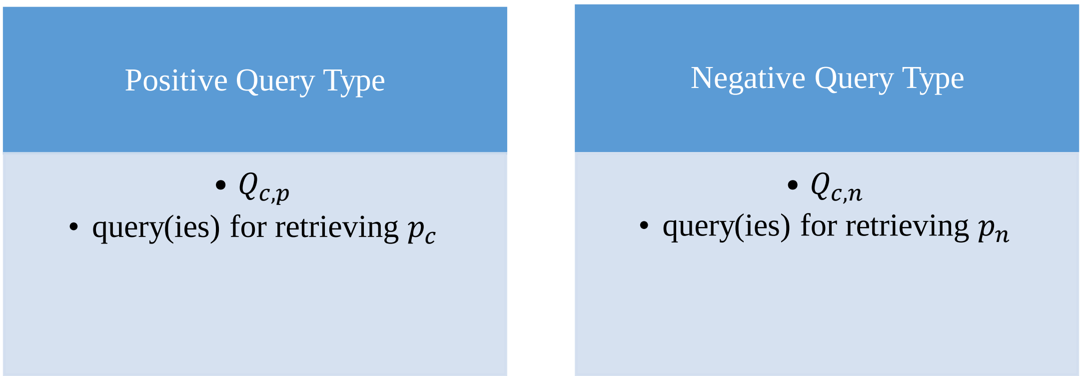
The queries to retrieve the values of the model parameters consist of text strings that are passed as query data to the web search APIs. Table 5.2 summarizes the positive cues, negative cues, and pragmatic constraints used by the proposed methodology to construct the two query types (one positive and one negative).

Table 5.2: Positive, Negative, and Pragmatic Cues Used for Estimating Regulatory Stance per Country

Positive cues	Negative cues	Pragmatic constraints
"recognizes", "allows", "issues", and "classifies"	"does not allow", "has forbidden", "restricts", "bans"	(cryptocurrencies OR blockchain regulation OR mining OR cryptocurrencies as property OR crypto assets OR stablecoins OR CBDCs OR tokens OR ICOs OR cryptocurrencies as security OR cryptocurrency trading OR Bitcoin OR blockchain OR Bitcoin as legal tender OR NFTs)

In the example of *Cyprus* displayed in Figure 5.1, an example of a positive query is *"Cyprus recognizes cryptocurrencies as property"*. An example of a negative query is *"Cyprus bans Bitcoin"*.

Figure 5.1: Query Types



The query types consist of lexical fields that define the complexity of the query. Our model considers synonyms of positive and negative cues to calculate results. The addition of the " " search operator (i.e., "recognizes" and "restricts") enables the consideration of synonyms (according to the Google Web search API). For example, the query "Cyprus adopts Bitcoin" will be included in the total number of positive queries, even though the word "adopts" is not included in the list of positive cues.

The first field outlines the country itself. Lexical variants can also be used for some countries, e.g., "USA" or "United States of America". The flexibility of variants in a single query is enabled via the use of the disjunctive "|" operator[24].

The second field outlines positive or negative lexical cues, as per Table 5.2 above. The technique allows for a lexical set to consist of one or multiple-word entries. For example, the field for negative allows the following query fragment ("bans" | "does not allow"), including synonyms of all positive and negative cues.

The third field outlines lexical entries that can thematically identify the scope of the web search. As per Table 5.2 above, the query fragment ("cryptocurrencies" | "crypto assets") can be appended to the query. The search queries retrieve results where entries are used according to the sense of the related field entries in order to filter results according to the relevance of the research.

5.4 Experimental Evaluation

[24] Assuming that this operator is supported by the utilized search engine. The "|" operator may also referred to as "OR".

This section presents an empirical evaluation of the Web harvesting methodology. For the purposes of the evaluation, we have extracted (using Web mining) datasets for 194 countries. These datasets represent the final regulatory tendency estimations per country. This experiment aims to provide each country's regulatory stance hypothesis and act as the individual regulation-related indicator toward the final versions of the proposed BRI; which is further discussed in Chapter 6.

The research considers historic web mining data until February 1st, 2022, the day on which the experiment took place. The decision to assess this historic data occurs because if the research only assesses data for one calendar year, i.e., the 365 days of 2021, the results for some countries are likely to mislead due to the small amount of information gathered. For example, *Montenegro* only returned seven positive and negative results for 2021, which meant that the technique placed Montenegro as the top-scoring country by far. This is not accurate, as the blockchain regulatory stance of *Montenegro* appears to be questionable compared to other countries (Global Legal Insights, 2021).

The BRI aims to be updated and published annually, so the web mining data will be assessed up to December 31st of each year for the next iterations. It is noted that since the index is numerical there are no restrictions as to when the BRI index is constructed, as long as all the indicators consider provide updated data in a numerical format.

For the Web search, Google's Programmable Search Engine[25] is utilized. Google's Programmable Search Engine was configured to consider the whole WWW's sample, as indexed by Google and offered via the relevant service, to obtain a maximum quantity of results. The supported language is set to English which is likely to return the most comprehensive results.

As presented in Table 5.2, the input data used for formulating the queries to extract positive and negative cues for the aforementioned pragmatic constraints. Also, the hq parameter[26] of the search engine was set to "regulation of cryptocurrencies". The hq parameter is set to express the context of the experiment in order to extract the most relevant results to the regulation-related topics. Table 5.3 displays the derived blockchain regulation scores and rankings as estimated by the adopted model (Iosif, Christodoulou and Vlachos, 2021).

[25] https://developers.google.com/custom-search

[26] More information about the supported parameters can be found in the documentation: https://developers.google.com/custom-search/v1/reference/rest/v1/cse/list

Decimal places in all tables and appendices relevant to the results of the methodology of this research, are displayed as retrieved from either the BRI versions or the indicators' sources.

The scores displayed in the second column are the ones reflected in the finalized BRI versions as one of the 19 indicators used, specifically the "Estimation of Regulatory Approach".

Table 5.3: Regulation Scores and Rankings per Country

Country (c)	Score Ratio $\frac{p_c - n_c}{max[p_c, n_c]}$	Ranking
MICRONESIA	0.20143	1
SAINT VINCENT AND THE GRENADINES	0.185325	2
NAURU	0.134294	3
KIRIBATI	0.101571	4
ANTIGUA and BARBUDA	0.100915	5
BERMUDAS	0.094531	6
COTE d' IVOIRE	0.074739	7
UKRAINE	0.058709	8
LESOTHO	0.033576	9
SAO TOME AND PRINCIPE	0.02723	10
SAINT KITTS AND NEVIS	0.026084	11
MALTA	0.022619	12
CURACAO	0.021234	13
DOMINICA	0.018971	14
SWEDEN	0.014724	15
REPUBLIC OF CONGO	0.004394	16
VANUATU	0.003049	17
ZAMBIA	-0.01099	18
MAURITANIA	-0.01306	19
GUINEA-BISSAU	-0.02554	20
GUYANA	-0.03743	21
MOLDOVA	-0.0515	22
BOSNIA	-0.05288	23

VIETNAM	-0.05668	24
GIBRALTAR	-0.05689	25
COMOROS	-0.06111	26
ERITREA	-0.06164	27
GAMBIA	-0.06272	28
TOGO	-0.0684	29
PHILIPPINES	-0.06953	30
BRAZIL	-0.06994	31
TAIWAN	-0.08111	32
HONG KONG	-0.08293	33
GRENADA	-0.08295	34
BAHAMAS	-0.08319	35
JAPAN	-0.08583	36
MALAYSIA	-0.09172	37
TANZANIA	-0.0925	38
UZBEKISTAN	-0.09343	39
TUVALU	-0.09538	40
SLOVAKIA	-0.09554	41
SOUTH KOREA	-0.0981	42
SINGAPORE	-0.09816	43
TRINIDAD AND TOBAGO	-0.10309	44
UK	-0.10397	45
IRELAND	-0.10446	46
IRAQ	-0.10595	47
TURKEY	-0.10927	48
USA	-0.11027	49
JORDAN	-0.11203	50
SURINAME	-0.1141	51
NIGERIA	-0.11413	52
GREECE	-0.1143	53
AUSTRALIA	-0.11638	54
RUSSIA	-0.11639	55
CHINA	-0.11717	56
SEYCHELLES	-0.11753	57

NEW ZEALAND	-0.12094	58
ISRAEL	-0.12166	59
SYRIA	-0.12397	60
PAKISTAN	-0.12769	61
BELIZE	-0.12942	62
BELARUS	-0.13242	63
DJIBOUTI	-0.13307	64
NETHERLANDS	-0.13804	65
ARMENIA	-0.1412	66
YEMEN	-0.14674	67
FINLAND	-0.14881	68
KYRGYZSTAN	-0.14912	69
FRANCE	-0.15145	70
THAILAND	-0.15243	71
GUINEA	-0.15359	72
INDONESIA	-0.15544	73
IRAN	-0.15646	74
ARGENTINA	-0.15721	75
CANADA	-0.15787	76
INDIA	-0.15817	77
PORTUGAL	-0.15859	78
CAYMAN ISLANDS	-0.15894	79
SWITZERLAND	-0.15956	80
PANAMA	-0.16011	81
MARSHALL ISLANDS	-0.16198	82
ITALY	-0.16238	83
KENYA	-0.16504	84
NORWAY	-0.16659	85
EL SALVADOR	-0.16891	86
ETHIOPIA	-0.16994	87
ESWATINI	-0.17011	88
TURKMENISTAN	-0.1705	89
BOLIVIA	-0.17128	90
MEXICO	-0.17185	91

LIBYA	-0.17321	92
SOMALIA	-0.17403	93
UGANDA	-0.17412	94
GERMANY	-0.17715	95
CROATIA	-0.17769	96
COSTA RICA	-0.17908	97
AUSTRIA	-0.18101	98
JAMAICA	-0.18172	99
QATAR	-0.18201	100
MYANMAR	-0.18328	101
COLOMBIA	-0.18455	102
ESTONIA	-0.18516	103
PERU	-0.18594	104
SPAIN	-0.18709	105
AFGHANISTAN	-0.18833	106
ROMANIA	-0.18865	107
CYPRUS	-0.1887	108
SOUTH AFRICA	-0.18949	109
MALI	-0.18958	110
SAUDI ARABIA	-0.19006	111
DENMARK	-0.19104	112
SOLOMON ISLANDS	-0.19231	113
SOUTH SUDAN	-0.19258	114
BANGLADESH	-0.19431	115
ICELAND	-0.19811	116
MONACO	-0.199	117
CZECH REPUBLIC	-0.20045	118
KUWAIT	-0.20195	119
AZERBAIJAN	-0.20527	120
SUDAN	-0.20718	121
EGYPT	-0.20793	122
LUXEMBOURG	-0.20802	123
HUNGARY	-0.20952	124
POLAND	-0.2097	125

BAHRAIN	-0.21297	126
SLOVENIA	-0.21529	127
HAITI	-0.21693	128
NEPAL	-0.21859	129
NICARAGUA	-0.21988	130
BULGARIA	-0.22053	131
CAMBODIA	-0.22251	132
PAPUA NEW GUINEA	-0.22336	133
CHILE	-0.22432	134
LEBANON	-0.22674	135
MOROCCO	-0.22981	136
SRI LANKA	-0.23049	137
CAMEROON	-0.23208	138
OMAN	-0.23678	139
BELGIUM	-0.23753	140
KAZAKHSTAN	-0.23823	141
LITHUANIA	-0.23834	142
BOTSWANA	-0.2393	143
MAURITIUS	-0.24151	144
DEMOCRATIC REPUBLIC OF CONGO	-0.24417	145
UAE	-0.24439	146
URUGUAY	-0.24566	147
GEORGIA	-0.24975	148
BARBADOS	-0.25062	149
MALDIVES	-0.25117	150
MOZAMBIQUE	-0.25183	151
NORTH MACEDONIA	-0.25268	152
HONDURAS	-0.25358	153
VENEZUELA	-0.2537	154
CUBA	-0.25498	155
SAINT LUCIA	-0.25821	156
GHANA	-0.26065	157
RWANDA	-0.26156	158

BURUNDI	-0.26303	159
TUNISIA	-0.26772	160
ALGERIA	-0.2687	161
ALBANIA	-0.28354	162
SERBIA	-0.28985	163
ECUADOR	-0.29234	164
LATVIA	-0.29239	165
LAOS	-0.293	166
GUATEMALA	-0.29453	167
SIERRA LEONE	-0.29864	168
ZIMBABWE	-0.29883	169
MONGOLIA	-0.30008	170
DOMINICAN REPUBLIC	-0.30138	171
SAN MARINO	-0.30224	172
EQUATORIAL GUINEA	-0.30354	173
NAMIBIA	-0.30494	174
BENIN	-0.30849	175
NIGER	-0.31303	176
MADAGASCAR	-0.31313	177
SAMOA	-0.31368	178
FIJI	-0.31381	179
PARAGUAY	-0.31654	180
BURKINA FASO	-0.32001	181
BRUNEI	-0.32785	182
BHUTAN	-0.33481	183
TONGA	-0.33781	184
ANDORRA	-0.33961	185
LIECHTENSTEIN	-0.34904	186
ANGOLA	-0.3622	187
MALAWI	-0.36792	188
MONTENEGRO	-0.37622	189
LIBERIA	-0.37658	190
SENEGAL	-0.3833	191
GABON	-0.38461	192

TAJIKISTAN	-0.39132	193
CAPE VERDE	-0.40842	194

According to the Web mining results, only 17 out of the 194 assessed countries indicate a positive stance towards blockchain regulation, while many currently impose a neutral regulatory stance (indicated by the countries whose score is near 0).

It is observed that within the top 50 ranks, the proposed model scores countries that have occasionally issued favorable blockchain regulatory guidelines and/or frameworks, such as *Bermuda* (6th), *Malta* (12th), *Gibraltar* (25th), *Hong Kong* (33rd) and *Singapore* (43rd) (Global Legal Insights, 2021). For example, *Bermuda* is one of the leading countries in establishing blockchain regulatory acts, such as the "Digital Asset Business Act" in 2018, which outlines licensing requirements, ICO regulation, taxation, and mining treatment (Carey Olsen, 2020). *Malta* has provided regulatory advisory and assistance with initial Virtual Financial Assets offerings and to Virtual Financial Asset services providers (German, 2018). *Gibraltar* announced an initiative to integrate blockchain technology into its legacy mechanisms to improve the delivery and efficiency of its public services[27]. *Hong Kong's* regulators released a comprehensive guide to "banks, intermediaries, and insurers on virtual asset-related activities"(Latham & Watkins, 2022). In the case of *Singapore*, even though it is considered a blockchain-friendly country (Cheong, 2022), the Monetary Authority of Singapore recently issued guidelines on the provision of digital payment token services to the public (MAS, 2022), which could discourage cryptocurrency trading by the general public. This discouraging update may be reflected in the calculated regulatory stance, which is slightly negative (-0.09816), indicating a close to neutral stance.

Among the low-scoring countries, the model ranks countries that are known for having a hostile stance, like banning blockchain and cryptocurrency-related activities, including *Nepal* (129th), *Morocco* (136th), *Tunisia* (160th), and *Algeria* (161st) (Global Legal Insights, 2021). The Nepal Rastra Bank classified Bitcoin as illegal in August 2017 (ORICA, 2018). An identical restrictive ban has been applied to *Morocco* since 2017 (Bziker, 2021) and to *Tunisia* and *Algeria* since 2018[28].

[27] https://www.gibraltar.gov.gi/press-releases/hm-government-of-gibraltar-to-integrate-blockchain-technology-into-government-systems-9122021-7505

[28] https://www.euronews.com/next/2022/04/27/bitcoin-ban-these-are-the-countries-where-crypto-is-restricted-or-illegal2

There are more notable findings; the top 5 scoring countries are *Micronesia*, *Saint Vincent and the Grenadines*, *Nauru*, *Kiribati*, and *Antigua and Barbuda*. Some of the top-ranked countries like *Saint Vincent and the Grenadines* (2nd), *Antigua and Barbuda* (5th), *St Kitts and Nevis* (11th), *Dominica* (14th), and *Grenada* (34th) have been pioneers in blockchain regulation since they belong to the economic blog of the Eastern Caribbean Central Bank that has issued the “DCash” Central Bank Digital Currency (Pasteur and Koch, 2020).

Some potential outlier values are spotted, such as *Liechtenstein’s* score, which is ranked 186th, but *Lichtenstein* has actually been engaged with blockchain adoption. Specifically, *Liechtenstein’s* parliament approved the Blockchain Act unanimously[29]. There is an expectation of certain outliers to be found, but the assumption is that the proposed model will be improved annually with the inclusion of more relevant positive and negative cues as well as pragmatic constraints. The emergence of more clear and more comprehensive regulatory guidelines may also enable the proposed model to return more accurate results over time.

The regulatory frameworks and guidelines governing blockchain technology and cryptocurrencies are continuously emerging (Global Legal Insights, 2021). The fast-paced blockchain regulatory environment indicates that several legal approaches might have been altered by the time end users access the tool and observe results. This might lead to a slight inaccuracy of results and conclusions.

5.5 Evaluation of Regulatory Stance Findings

The results presented in Table 5.3 indicate that most countries whose regulatory approach is relatively known, either *hostile*, *neutral*, or *non-hostile*, are fairly scored. However, since a justified expert opinion cannot be obtained for all 194 examined countries, a ground truth mechanism is developed as follows:

- The scoring scheme displayed in Table 5.4 was designed to score a sample of countries based on their known blockchain regulatory stance to date.

Table 5.4: Scoring Scheme for the Sample of Countries

Status	Complete Framework	Guidelines	Legal to Trade	Partial Restrictions	Ban

[29] http://www.liechtensteinusa.org/article/liechtensteins-parliament-approves-blockchain-act-unanimously

Points	3	2	1	-1	-2

- According to the expert opinion derived by 3 regulatory and blockchain researchers, a sample of 20 countries is selected. Eight countries have addressed blockchain-related regulatory guidelines, four are known to be pioneers in one aspect of blockchain technology, and eight have issued partial or full restrictive measures on blockchain-related activities (Global Legal Insights, 2021). Based on regulatory developments to date the scoring matrix is summarised in Table 5.5.

Table 5.5: Countries for Ground-Truth Testing

Countries	Reason for Selection	Complete Framework	Guidelines	Legal to Trade	Partial Restrictions	Ban	**Score**
Hong Kong	Known to Address Blockchain Regulation		x	x			**3**
Singapore			x	x			**3**
Gibraltar		x		x			**4**
Malta		x		x			**4**
Switzerland			x	x			**3**
USA			x	x	x		**2**
UK			x	x			**3**
Bermuda			x	x	x		**2**
El Salvador	Bitcoin Adoption		x	x			**3**
Nigeria	Local Interest		x	x			**3**
Iceland	Mining			x	x		**0**
Cayman Islands	Industry Presence	x		x			**4**

Kenya	Known to Impose Bans			x	x		**3**
Bolivia						x	**-2**
Egypt					x		**-1**
Morocco						x	**-2**
Bangladesh						x	**-2**
Nepal						x	**-2**
Tunisia						x	**-2**
Algeria						x	**-2**

- The scores of the 20 countries are then cross-checked with the corresponding 20 country scores, as displayed in Table 5.3, via both the *Spearman* and *Pearson correlations*. The Pearson correlation coefficient is considered as it is commonly used for non-normally distributed continuous data, for ordinal data, or with relevant outliers (Schober, Boer, and Schwarte, 2018). Adding both correlation methods minimizes the risk of misjudgement in terms of evaluation. Both correlation coefficient scores, *0.862* via Spearman and *0.760* via Pearson, indicate high correlation and, therefore, a high degree of accuracy of the proposed methodology. Pearson correlation coefficient is slightly lower than Spearman, which might indicate the presence of outliers. It is important that the ground truth used for validation is derived simultaneously with the actual proposed model since the blockchain regulatory landscape is updated regularly in many countries (Global Legal Insights, 2021).

5.6 Summary

The proposed computation model for estimating the blockchain regulatory stance of countries leverages Web mining techniques from information retrieval. The model is designed with the capability to assess an unlimited range of countries based on a set of positive and negative cues that may indicate the legal stance of governmental authorities toward blockchain technology.

The key concept is the regulatory stance hypothesis. The regulatory stane hypothesis proposes that the co-occurrence of positive and negative regulation-related cues (aligned with pragmatic constraints) within online Web sources, can be assessed to assume a country's tendency towards a positive or negative stance.

The assessment of regulation-related indicators in previously examined indexes and studies suggests a gap in establishing a methodology that can dynamically process information for an unlimited range of countries. An additional observation is that many indexes depend on a manual judgment of regulatory environments to establish the individual scores of countries. This manual judgment of Web documents, sources, and frameworks is usually translated into scores according to a manually created scoring matrix. The BRI attempts to automate the scoring process and eliminate human judgment to the greater extent possible. The assumption is that the incorporation of this automatically computed indicator into the greater set of BRI indicators can be the first step towards establishing a model for blockchain regulatory assessment.

The examination of the methodology of blockchain-related indexes (e.g., CRI) and studies (e.g., Cryptocurrency Regulation Analysis) that are assessing regulation indicate an additional challenge. These studies base their assessment of regulatory landscapes solely on Wikipedia sources, which may be considered outdated or inaccurate. The CMPI regulatory assessment is based on the assessment of legal experts but is not included in the final CMPI rankings, and the country scores are not published. BMPI, one of the first country-based blockchain-related indexes, does not consider the regulatory stance at all. These methodology drawbacks, alongside the degree of human judgment, manual scoring processes, and non-transparency of scores, indicate the need for an objective methodology.

The utilization of Web search engines, experimentally justified the regulatory stance and constituted a significant finding of our contribution and proposed BRI. Countries like *Singapore*, *Malta*, *Bermuda*, and *Gibraltar* are assigned with high regulation scores based on the "contrast" of search results corresponding to positive and negative lexical cues. The normalized difference of the respective numbers of positive and negative hits expresses the "contrast". In addition, countries with restrictive measures, like *Nepal* and *Algeria*, are assigned low scores. The proposed technique seems to yield a relatively reliable single score quantifying the regulatory stance for the majority of countries.

A ground truth data matrix is derived by experts and used to justify the findings of the proposed model. More specifically, a manual scoring scheme is employed for a set of 20 countries, where individual scores are derived according to current *hostile* or *non-hostile* measures. The manually derived scores are aligned with the respective country scores computed by the proposed model. The *Pearson* and *Spearman* correlation coefficients are computed to examine the degree of similarity between values. Both correlation methods indicate a high degree of relevancy between values, which supports the notion that the methodology used for the proposed model yields relatively realistic results.

Experimentation considered the use of the Google's Programmable Search Engine. The enhanced flexibility of queries, including context and the inclusion of synonyms, can reduce implementation time and query complexity.

The technical and fundamental characteristics that improve previous assessments of regulatory approaches are identified as follows:

- A numerical approach is proposed compared to previous manual approaches that are time-consuming and require expert knowledge. This degree of knowledge around legal frameworks may be unavailable or challenging to find at this stage for a wide range of countries.
- Upon proper configuration, the assumption is that constant query complexity can be feasible.
- The proposed model can assess an unlimited set of countries and enhance full parallelization since there are no dependencies between them.

Future improvements to the suggested model can enable the community to perform additional multiple correlation schemes on the BRI results. The adjustment of positive and negative cues and pragmatic constraints may yield more accurate results over time and reflect new regulatory approaches worldwide. The inclusion of a flexible tool that allows for such query modifications aligns with the overall BRI customization approach, reflected by the versions that enable adjustment of weights for all indicators. Legal experts' assessment of scores and rankings can be an alternative ground truth mechanism for future iterations of the proposed model. The success of this alternative ground truth mechanism depends on the ease of identifying these experts that have the required knowledge to assess the regulatory landscape for a wide range of countries.

CHAPTER 6 THE BLOCKCHAIN READINESS INDEX FOR PUBLIC AND PRIVATE USE

6.0 Introduction

The methodology for constructing the BRI pillars and indicators (Chapter 3), along with the proposed approach for assessing the regulatory stance (Chapter 5), establish the groundwork for the 2021 versions of the BRI. These versions aim to meet the needs of industry participants active in both the public and private sectors.

Chapter 3 outlines the methodology used to derive the pillars and indicators for the proposed BRI, as well as the mathematical formula used to calculate the final scores for each country according to the country's cryptocurrency and blockchain engagement. Considering the findings from the literature review and the result from *Survey 1*, 19 indicators are identified and classified in four pillars. The preliminary BRI 2020 Standard Version results were compared with the countries' assessment vs the community's view from *Survey 2*. The correlation coefficient between the two sets (the BRI ranking and the community results from Survey 2) suggests a degree of relevance in the results.

This chapter follows from the methodology outlined in Chapter 3, where the methodology is parameterized to derive the final versions of the BRI rankings BRI; (a) the BRI 2021 Standard Version, (b) the BRI 2021 Weights-Adjustment Version, and (c) the BRI 2021 Community-Driven Version. All three versions of the BRI rankings require the indicators to reflect updated numerical sources where applicable, i.e., when new values can be derived. On certain occasions, the preliminary BRI 2020 Standard Version indicators are replaced to reflect values from more reliable sources. The BRI 2021 Community-Driven Version considers the voting weights derived by the findings from the community Survey 1 (as summarised in Table 4.6). This chapter discusses the results and findings by considering all three versions of the rankings produced by the proposed BRI. Particular emphasis is placed on the supported weighting strategies, highlighting how alterations in weights can influence business decisions in both the public and private sectors. It is anticipated that the ability to adjust weights in the BRI could enhance the study's relevance, extending its impact beyond academia to the blockchain industry and governmental authorities.

The proposed model developed to estimate the numerical score of each country's regulatory stance in cryptocurrencies and blockchain technology is described in Chapter 5. This method which is based on a web-mining technique, attempts to solve one of the main objectives of this research and provide a well-defined objective methodology for the use of public and private sectors.

After successfully implementing the regulation experiment, the country scores are reflected on all finalized BRI versions presented in this chapter. The regulation-related indicator relies solely on the estimation of the proposed model as introduced in Chapter 5. This research suggests that this indicator is highly considered by public and private organizations engaged with blockchain technology. This finding is also validates from the community's votes in *Survey 1*, which classified regulation as the second most important indicator.

This chapter begins by outlining the main challenges faced in implementing this industry index, including the identification of sources, methodologies for the two main experiments, technical implementations, and the needs of the public and private sectors. The implementation of the three finalized BRI versions is then presented, with the final results and findings discussed. The potential utilization of the BRI 2021 Weights-Adjustment Version and the BRI 2021 Community-Driven Version by the public and private sectors is analysed with specific examples.

An experimental evaluation that is based on data with ground truth scores is implemented to verify that the accuracy of the results is improved compared to the preliminary BRI 2020 Standard Version.

6.1 Challenges and Limitations

The proposed BRI model suggests a technique that eliminates the need for human judgment and automates the scoring process for the entire set of countries considered by the index. Another challenge, relates to the query complexity that's required for the examination of Web results (Global Legal Insights, 2021) (Global Legal Insights, 2021) used to identify the most common words and phrases that are used to describe the positive and negative regulatory stances of countries. Furthermore, the web harvesting technique is dependent on Google's Custom Search API[30]. Although any search API could be used some parameterization is manually required.

The identification of pillars, indicators applicable to all BRI versions, and the weights of indicators applicable to the BRI 2021 Community-Driven Version have been discussed in Chapters 3 and 4. This was another challenge that I had to deal with. The weighted average scores of BRI indicators per community voting are displayed in Table 4.6. Further technical

[30] https://developers.google.com/custom-search/v1/introduction

work is required in order to assign weights for all 19 indicators on a scale of 0 to 1. The sum of all weights shall be equal to 1 for all BRI versions as follows:

- For the BRI 2021 Standard Version, all indicators are weighted equally, as:
  - $\frac{1}{19} = 0.05263$ or 5.263%
- For the BRI 2021 Community-Driven Version, weights depend on the weighted average scores of indicators in Table 4.6, and the calculation for each one of them is presented later in this chapter.
- For the BRI 2021 Weights-Adjustment Version, the online BRI service shall allow users to adjust the weight of any indicator according to customized preferences. A demonstration of this tool is presented in Appendix X.

Currently, I have applied the methodology for the BRI, and have populated the model with data from public sources. It is crucial to emphasize that the index needs regular updates with new, validated data sources for the indicators to ensure the highest level of accuracy. It's also worth noting that using scientifically unverified, irrelevant indicators may lead to inaccurate and misleading global conclusions.

The identification of new sources is considered an ongoing task. The objective is to reach a point where all sources adopted will be numerical, automatically extracted, updated, and relevant to the scope of the BRI. In the ideal case scenario, the indicators could also be normalized to eliminate the normalization step of the proposed BRI methodology. Not all ideal characteristics are expected to apply to all BRI indicators for the initial BRI versions.

Moving forward with the BRI research, the identification of relevant and up-to-date sources is suggested. Exploring the potential addition of new, relevant indicators is also important for the future evolution of the index. It is noted that the inclusion of new indicators shall be justified by conducting a community-based survey, ensuring that the index is not up-to-date but also aligns with the interests of the community.

Blockchain technology is still considered a developing field in terms of research (Alshamsi, Al-Emran, and Shaalan, 2022), so the business strategy of public and private industry participants may not be sufficiently determined across all vectors. The BRI is a tool that addresses key indicators that a participant would consider, depending on the community's judgment and the literature review findings.

There is still a need to examine the effect of BRI rankings, its utility, and potential constraints. The real-world applicability and value for the end-user will be objectively assessed as the adoption of the BRI service broadens. The strategy to expand the BRI service among the blockchain community is not part of this research, thus a focus area for future work that is discussed in Chapter 7.

6.2 Implementation of Finalized BRI 2021 Versions

This section discusses the results from the BRI 2021 rankings. For the derivation of these rankings our methodology considers the Web mining regulatory stance estimation, missing indicators derivations, and a revised set of updated data sources for existing indicators. The preliminary BRI Standard Version for 2020 served as the baseline model for constructing the index. The changes that relate to the context and the sources of indicators for the updated BRI 2021 versions are:

- **Estimation of Regulatory Approach**: The Cryptocurrency Regulation Analysis(Cointobuy.io, 2020) was replaced with the results derived from running our Web mining technique described in Chapter 5. The findings from the initial source were published in 2020, while the new technique considers all historic web mining data until February 1st, 2022.

- **FinTech Presence:** The data feed from Global FinTech Index (Findexable, 2019) was replaced with the new version of The Global FinTech Index (Findexable, 2021).

- **Internet Penetration:** The most updated values for each country are sourced from the Internet World Stats (Miniwatts Marketing Group, 2021). Some countries reflect more updated values than those sourced for the preliminary BRI Standard Version.

- **Innovation Level:** The most updated version of the Global Innovation Index is considered (World Intellectual Property Organization, 2021).

- **Mobile Subscriptions:** The most updated values for each country are sourced from the Mobile Cellular Subscriptions (World Bank, 2021). Some countries reflect more updated values than those sourced for the preliminary BRI 2020 Standard Version.

- **Human Development Level:** The most updated version of the Human Development Index is considered (UNDP, 2021).

- **Cryptocurrency Activity**: The Top 100 Cryptocurrency Exchanges per country according to the Total Volume of Coinmarketcap (CoinMarketCap, 2020) was replaced with the Trust Score (Coingecko, 2020) by Coingecko, which assesses more operational factors of exchanges as described in section 3.1.1 – "Identification of Pillars and Indicators".

- **Crypto ATMs:** The most updated values for each country are sourced from the Coin ATM Radar Data (Coin ATM Radar, 2021). All countries reflect more updated values than those sourced for the preliminary BRI 2020 Standard Version.

- **Mining Operations:** The Bitcoin Mining Costs Throughout the World (Elite Fixtures, 2018) was replaced with The Cambridge Bitcoin Electricity Consumption Index (CCAF, 2021) , which provides relatively more updated values for the assessed countries.

- **Bitcoin Nodes:** The most updated values for each country are sourced from the Bitnodes Data (BITNODES, 2021). All countries reflect more updated values than those sourced for the preliminary BRI 2020 Standard Version.

- **Ethereum Nodes:** The most updated values for each country are sourced from the Ethernodes Data (Ethernodes.org, 2021). All countries reflect more updated values than those sourced for the preliminary BRI Standard Version.

- **Interest on Bitcoin:** The most updated values for each country are sourced from Google Trends for the word "Bitcoin"[31]. The dataset is updated to reflect data for the calendar year 2021, while the preliminary BRI 2020 Standard Version's dataset reflects data for the calendar year 2020.

- **Interest on Blockchain:** The most updated values for each country are sourced from Google Trends for the word "Blockchain"[32]. The dataset is modified to reflect data

[31] https://trends.google.com/trends/explore?date=all&q=bitcoin
[32] https://trends.google.com/trends/explore?date=all&q=blockchain

for the calendar year 2021, while the preliminary BRI 2020 Standard Version's dataset reflects data for the calendar year 2020.

- **Interest on Ethereum:** The most updated values for each country are sourced from Google Trends for the word "Ethereum"[33]. The dataset is modified to reflect data for the calendar year 2021, while the preliminary BRI 2020 Standard Version's dataset reflects data for the calendar year 2020.

- **Bitcoin Core Downloads:** The most updated values for each country are sourced from the Sourceforge Data[34]. The dataset is modified to reflect data up to December 31st, 2021, while the preliminary BRI 2020 Standard Version's dataset reflects data up to December 31st, 2020.

- **Ethereum Wallet Downloads:** The most updated values for each country are sourced from the Sourceforge Data[35]. The dataset is modified to reflect data up to December 31st, 2021, while the preliminary BRI 2020 Standard Version's dataset reflects data up to December 31st, 2020.

A total of 16 BRI indicators required actions related to extracting updated indicator values. Only 3 BRI indicators were not updated because of lack of updated data; these are the UN E-Government Survey (United Nations, 2020), the ICT Development Index (ITU, 2019), and the Ease of Doing Business Index (Mundial, 2020). This indicates that an automated procedure of extracting indicator values may be beneficial as most indicators are expected to require updates annually. It also justifies the selection of indicators in terms of their context, as most sources can provide recent numerical information. If a set of indicator sources are not updated frequently, the model may consider adding new relevant sources which are updated at least annually. For future work I am considering improved Web scrapping techniques to regularly source changes in values and consider updated sets for future releases of the index.

6.2.1 BRI 2021 Standard Version – Results & Discussion

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[33] https://trends.google.com/trends/explore?date=all&q=ethereum

[34] https://sourceforge.net/projects/bitcoin/files/stats/map

[35] https://sourceforge.net/projects/ethereum-wallet.mirror/files/stats/map

Considering the equal weighting strategy for all indicators, and following the estimation of missing indicators' values, data normalization, and the addition of values for the Ideal Country, the final country rankings for the BRI 2021 Standard Version are computed and displayed in Appendix V. Table 6.1 displays the top 20 ranked countries.

Table 6.1: BRI 2021 Standard Version - Top 20 Countries

Country	**Score**	**Rank**
Ideal Country	**1**	**-**
SINGAPORE	0.73297	1
SWEDEN	0.696657	2
MALTA	0.687242	3
USA	0.684259	4
IRELAND	0.677086	5
CANADA	0.662423	6
HONG KONG	0.659005	7
NETHERLANDS	0.655115	8
FINLAND	0.651841	9
SWITZERLAND	0.641094	10
COTE d' IVOIRE	0.636538	11
UKRAINE	0.632936	12
UK	0.630973	13
ANTIGUA and BARBUDA	0.629741	14
GERMANY	0.616065	15
AUSTRALIA	0.615367	16
SLOVAKIA	0.592203	17
AUSTRIA	0.58433	18
TURKEY	0.579117	19
LUXEMBOURG	0.578752	20

Singapore, *Switzerland*, and *Malta* rank among the top 3 positions. The top-10 ranked countries are developed countries, similarly to the context of the CRI rankings. Developing countries like *Cote d'Ivoire* and *Antigua* and *Barbuda* also two of the top-20 BRI positions. Using the Web app (see Appendix X) detailed scores per indicator can be observed (using Radar charts) in order to observe the scoring for each indicator, allowing the user to analyse the strengths and weaknesses of each country. These details shall be available to the end-user in the form of annual reports so the assessment of each country is transparent. The full country results for the "Regulation" pillar, are displayed in Table 5.3. As previously discussed, a country's regulatory stance is a crucial pillar, and as such, I devote additional focus to its analysis.

The scores and rankings for the remaining 18 indicators regarding the Top 20 countries of the BRI 2021 Standard Version are displayed in the following tables. The full country list of indicators' values for each pillar is displayed in Appendix VI, Appendix VII, and Appendix VIII (beyond the "Regulation" pillar that is the focus in Table 5.3).

Table 6.2: Top 20 Countries for the Indicator: "e-Government Development Index"

Country	Score	Rank
DENMARK	0.9758	1
KOREA(REPUBLIC)	0.9560	2
ESTONIA	0.9473	3
FINLAND	0.9452	4
AUSTRALIA	0.9432	5
SWEDEN	0.9365	6
UK	0.9358	7
NEW ZEALAND	0.9339	8
USA	0.9297	9
NETHERLANDS	0.9228	10
SINGAPORE	0.9150	11
ICELAND	0.9101	12
NORWAY	0.9064	13
JAPAN	0.8989	14
AUSTRIA	0.8914	15
SWITZERLAND	0.8907	16
SPAIN	0.8801	17
CYPRUS	0.8731	18
FRANCE	0.8718	19
LITHUANIA	0.8665	20

As displayed in Table 5.3, e-Government Development initiatives appear to be emerging in developed countries, whose populations have the capabilities to adopt electronic services. The top-ranked countries of this indicator vary in population size, i.e., *South Korea*, the *USA*, the *UK*, and *France* are significantly bigger countries than *Cyprus*, *Iceland*, and *Singapore*. The conclusion for BRI users is that country size is irrelevant when it comes to facilitating electronic initiatives by the public sector, but these initiatives are relatively absent in developing countries. Blockchain organizations can assess the findings from this indicator to estimate which countries have the tendency to provide the e-infrastructure that could facilitate blockchain-related activities.

Table 6.3: Top 20 Countries for the Indicator: "FinTech Presence"

Country	Score	Rank
USA	69.1513	1
UK	38.7072	2
ISRAEL	19.405	3
HONG KONG	16.41	4
SINGAPORE	15.8284	5
SWITZERLAND	14.9513	6
AUSTRALIA	13.7292	7
SWEDEN	13.1409	8
NETHERLANDS	11.8726	9
GERMANY	11.1183	10
LITHUANIA	11.1071	11
ESTONIA	10.4462	12
CANADA	10.2642	13
SERBIA	8.6538	14
FINLAND	8.3042	15
BRAZIL	8.1635	16
CHINA	8.0719	17
SPAIN	7.67	18
GUINEA-BISSAU	6.635033	19
URUGUAY	6.5785	20

Considering that FinTech and blockchain are correlated technologies (Karkeraa, 2020), the rankings of this indicator (as in Table 6.3) demonstrate that blockchain industry participants engaged in both industries may consider focusing their operations in the *USA* or the *UK*. These two countries are scored higher than the rest of the world's countries. Businesses related to both technologies may involve operations like fiat-to-crypto payment gateways (and vice-versa) and crypto remittances. An interesting finding is that some underdeveloped countries like *Guinea-Bissau* and *North Macedonia* are placed among the top positions indicating increased activity in the FinTech ecosystem. These regions are likely to provide operational opportunities for blockchain businesses with a limited budget.

Table 6.4: Top 20 Countries for the Indicator: "Internet Penetration"

Country	Score	Rank
UAE	1.000	1
QATAR	1.000	2
BRUNEI	1.000	3
BERMUDAS	0.998	4
ICELAND	0.987	5
NORWAY	0.986	6
LIECHTENSTEIN	0.985	7
KUWAIT	0.983	8
ESTONIA	0.979	9
DENMARK	0.978	10
LUXEMBOURG	0.978	11
GIBRALTAR	0.977	12
BAHRAIN	0.977	13
MONACO	0.965	14
SWEDEN	0.964	15
KOREA(REPUBLIC)	0.963	16
GERMANY	0.960	17
NETHERLANDS	0.956	18
JAPAN	0.945	19
ANDORRA	0.945	20

Internet access (as in Table 6.4) seems to be a privilege for the local populations of “Gulf countries” like *UAE*, *Qatar*, *Kuwait*, and *Bahrain*, as internet addiction has recently been a case of discussion for this region (Al-Khan*i et al.*, 2021). People residing in these countries are experiencing digitalization disruption that has revolutionized many countries' business procedures (Iyer and Gernal, 2022). Internet access is essential for blockchain and cryptocurrency activities (Mushtaq and Haq, 2019) as the emergence of “smart cities” (Krishnamoorthy *et al.*, 2022) in cities like *Dubai*, integrating disruptive technologies like blockchain and artificial intelligence. The high rates of Internet penetration have enabled *UAE* to initiate multiple public and private initiatives (Khan *et al.*, 2022) (Salman, Ljepava, and Petratos, 2018) with the aim of attracting blockchain-related businesses to operate in the country. This BRI indicator highlights the countries that follow the *UAE's* paradigm and can potentially become the next hubs of “smart cities” and digitalization.

Table 6.5: Top 20 Countries for the Indicator: “ICT Level”

Country	Score	Rank
ICELAND	0.898	1
KOREA(REPUBLIC)	0.885	2
SWITZERLAND	0.874	3
DENMARK	0.871	4
UK	0.865	5
HONG KONG	0.861	6
NETHERLANDS	0.849	7
LUXEMBOURG	0.847	8
NORWAY	0.847	9
JAPAN	0.843	10
SWEDEN	0.841	11
GERMANY	0.839	12
NEW ZEALAND	0.833	13
AUSTRALIA	0.824	14
FRANCE	0.824	15
LIECHTENSTEIN	0.819	16
USA	0.818	17
ESTONIA	0.814	18
SINGAPORE	0.805	19

MONACO	0.805	20

The ICT level of local populations (as in Table 6.5) is high in many small countries like *Iceland, Hong Kong, Luxembourg, Liechtenstein, Estonia, Monaco,* and *Singapore.* Countries like Estonia have been active in cultivating blockchain talent as they emphasize on the development of skills and academic research in the field (Norta, 2019). *Hong Kong's* population is also actively engaged in cryptocurrency activities, probably due to its high ICT literacy (Li and Harkiolakis, 2020). The top-ranked countries may indicate areas with a pool of ICT talents and potentially skilled blockchain developers required by blockchain organizations. The ranking of these indicators may also signify where the target audience of blockchain organizations should be, especially for those who develop services requiring technical understanding.

Table 6.6: Top 20 Countries for the Indicator: "Innovation Level"

Country	**Score**	**Rank**
SWITZERLAND	0.655	1
SWEDEN	0.631	2
USA	0.613	3
KOREA(REPUBLIC)	0.593	4
LIECHTENSTEIN	0.588	5
NETHERLANDS	0.586	6
FINLAND	0.584	7
SINGAPORE	0.578	8
DENMARK	0.573	9
GERMANY	0.573	10
FRANCE	0.550	11
CHINA	0.548	12
JAPAN	0.545	13
HONG KONG	0.537	14
ISRAEL	0.534	15
CANADA	0.531	16
ICELAND	0.518	17
VENEZUELA	0.512	18

AUSTRIA	0.509	19
IRELAND	0.507	20

According to Table 6.6 - the Global Innovation Index (World Intellectual Property Organization, 2021), innovative procedures in the public and private sectors are being implemented in countries with high internet penetration and ICT levels. There is an observation of this correlation from the BRI findings, as most high-ranked countries in the corresponding indicators are mutual. This demonstrates a tendency for literacy and innovation potential. Innovative procedures in the public and private sectors could enable the adoption of blockchain technology as a tool to minimize costs and time-consuming tasks (Potts, Davidson, and Berg, 2020). Since the early blockchain implementations and pilots, the innovative mind-set of organizations has been linked with a tendency to use blockchain to impose internal efficiency (Zhao, Fan, and Yan, 2016). BRI users shall be able to assess these findings to understand the innovation tendency of countries and their potential to adopt blockchain-related policies and practices.

Table 6.7: Top 20 Countries for the Indicator: "Mobile Subscriptions"

Country	Score	Rank
HONG KONG	292	1
ANTIGUA and BARBUDA	193	2
SEYCHELLES	187	3
UAE	186	4
LITHUANIA	174	5
MONTENEGRO	172	6
THAILAND	167	7
RUSSIA	164	8
TURKMENISTAN	163	9
SOUTH AFRICA	162	10
BOTSWANA	162	11
EL SALVADOR	161	12
KUWAIT	159	13
PHILIPPINES	155	14
SURINAME	153	15

JAPAN	152	16
CAYMAN ISLANDS	152	17
IRAN	152	18
COTE d' IVOIRE	152	19
MAURITIUS	150	20

A notable observation (as in Table 6.7) for the Mobile subscriptions indicator is that small countries, such as countries from the Gulf region and the Caribbean, enhance high mobile connectivity to local populations. The case of M-Pesa in Kenya sparked the digital financial services revolution in *Kenya* (Ndung and Ndung'u, 2021), indicating the importance of mobile access for unbanked populations. M-Pesa provided solutions for many unbanked people who lacked access to financial services and is often linked with the emergence of Bitcoin as an efficient, decentralized money transfer channel (Natile, 2020). Countries that feature on the top ranks of this indicator could represent the target regions for blockchain organizations developing crypto remittance solutions and other types of decentralized applications that allow access and usability from mobile devices.

Table 6.8: Top 20 Countries for the Indicator: "Business Operations"

Country	Score	Rank
NEW ZEALAND	86.8	1
SINGAPORE	86.2	2
HONG KONG	85.3	3
DENMARK	85.3	4
KOREA(REPUBLIC)	84	5
USA	84	6
GEORGIA	83.7	7
UK	83.5	8
NORWAY	82.6	9
SWEDEN	82	10
LITHUANIA	81.6	11
MAURITIUS	81.5	12
MALAYSIA	81.5	13
AUSTRALIA	81.2	14

UAE	80.9	15
TAIWAN	80.9	16
NORTH MACEDONIA	80.7	17
ESTONIA	80.6	18
LATVIA	80.3	19
FINLAND	80.2	20

Considering that this is a business-oriented research, the BRI aims to provide information that blockchain organizations could assess and determine, among other decisions, the regions they could operate. The "Business Operations" indicator (as in Table 6.8) is assessing the ease of establishing business operations. Although this indicator is not directly related to blockchain and cryptocurrency activities but enables business executives to determine which countries provide operational opportunities and non-hostile regulatory landscapes for the emergence of new companies and start-ups. The research assumes that the findings of this indicator, alongside the findings regarding the blockchain regulatory tendency per county, could determine the optimal countries where blockchain operations, activities, and company headquarters could be hosted.

Table 6.9: Top 20 Countries for the Indicator: "Human Development Level"

Country	Score	Rank
NORWAY	0.954	1
SWITZERLAND	0.946	2
IRELAND	0.942	3
HONG KONG	0.939	4
GERMANY	0.939	5
AUSTRALIA	0.938	6
ICELAND	0.938	7
SWEDEN	0.937	8
SINGAPORE	0.935	9
NETHERLANDS	0.933	10
DENMARK	0.93	11
FINLAND	0.925	12
CANADA	0.922	13

NEW ZEALAND	0.921	14
USA	0.92	15
UK	0.92	16
BELGIUM	0.919	17
LIECHTENSTEIN	0.917	18
JAPAN	0.915	19
AUSTRIA	0.914	20

The "Human Development Index" indicator (as in Table 6.9), shows the top-25 ranked countries that achieve a score of greater than 0.9/1. Score values for each country are marginal, however, it seems that the scores of this indicator are highly correlated with other indicators that provide insights on literacy and skills like "Innovation Level" and "ICT Level". It is assumed that this set of indicators demonstrates a broad overview of blockchain organizations regarding countries with populations that can understand and adapt their innovative solutions. An increased level of human skills may also indicate where blockchain organizations can focus their hiring procedures and other training-related activities since locals may be more willing and able to develop blockchain skills. This is because reliable metrics that demonstrate country populations with blockchain-specific skills are relatively absent at this stage from the market.

Table 6.10: Top 20 Countries for the Indicator: "Cryptocurrency Activity"

Country	**Score**	**Rank**
SEYCHELLES	0.000193193	1
CAYMAN ISLANDS	0.000091300	2
GIBRALTAR	0.000059400	3
LIECHTENSTEIN	0.000052500	4
SAINT VINCENT AND THE GRENADINES	0.000018000	5
ESTONIA	0.000012800	6
ANTIGUA and BARBUDA	0.000010200	7
MALTA	0.000009060	8
BELIZE	0.000007540	9
SINGAPORE	0.000002910	10

BAHAMAS	0.000002540	11
HONG KONG	0.000000934	12
SLOVENIA	0.000000481	13
LITHUANIA	0.000000367	14
PANAMA	0.000000232	15
SWITZERLAND	0.000000231	16
UAE	0.000000202	17
KOREA(REPUBLIC)	0.000000195	18
NORWAY	0.000000184	19
UK	0.000000162	20

As in Table 6.10 - "Cryptocurrency Activity", top-rated cryptocurrency exchanges are mostly located in small-sized countries that enhance flexible regulatory frameworks, like *Seychelles*, the *Cayman Islands*, and *Gibraltar* (Global Legal Insights, 2021). There seems to be a lack of alternative relevant metrics to assess cryptocurrency activity in a numerical form reliably on a country-by-country basis. There is some degree of transparency for aspects of cryptocurrency exchanges like daily volume and traffic, which form the indicator examined - the Trust Score. Findings could be useful for new and existing cryptocurrency exchanges, considering the locations to set up their headquarters and initiate their business operations.

Table 6.11: Top 20 Countries for the Indicator: "Crypto ATMs"

Country	Score	Rank
USA	0.000091400	1
CANADA	0.000059800	2
EL SALVADOR	0.000031600	3
SAN MARINO	0.000029500	4
ANTIGUA and BARBUDA	0.000020400	5
SAINT KITTS AND NEVIS	0.000018800	6
HONG KONG	0.000018500	7
SWITZERLAND	0.000016400	8
AUSTRIA	0.000015800	9
SLOVENIA	0.000010600	10

SLOVAKIA	0.000009710	11
GEORGIA	0.000009020	12
IRELAND	0.000007900	13
CZECH REPUBLIC	0.000006910	14
GREECE	0.000006520	15
ROMANIA	0.000006080	16
PANAMA	0.000005560	17
HUNGARY	0.000005280	18
BAHAMAS	0.000005090	19
SPAIN	0.000004260	20

Crypto ATMs (as in Table 6.11) represent a metric relative to the total cryptocurrency traffic, though it is a minimal fraction compared to the total volume transacted (Matsumoto, Igaki, and Kikuchi, 2021). The instalment of crypto ATMs is emerging in countries like *El Salvador* that have recently embraced Bitcoin adoption, demonstrating the connection of non-hostile regulatory frameworks with the increased presence of the blockchain industry and local engagement (Sparkes, 2022). The location map of crypto ATMs is a sign of local cryptocurrency activity, the awareness of populations, and perhaps non-restrictive regulatory measures. Countries that are ranked low in this indicator could probably be exposed to restrictive measures, as crypto ATMs are considered an exchange mechanism and are regularly subject to AML and KYC procedures (Schueffel and Hammer, 2021).

Table 6.12: Top 20 Countries for the Indicator: "Mining Operations"

Country	**Score**	**Rank**
ICELAND	0.00000117000	1
KAZAKHSTAN	0.00000096400	2
IRELAND	0.00000094800	3
CANADA	0.00000025300	4
MALAYSIA	0.00000014200	5
SWEDEN	0.00000011500	6
USA	0.00000010700	7
NORWAY	0.00000010700	8
RUSSIA	0.00000007700	9

GERMANY	0.00000005350	10
GEORGIA	0.00000004510	11
MONGOLIA	0.00000003970	12
IRAN	0.00000003700	13
KUWAIT	0.00000003040	14
PARAGUAY	0.00000002520	15
THAILAND	0.00000001420	16
OMAN	0.00000001170	17
NETHERLANDS	0.00000000875	18
ESTONIA	0.00000000754	19
AUSTRALIA	0.00000000745	20

According to the findings of the "Mining Operations" indicator (as in Table 6.12), the Bitcoin mining hashrate is proportionately distributed mainly to countries with low electricity price rates. Bitcoin mining rates and required energy might have been increasing alongside the emergence of public and private sector interest (Onat et al., 2021). Countries with high mining hashrate, like *Iceland* and *Kazakhstan*, are engaged in the global distribution of greenhouse gas emissions (Onat et al., 2021) and are currently setting the paradigm for Bitcoin mining companies to establish their operations. The indicator addresses only Bitcoin mining and not other Proof-of-Work mining-related activities. According to the source, some small-sized countries with high scores in other BRI indicators like *Singapore* and *Hong Kong*, appear to have non-existent mining operations. This might be misleading as the values are sourced from a visualization map[36] (and not some formal database) that may exclude some small-sized countries. This research project assumes that the visualization map is updated and includes relevant countries with mining operations.

Table 6.13: Top 20 Countries for the Indicator: "Bitcoin Nodes"

Country	**Score**	**Rank**
GIBRALTAR	0.000059400	1
FINLAND	0.000038600	2
LIECHTENSTEIN	0.000026200	3
ICELAND	0.000023400	4

[36] https://ccaf.io/cbeci/mining_map

SINGAPORE	0.000022200	5
NETHERLANDS	0.000022100	6
GERMANY	0.000020900	7
LITHUANIA	0.000018400	8
SWITZERLAND	0.000015000	9
LUXEMBOURG	0.000014400	10
IRELAND	0.000010300	11
SEYCHELLES	0.000010200	12
HONG KONG	0.000009200	13
FRANCE	0.000008760	14
SWEDEN	0.000008610	15
CANADA	0.000007790	16
CZECH REPUBLIC	0.000006630	17
SLOVENIA	0.000005770	18
BULGARIA	0.000005760	19
NORWAY	0.000005530	20

Table 6.14: Top 20 Countries for the Indicator: "Ethereum Nodes"

Country	Score	Rank
SINGAPORE	0.000049700	1
FINLAND	0.000036500	2
IRELAND	0.000024700	3
ANDORRA	0.000012900	4
HONG KONG	0.000011500	5
GERMANY	0.000009350	6
USA	0.000006480	7
SWITZERLAND	0.000005320	8
LITHUANIA	0.000005140	9
NETHERLANDS	0.000004790	10
CANADA	0.000004080	11
UK	0.000003980	12
CROATIA	0.000003900	13

KOREA(REPUBLIC)	0.000003900	14
ESTONIA	0.000003770	15
AUSTRALIA	0.000003690	16
AUSTRIA	0.000003550	17
SLOVENIA	0.000003370	18
FRANCE	0.000002900	19
NORWAY	0.000002580	20

The distribution of Bitcoin and Ethereum nodes per country (as in Table 6.13, and Table 6.14) signifies local users' engagement and potential target audience for blockchain organizations to identify crypto-involved populations. The two related indicators have many countries in common, featuring in the top 20 positions. An interesting finding that blockchain projects could consider is that some outliers exist, like *Gibraltar*, which ranks first in "Bitcoin Nodes" and is not among the top 20 countries in "Ethereum Nodes". This might indicate the tendency of the local population to use Bitcoin-related services rather than engage with the developing decentralized applications (e.g. DeFi and NFT projects). Depending on the scope of each blockchain organization, strategic decisions could be made based on the interest of potential users. For example, *Gibraltar* could be a good location for Bitcoin-centric startups to operate, while DeFi projects could aim at locations like *Singapore* and *Finland*.

Table 6.15: Top 20 Countries for the Indicator: "Interest on Bitcoin"

Country	**Score**	**Rank**
EL SALVADOR	100	1
LIECHTENSTEIN	52	2
NIGERIA	46	3
NETHERLANDS	43	4
TURKEY	42	5
CAYMAN ISLANDS	42	6
BERMUDAS	42	7
CURACAO	41	8
SWITZERLAND	39	9
SINGAPORE	38	10

SLOVENIA	38	11
AUSTRIA	36	12
NAMIBIA	36	13
CANADA	33	14
CYPRUS	32	15
AUSTRALIA	30	16
GIBRALTAR	29	17
GERMANY	28	18
BENIN	28	19
MALTA	27	20

Table 6.16: Top 20 Countries for the Indicator: "Interest on Ethereum"

Country	Score	Rank
LIECHTENSTEIN	100	1
CAYMAN ISLANDS	79	2
NORTH MACEDONIA	67	3
TURKEY	66	4
SWITZERLAND	63	5
SINGAPORE	60	6
AUSTRIA	59	7
CANADA	56	8
SLOVENIA	54	9
NETHERLANDS	51	10
GERMANY	47	11
LUXEMBOURG	45	12
MALTA	44	13
BERMUDAS	43	14
CYPRUS	43	15
AUSTRALIA	41	16
IRELAND	40	17
SWEDEN	40	18
SERBIA	38	19

CURACAO	37	20

Table 6.17: Top 20 Countries for the Indicator: "Interest on Blockchain"

Country	**Score**	**Rank**
NIGERIA	100	1
TOGO	86	2
ANDORRA	82	3
GHANA	82	4
LIECHTENSTEIN	69	5
BENIN	63	6
CAMEROON	60	7
SINGAPORE	54	8
CHINA	48	9
BHUTAN	46	10
COTE d' IVOIRE	46	11
CAYMAN ISLANDS	44	12
BOTSWANA	44	13
ZIMBABWE	41	14
LUXEMBOURG	40	15
CYPRUS	39	16
HONG KONG	37	17
BURKINA FASO	37	18
SWITZERLAND	36	19
GIBRALTAR	36	20

Similar to the other indicators related to local users' engagement, the interest derived from Google Trends signifies the topics and types of blockchain services local populations might use (as in Tables 6.15 to 6.17). For example, *El Salvador* seems like a Bitcoin-maximalist country in terms of people's interests. African countries like *Nigeria*, *Togo*, *Ghana*, and *Benin* may be hubs for wider blockchain adoption beyond the concept of cryptocurrency value transfers as an alternative payment mechanism. Google Trends can be a tool for corporates to understand the potential consumers' behaviour and needs (Silva and Madsen, 2021), so the research assumes this information could be a fundamental market analysis tool for BRI users. The interest levels capture a signal on each country's stance toward key blockchain-related concepts.

Table 6.18: Top 20 Countries for the Indicator: "Bitcoin Core Downloads"

Country	Score	Rank
ANDORRA	0.0000259000	1
SWITZERLAND	0.0000087800	2
LUXEMBOURG	0.0000079900	3
MONTENEGRO	0.0000079600	4
GERMANY	0.0000071900	5
HONG KONG	0.0000068000	6
MALTA	0.0000067900	7
AUSTRIA	0.0000067700	8
NETHERLANDS	0.0000055400	9
SINGAPORE	0.0000051300	10
CYPRUS	0.0000049700	11
NORWAY	0.0000040600	12
AUSTRALIA	0.0000039200	13
LATVIA	0.0000037100	14
CANADA	0.0000034700	15
CZECH REPUBLIC	0.0000032700	16
BELARUS	0.0000031700	17
FRANCE	0.0000031100	18
SWEDEN	0.0000030700	19
FINLAND	0.0000030700	20

Table 6.19: Top 20 Countries for the Indicator: "Ethereum Wallet Downloads"

Country	Score	Rank
LUXEMBOURG	0.0000032000	1
BOSNIA	0.0000024400	2
SLOVENIA	0.0000024100	3
FINLAND	0.0000023500	4

TRINIDAD AND TOBAGO	0.0000021400	5
GEORGIA	0.0000020100	6
HONG KONG	0.0000020000	7
NETHERLANDS	0.0000019800	8
CANADA	0.0000017800	9
SINGAPORE	0.0000015400	10
ESTONIA	0.0000015100	11
NORTH MACEDONIA	0.0000014400	12
GERMANY	0.0000013100	13
SLOVAKIA	0.0000012800	14
SERBIA	0.0000011400	15
USA	0.0000011200	16
UAE	0.0000010100	17
AUSTRALIA	0.0000009800	18
SWEDEN	0.0000008910	19
BULGARIA	0.0000008640	20

All indicators are normalized and calculated according to the population of each country. As a result, several small countries top the rankings related to software downloads for the two most popular cryptocurrencies, i.e., Bitcoin and Ethereum. *Luxembourg's* population is actively trading with both popular cryptocurrencies and potentially could be a hub for blockchain organizations launching crypto wallets to base their operations (refer to Tables 6.18, 6.19).

It should be noted that BRI indicators are normalized according to the country's population. This clarification explains that, for example, the BRI indicator "Bitcoin Core Downloads" does not represent the total number of people downloading the Bitcoin Core. The values representing the total number of people for each indicator are also gathered and could be provided as an additional feature for BRI users, such as crypto wallet companies implementing market research.

Certain countries like *Singapore, Switzerland,* and *Hong Kong* tend to be among the top-scoring positions for indicators directly related to blockchain activities, as well as for indicators that may not have a direct relation with blockchain technology. This correlation may display the accuracy of the selected BRI indicators.

Findings demonstrate that some people in countries like *Luxembourg* and *Hong Kong* are particularly interested in software downloads, thereby trading activity and interaction with wallet interfaces. Due to the decentralized nature of the blockchain ecosystem, trading values per country have been an area of a knowledge gap. These metrics are either kept centrally by cryptocurrency exchanges or hard to be estimated from non-custodial wallets. The BRI aims to estimate a signal toward these values per country by including several indicators and transparently presenting the results to the community.

The BRI findings demonstrate that populations of underdeveloped countries located in the African region have been showing a growing interest in blockchain-related topics. However, and due to a lack of infrastructure, the adoption rates are still low. Assuming that local governments improve the levels of infrastructure and literacy of people in such regions, countries with high local interest, like *Nigeria* and *Ghana*, have the potential to become central hubs for the implementation of blockchain projects.

The BRI is not just a tool that captures the engagement of countries according to blockchain technology but it could be used as a tool for assessing countries whose policies and regulations shall be avoided in order to embrace blockchain readiness. Countries that are positioned in the lower ranks of the BRI 2021 Standard Version Rankings (Appendix V) represent paradigms of failed or non-existing blockchain-related policies and practices.

The analysis of the findings for each BRI indicator demonstrates that each blockchain organization, governmental authority, and any related party might consider different factors that would differentiate BRI rankings according to their customized preferences. As presented in Appendix V, the full rankings might not be useful for a range of BRI users wishing to evaluate the index's individual components and establish their decision-making procedures. This assumption has motivated the design of the two additional variations of BRI versions discussed in the following sections.

6.2.2 BRI 2021 Community-Driven Version – Results & Discussion

The BRI 2021 Community-Driven Version is computed with adjustable indicators' weights based on the Weighted Average column in Table 4.6 (from the survey conducted). The findings of Survey 1 indicate an overview of how significant each BRI indicator is, taking into account opinions from blockchain industry participants with various backgrounds, levels of expertise, and preferences.

The BRI 2021 Community-Driven Version scores and rankings of countries depend on the voting of the community that has identified community-driven weights. Considering that the BRI consists of 19 indicators, a relevant community-driven weight must be assigned to each indicator, where all weights add up to 1. The application of weights for the BRI 2021 Community-Driven Version is displayed in the BRI online tool[37].

The calculation of indicator weights based on community voting can be presented as follows:

$$Weight\ of\ Indicator\ x = \frac{Weighted\ Average\ of\ Indicator\ x}{Total\ Sum\ of\ Weighted\ Averages\ of\ all\ Indicators}$$

To compute each indicator's weight on a scale of 0 to 1, a given indicator's weighted average, according to Table 4.6 (i.e., 4.24 for "Regulation"), is divided by the sum of all indicators' weights which adds up to 67.86. For example:

$$Weight\ of\ Indicator\ "Regulation" = \frac{4.24}{67.86} = \mathbf{0.06248158}$$

Table 6.20 presents the weights of each indicator according to community voting.

Table 6.20: BRI 2021 Community-Driven Version – Weights of Indicators

BRI Indicator	Weights of Indicators per BRI Standard Version	Weighted Average per Community Voting	**Weights of Indicators per BRI Community-Driven Version**
Internet Penetration	0.05263	4.26	**0.06278**
Estimation of Regulatory Approach	0.05263	4.23	**0.06248**
Business Operations	0.05263	4.09	**0.06027**
Innovation Level	0.05263	4.05	**0.05953**
E-Government Development Index	0.05263	3.82	**0.05644**
Fintech Presence	0.05263	3.81	**0.05585**
ICT Level	0.05263	3.78	**0.05556**
Human Development Level	0.05263	3.73	**0.05497**

[37] http://readiness.unic.ac.cy/

Interest on Blockchain	0.05263	3.73	**0.05482**
Mobile Subscriptions	0.05263	3.61	**0.0529**
Interest on Bitcoin	0.05263	3.54	**0.05202**
Cryptocurrency Activity	0.05263	3.33	**0.04907**
Bitcoin Nodes	0.05263	3.32	**0.04863**
Interest in Ethereum	0.05263	3.31	**0.04863**
Ethereum Nodes	0.05263	3.18	**0.04671**
Mining Operations	0.05263	3.18	**0.04671**
Bitcoin Core Downloads	0.05263	3.09	**0.04539**
Ethereum Wallet Downloads	0.05263	3.06	**0.04495**
Crypto ATMs	0.05263	2.87	**0.04229**

While in the case of equal weight distribution, each indicator is weighted at 0.05263, the community voting determines a variable weight distribution among indicators. The highest weight (0.062776304) is assigned to "Internet Penetration", and the lowest weight (0.042292956) is assigned to "Crypto ATMs".

A broader analysis of the results indicates an interesting finding regarding the community's opinions on what factors are important for the construction of the BRI. Community voting indicates that the nine (9) lowest-scoring indicators may be considered directly relevant to blockchain technology and cryptocurrencies. The eight (8) highest-scoring indicators (excluding "Estimation of Regulatory Approach) may all be considered not directly relevant to blockchain technology and cryptocurrencies. This observation may justify the selection of non-blockchain-centric indicators as optimal due to the community's weighted opinion to assign heavy importance scores.

The individual country scores and rankings per indicator remain as presented in Section 6.2.1 - "BRI 2021 Standard Version – Results & Discussion". The assignment of community-based weights changes the weight, i.e., each indicator's importance. As a result, the BRI 2021 Community-Driven Version scores and rankings are presented in Appendix IX. Countries with high rates of internet penetration and an estimated non-hostile blockchain regulatory landscape gained higher scores, and consequently, BRI ranks compared to the BRI 2021 Standard Version.

For example, to calculate Singapore's score using the BRI 2021 Community-Driven Version, the scores of all normalized indicators shall be multiplied by their corresponding weights.

The top-5 positions on both BRI versions feature the same countries; (1) Singapore, (2) Sweden, (3) Malta, (4) USA, and (5) Malta.

Beyond the top-5 positions, a finding demonstrates that some developing countries are ranked higher when the community-driven weight distributions are applied. Table 6.21 displays notable BRI ranking adjustments that occur when applying the BRI 2021 Community-Driven methodology in the top-50 positions.

Table 6.21: Notable Ranking Adjustments between BRI Standard Version and BRI Community-Driven Version

Country	BRI 2021 Standard Version Rank	BRI 2021 Community-Driven Version Rank	Change in Rankings
Canada	7th	10th	-3 positions
Switzerland	11th	14th	-3 positions
Luxembourg	21th	25th	-4 positions
Estonia	24th	32nd	-8 positions
Cyprus	28th	39th	-11 positions
Cote d'Ivoire	12th	8th	+4 positions
Antigua and Barbuda	15th	13th	+2 positions
Lesotho	33rd	22nd	+11 positions
Dominica	35th	28th	+7 positions
Congo	40th	24th	+16 positions
Kiribati	48th	38th	+10 positions

Adjusted weights according to community voting imposed limited importance on some indicators that are directly related to blockchain and cryptocurrencies. Factors like the location of ATMs, Bitcoin and Ethereum software downloads, and mining operations are mostly popular in developed countries, as indicated in Appendix VII and Appendix VIII.

The community believes that aspects like the availability of the internet, the estimated regulatory stance, and the local interest toward key blockchain-related definitions are more important for a country to indicate engagement in blockchain technology. These indicators seem to demonstrate the potential of underdeveloped or developing countries to become blockchain hubs and cause big ranking changes, e.g., 16 ranks gained from *Congo* and 11 ranks gained for *Lesotho*. Counties like *Cote d'Ivoire* and *Antigua and Barbuda*, which were already ranked high in the BRI 2021 Standard Version Rank, have gained higher positions when community voting is applied to weights.

The BRI 2021 Community-Driven Version is based on community voting. It is believed that this version of the BRI is mostly suitable for users that are relatively new to the blockchain ecosystem, thereby wishing to understand the preferences of the community.

An overview of the community's preferences could be ideal for new blockchain industry participants to take decisions, for example, for a tech company that switches its focus toward cryptocurrencies (Arslanian, 2022). Blockchain is transforming the structure of organizations and markets whose personnel was not aware of the technology until recently (Leiponen *et al.*, 2018). Participants in industries like insurance (Cooper and Stanway, 2018) and marketing (Harvey, Moorman, and Toledo, 2018) are considering the use of blockchain technology to enhance transparency and efficiency to their procedures and leadership strategies (Richard, 2022). The most major disruption of traditional businesses is expected to occur in the banking industry (Soley, 2017), while the significance of this innovation dives into governmental practices (Alexopoulos *et al.*, 2021). This research assumes that the BRI 2021 Community-Driven Version is suitable for industry participants operating in such private and public sectors, who may currently have limited blockchain expertise and understanding.

The BRI 2021 Community-Driven Version is based on community voting. Probably this version of the BRI is mostly suitable for users that are relatively new to the blockchain ecosystem, thereby wishing to understand the preferences of the community.

6.2.3 BRI 2021 Weights-Adjustment Version – Results & Discussion

The need for developing a tool for adjusting the weight of indicators has been discussed in Section 6.2.1 – "BRI 2021 Standard Version – Results & Discussion". Each indicator applies to a different blockchain readiness source that could apply to variable industries. Certain indicators relate to the potential and tendency of the technology, while others reflect current values and metrics.

The BRI 2021 Weights-Adjustment Version does not impose fixed weights and scores; therefore, no final BRI rankings are presented for this version. According to the experience and beliefs of each user, users can make weight adjustment that are most relevant to their business and scope. Thus, each user can apply a weight to all 19 indicators. Using the tools developed the user can also select any number of countries to which the indicators will be assigned considering different weights. This feature allows users to create customized BRI rankings considering only the set of countries or regions of interest. The feature is accessible via the BRI Web app[38]. The scores for the 'Ideal Country' can be derived from the highest indicator scores among the selected countries or from the default "Ideal Country" set established by the BRI 2021 Standard Version.

For demonstration purposes, four hypothetical scenarios are presented to explain how BRI scores and rankings might change depending on the preferences of different users operating in different industries. It is assumed that the "Ideal Country" is derived from the highest scores among the selected countries for all scenarios.

Scenario 1 - Cryptocurrency Exchange looking to establish headquarters in Central Europe

An executive of a cryptocurrency exchange currently located in the USA aims to open European headquarters and wants to search for the ideal location in Central Europe. The executive wants to select the location of the company's headquarters based on aspects like ease of establishing a business, the number of top cryptocurrency exchanges, local blockchain regulatory stance, and local interest in Bitcoin and Ethereum. The 14 countries that the executive chooses to be assessed by the BRI are the following: *Austria, Belgium, Croatia, the Czech Republic, Germany, Hungary, Liechtenstein, Luxembourg, the Netherlands, Poland, Romania, Serbia, Slovakia,* and *Switzerland*. The customized weights of indicators as set by the exchange executive are the following:

[38] http://readiness.unic.ac.cy/

- Cryptocurrency Activity (25%)
- Business Operations (25%)
- Estimation of Regulatory Approach (10%)
- Interest on Bitcoin (6%)
- Interest on Blockchain (6%)
- Interest on Ethereum (6%)
- E-Government Development Index (3%)
- Crypto ATMs (3%)
- Mining Operations (3%)
- Internet Penetration (2%)
- FinTech Presence (2%)
- Innovation Level (2%)
- ICT Level (1%)
- Mobile Subscriptions (1%)
- Human Development Level (1%)
- Bitcoin Nodes (1%)
- Ethereum Nodes (1%)
- Bitcoin Core Downloads (1%)
- Ethereum Wallet Downloads (1%)

The exchange executive selects to assign weights to all BRI indicators, assuming that all should account for a degree of importance that may affect the decision-making procedures of the company. Table 6.22 shows the countries selected for assessment, their BRI scores, and respective rankings.

Table 6.22: Scenario 1 – BRI Country Results

Country	Score	Rank
SWITZERLAND	55.00977	1
LUXEMBOURG	54.67034	2
NETHERLANDS	54.11901	3
AUSTRIA	52.68024	4
GERMANY	52.08924	5

LIECHTENSTEIN	50.37502	6
BELGIUM	49.81358	7
CROATIA	48.79559	8
CZECH REPUBLIC	48.36643	9
SLOVAKIA	47.79058	10
HUNGARY	47.37202	11
ROMANIA	47.02414	12
POLAND	46.99434	13
SERBIA	44.51689	14

The presence of top cryptocurrency exchanges and the ease of establishing business operations account for 50% of the executive's importance in assigning weights to the BRI indicators and, consequently, country scores. The BRI enables the executive to set customized weights according to the company's strategy of considering certain factors to assess its future operational strategies. *Switzerland*, the top-ranked country, has been characterized as the "Blockchain Country" with an advanced industry presence (Kondova, 2019). *Luxembourg* and *Netherlands* follow close in the top 3 positions of these customized BRI rankings, while countries like *Serbia* and *Poland* seem inadequate for consideration.

Scenario 2 – Governmental Authorities looking for Blockchain Hub paradigms in the Middle East

In the first scenario, the executive of the cryptocurrency exchange selected to assign weights to all indicators. This might be the case mostly for parties operating directly within the blockchain ecosystem and can estimate the importance of all indicators.

In Scenario 2, the Ministry of Digital Innovation of a country in Southern Europe aims to establish strategic alliances with governments in the Middle East that have been accelerating blockchain technology usage. The Ministry advisor is unsure which of these countries is more advanced in blockchain technology and uses the BRI to compute customized rankings according to the areas of potential collaboration. 16 Middle East countries are selected as the candidate countries required to be assessed via the BRI. *Bahrain, Cyprus, Egypt, Iran, Iraq,* *Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, the Syrian Arab Republic, Turkey, the United Arab Emirates,* and *Yemen.*

The advisor identifies ten relevant indicators and excludes nine considered irrelevant to the project's scope. The ten selected indicators are equally weighted as follows:

- Cryptocurrency Activity (10%)
- Estimation of Regulatory Approach (10%)
- Interest on Bitcoin (10%)
- Interest on Blockchain (10%)
- Interest on Ethereum (10%)
- E-Government Development Index (10%)
- FinTech Presence (10%)
- Innovation Level (10%)
- Bitcoin Core Downloads (10%)
- Ethereum Wallet Downloads (10%)

A combination of development and innovation-related indicators alongside blockchain-specific indicators displaying industry advancement and local interest are selected. Table 6.23 demonstrates the countries selected for assessment, their BRI scores, and rankings.

Table 6.23: Scenario 2 – BRI Country Results

Country	Score	Rank
TURKEY	65.96429	1
CYPRUS	64.97104	2
ISRAEL	61.61305	3
UAE	59.54392	4
JORDAN	57.78996	5
LEBANON	54.16867	6
SAUDI ARABIA	53.64709	7
IRAN	53.6416	8
QATAR	51.02804	9

BAHRAIN	50.28481	10
EGYPT	47.96047	11
KUWAIT	47.36175	12
OMAN	46.46879	13
SYRIA	43.54087	14
IRAQ	39.10003	15
YEMEN	36.0828	16

Turkey and *Cyprus* top the rankings due to their combination of local users' interest and recent blockchain industry developments (as indicated in relevant Appendices). Specifically, *Turkey's* blockchain community tops these customized BRI rankings proposed blockchain solutions for real estate (Mendi *et al.*, 2020) and the barter system (Tandogan, 2021), two industries relevant to governmental procedures. *Israel*, *UAE*, and *Qatar* follow, where these countries could be scored higher if the advisor decided to assign weights only to innovation-related indicators. Countries with limited blockchain activity and interest, like *Yemen* and *Iraq*, seem inappropriate for governmental strategic alliances. Due to the relatively big scoring difference between top and lower-ranked countries, the findings of this customized BRI version could assist the governmental authorities in identifying strategic alliances to avoid besides collaboration opportunities.

<u>Scenario 3 - Crypto ATM Manufacturer looking to install machines in the Caribbean</u>

A company that manufactures and installs Crypto ATMs is looking to expand into the Caribbean after recent studies presented increased intraregional trade volumes in the region (Lopez *et al.*, 2020). The CEO of the manufacturing company selected 11 countries based on the current rates of ATMs installed, internet access, the ease of doing business, mobile subscriptions, Ethereum wallet downloads, and public interest on blockchain.

The second scenario included a limited number of equally weighted indicators. In this scenario, six indicators are selected, but the company's CEO wishes to apply variable weights. Specifically, the CEO uses the BRI weight-adjustment tool to assign higher importance to the number of Crypto ATMs per country due to the scope of the company. The indicators' weights are assigned as follows:

- Crypto ATMs (50%)
- Business Operations (10%)
- Interest on Blockchain (10%)
- Internet Penetration (10%)
- Mobile Subscriptions (10%)
- Ethereum Wallet Downloads (10%)

The flexibility of the BRI tool allows the CEO to derive customized country scores with higher importance assigned to the instalment of Crypto ATMs, as presented in Table 6.24.

Table 6.24: Scenario 3 – BRI Country Results

Country	Score	Rank
DOMINICAN REPUBLIC	48.11557	1
BARBADOS	39.33766	2
BAHAMAS	39.04257	3
HAITI	37.61311	4
GRENADA	37.55912	5
DOMINICA	37.11966	6
ANTIGUA and BARBUDA	33.81354	7
SAINT LUCIA	27.92925	8
SAINT VINCENT AND THE GRENADINES	27.84284	9
CUBA	27.49475	10
SAINT KITTS AND NEVIS	24.13064	11

Dominican Republic tops the customized BRI rankings due to its high performance on the selected indicators compared to the other assessed countries. This may impose an interesting finding for the BRI user, i.e., the company's CEO, as the *Dominican Republic* is ranked relatively low on the BRI 2021 Standard Version rankings (158th) and the BRI 2021 Community-Driven rankings (157th). This difference in the assessment of countries between BRI versions justifies the usability of the weight-adjustment tool to reflect the customized preferences of blockchain professionals.

Scenario 4 – Recruitment of personnel from the public and private sectors in Latin America

The need for blockchain skills is emerging in the public and private sectors, as the development of relevant talent is considered in industries like computer science, business and finance, supply chain logistics, academia, and more (Düdder *et al.*, 2021).

In the final hypothetical scenario, governmental authorities and private blockchain organizations in Latin America recognize the need to acquire local blockchain talents as advisors and full-time employees, respectively.

The customization BRI tool allows users to disqualify the majority of indicators for this assessment due to irrelevancy. 14 Latin American countries are considered; *Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Panamas, Paraguay, Uruguay,* and *Venezuela.* The weights of the indicators are assigned to only three indicators that are considered relevant to recruiting talent, as follows:

- Human Development Level (70%)
- Interest on Blockchain (20%)
- Interest on Ethereum (10%)

Table 6.25: Scenario 4 – BRI Country Results

Country	Score	Rank
ARGENTINA	14.36908	1
BRAZIL	14.31863	2
CHILE	13.99819	3
URUGUAY	13.91893	4
COLOMBIA	13.40379	5
ECUADOR	12.10604	6
PARAGUAY	9.545278	7
GUATEMALA	8.792773	8
VENEZUELA	8.554915	9
PANAMA	8.534672	10
COSTA RICA	8.253563	11

EL SALVADOR	8.166917	12
BOLIVIA	8.166527	13
HONDURAS	7.94133	14

The index that provides country scores for “Human Development Level” assesses aspects like literacy, the willingness to learn, ICT skills, and expected years of schooling. Since its rankings seem to correlate with the country rankings of “Innovation Level” and “ICT Level”, it fulfils the scope of understanding the competencies of the local population. The user in this scenario sets the weight of the indicator - “Human Development Level” at 70%. The remaining weight of 30% that is assigned to “Interest on Blockchain” (20%) and “Interest on Ethereum” (10%) is chosen to estimate how the skilled population distributes its interest toward blockchain aspects. It is assumed that the interest in blockchain and Ethereum is interpreted as a willingness to learn related skills and apply them by developing and running decentralized applications. An interesting finding is that *El Salvador*, which has recently embraced Bitcoin adoption (Sparkes, 2022), may not have an adequate talent pool for recruiting blockchain professionals at this stage.

The customized selection of indicators and application of weights may retrieve variable results for blockchain industry participants compared to fixed ranking schemes. The proposed methodology for constructing a BRI is dynamic and implements enhanced features, like the weight-adjustment tool. Compared to the current literature, and to the best of our knowledge other technological and blockchain-related indexes do not offer a similar feature.

6.2.3.1 Random Weighting

The aim of this experiment is confirmation that the weights-adjustment tool provide reasonable ranking estimates based on the embedded preferences of the user. Therefore I compare the results derived by the proposed BRI with a set of randomly weighing indicators for the four scenarios presented in “BRI 2021 Weights-Adjustment Version”. A variable re-calculation of rankings in each scenario is assumed to further justify that the tool is producing relatively reliable results in the probable real-world scenarios that enhance realistic weights, as discussed in the previous section.

Scenario 1 - Cryptocurrency Exchange looking to establish headquarters in Central Europe

In the first scenario, all 19 indicators were weighted to mimic how a CEO of a cryptocurrency exchange could adjust weights for deciding on the company's headquarters location. Random weight adjustments are applied. Then, it is observed how country scores and rankings may change:

- Cryptocurrency Activity (from 25% to 2%)
- Business Operations (from 25% to 2%)
- Estimation of Regulatory Approach (from 10% to 3%)
- Interest on Bitcoin (from 6% to 2%)
- Interest on Blockchain (from 6% to 2%)
- Interest on Ethereum (from 6% to 11%)
- E-Government Development Index (from 3% to 8%)
- Crypto ATMs (from 3% to 12%)
- Mining Operations (from 3% to 1%)
- Internet Penetration (from 2% to 7%)
- FinTech Presence (from 2% to 2%)
- Innovation Level (from 2% to 3%)
- ICT Level (from 1% to 2%)
- Mobile Subscriptions (from 1% to 2%)
- Human Development Level (from 1% to 5%)
- Bitcoin Nodes (from 1% to 9%)
- Ethereum Nodes (from 1% to 14%)
- Bitcoin Core Downloads (from 1% to 8%)
- Ethereum Wallet Downloads (from 1% to 5%)

Table 6.26 indicates how the restructuring of realistic weights to random weights affects the country scores and rankings for the given country set.

Table 6.26: Scenario 1 – Results of Realistic vs. Random Weights

Country	Score	Score based on Random Weights	Rank	Rank based on Random Weights
SWITZERLAND	55.00977	82.44314	1	4
LUXEMBOURG	54.67034	86.72362	2	1

NETHERLANDS	54.11901	85.65865	3	2
AUSTRIA	52.68024	81.76237	4	5
GERMANY	52.08924	84.02369	5	3
LIECHTENSTEIN	50.37502	68.13139	6	14
BELGIUM	49.81358	79.43254	7	7
CROATIA	48.79559	77.15624	8	9
CZECH REPUBLIC	48.36643	77.84494	9	8
SLOVAKIA	47.79058	81.22179	10	6
HUNGARY	47.37202	76.03193	11	11
ROMANIA	47.02414	76.76714	12	10
POLAND	46.99434	74.57561	13	13
SERBIA	44.51689	75.40509	14	12

Findings indicate that 11 out of the 14 countries have experienced a change in their ranking due to randomization of weights, whereas the difference in the ranking of some countries like *Liechtenstein* (6^{th} to 14^{th}) and *Slovakia* (10^{th} to 6^{th}) is more significant. The top 5 countries are the same but have switched rankings between them; therefore, the random weighting could affect decision-making toward inadequate conclusions. . The overall score for all countries has been increased, the top country considering random weights scored 86.72362 compared to 55.00997 which is the score derived with realistic weights.

Scenario 2 – Governmental Authorities looking for Blockchain Hub paradigms in the Middle East

The second scenario involved ten (10) indicators equally assigned at 10%, which is assumed to be a realistic case of a government attempting to understand the paradigms of blockchain hubs. The following weight changes are applied to the assessed country list to assign random weights:

- Cryptocurrency Activity (from 10% to 2%)

- Estimation of Regulatory Approach (from 10% to 3%)
- Interest on Bitcoin (from 10% to 8%)
- Interest on Blockchain (from 10% to 5%)
- Interest on Ethereum (from 10% to 22%)
- E-Government Development Index (from 10% to 11%)
- FinTech Presence (from 10% to 14%)
- Innovation Level (from 10% to 4%)
- Bitcoin Core Downloads (from 10% to 16%)
- Ethereum Wallet Downloads (from 10% to 15%)

Table 6.27: Scenario 2 – Results of Realistic vs. Random Weights

Country	Score	Score based on Random Weights	Rank	Rank based on Random Weights
TURKEY	65.96429	53.71779	1	8
CYPRUS	64.97104	61.36687	2	2
ISRAEL	61.61305	58.6393	3	4
UAE	59.54392	61.97519	4	1
JORDAN	57.78996	57.3318	5	5
LEBANON	54.16867	60.78711	6	3
SAUDI ARABIA	53.64709	53.91772	7	6
IRAN	53.6416	52.4304	8	11
QATAR	51.02804	53.00231	9	9
BAHRAIN	50.28481	52.49647	10	10
EGYPT	47.96047	53.81218	11	7
KUWAIT	47.36175	48.10823	12	13
OMAN	46.46879	50.65939	13	12

SYRIA	43.54087	44.50126	14	14
IRAQ	39.10003	40.20908	15	16
YEMEN	36.0828	43.18816	16	15

Similar to the first scenario, only 25% of the evaluated countries maintained their ranking after the assignment of random weights. The most noticeable change in ranking and score is derived by *Turkey*, which was ranked first in the realistic scenario and fell to 8^{th} place after random weights were assigned to indicators. This outcome demonstrates that realistic weights can assist users to avoid underestimating high-scored countries.

Scenario 3 - Crypto ATM Manufacturer looking to install machines in the Caribbean

The third scenario involves six (6) assessed indicators where the five (5) are equally weighted at 10%, and a single one is assigned half the score's importance at 50% due to its direct relevancy to the use case. A crypto ATM manufacturer may likely use the BRI to explore where the industry and its competitors operate. For the purpose of the random weights experiment, the following weights are assigned:

- Crypto ATMs (from 50% to 15%)
- Business Operations (from 10% to 5%)
- Interest on Blockchain (from 10% to 30%)
- Internet Penetration (from 10% to 30%)
- Mobile Subscriptions (from 10% to 15%)
- Ethereum Wallet Downloads (from 10% to 5%)

Table 6.28: Scenario 3 – Results of Realistic vs. Random Weights

Country	Score	Score based on Random Weights	Rank	Rank based on Random Weights
DOMINICAN REPUBLIC	48.11557	40.08636	1	1
BARBADOS	39.33766	32.6859	2	5
BAHAMAS	39.04257	32.4193	3	6
HAITI	37.61311	34.75062	4	2
GRENADA	37.55912	31.33756	5	7
DOMINICA	37.11966	33.00225	6	4
ANTIGUA and BARBUDA	33.81354	34.60787	7	3
SAINT LUCIA	27.92925	23.17805	8	10
SAINT VINCENT AND THE GRENADINES	27.84284	23.01312	9	11
CUBA	27.49475	25.21334	10	8
SAINT KITTS AND NEVIS	24.13064	23.59752	11	9

The *Dominican Republic* is the only country that keeps its rank (1st) after assigning random weights. This finding might indicate the overall dominance of the country in the Caribbean region regarding its blockchain engagement. However, there is a noticeable rearrangement of ranks among other countries, with some of the most important being the high-ranked countries of *Barbados* (2nd to 5th) and the *Bahamas* (3rd to 6th) to retreat toward middle-ranked positions. *Antigua and Barbuda* upsurge from 7th to 3rd position. The application of realistic weights for this use case is able to eliminate such misjudgments that are likely to affect the decision-making processes of a crypto ATM manufacturer.

<u>Scenario 4 – Recruitment of personnel from the public and private sectors in Latin America</u>

The scenario of recruiting industry personnel may realistically require skilled labor and some interest in the technology of blockchain. Assume that the realistic weights that rated the importance of human development at 70% are randomly weighted equally as follows:

- Human Development Level (from 70% to 33.3%)
- Interest on Blockchain (from 20% to 33.3%)
- Interest on Ethereum (from 10% to 33.3%)

Table 6.29: Scenario 4 – Results of Realistic vs. Random Weights

Country	Score	Score based on Random Weights	Rank	Rank based on Random Weights
ARGENTINA	14.36908	13.79665	1	5
BRAZIL	14.31863	13.97792	2	4
CHILE	13.99819	14.28509	3	3
URUGUAY	13.91893	14.31747	4	2
COLOMBIA	13.40379	14.36199	5	1
ECUADOR	12.10604	13.67229	6	6
PARAGUAY	9.545278	9.318601	7	10
GUATEMALA	8.792773	9.545954	8	7
VENEZUELA	8.554915	9.454203	9	8
PANAMA	8.534672	9.444074	10	9
COSTA RICA	8.253563	9.22615	11	11
EL SALVADOR	8.166917	9.197815	12	12
BOLIVIA	8.166527	9.197796	13	13
HONDURAS	7.94133	8.991202	14	14

Assigning random weights that are equal for the three indicators, in this case, rearranges the majority of top rankings. *Argentina* (1st to 5th) and *Brazil* (2nd to 4th) may be wrongly underestimated if no realistic weights are assigned. Similar to the previous scenarios examined, applying realistic weights could indicate promising opportunities for the end user.

6.3 Evaluation of Finalized BRI Versions

The finalized BRI versions of 2021 are evaluated based on a ground truth. Due to the wide range of examined countries, obtaining detailed opinions on a per-country basis is not feasible at this stage but is subject to future work. A similar ground truth approach to the evaluation strategy followed to justify the preliminary BRI 2020 scores is conducted. The Pearson rank correlation coefficient for the preliminary BRI 2020 version was calculated at 0.742177168, which justifies the initial methodology used.

The assumption is that if the equivalent correlation coefficient for the BRI 2021 Standard Version is higher than its preliminary version, the updated methodology will be justified as an improved iteration. The Pearson rank correlation coefficient between the Country Scores per Community Voting (Table 4.10) and the BRI 2021 Standard Version Rankings (Appendix V) is calculated at 0.750437139. This figure demonstrates an increase in the correlation coefficient and justifies the improvements done in the methodology, i.e., the use of more reliable and updated indicators and the estimation of blockchain regulatory stance using the Web mining approach.

The same ground truth is applied to the country scores of the BRI 2021 Community-Driven Version. The application of weights by community voting shall be justified in terms of accuracy and relevancy. The Pearson rank correlation coefficient between the Country Scores per Community Voting (Table 4.10) and the BRI 2021 Community-Driven Version Rankings (Appendix IX) is calculated at 0.770762. This figure may imply a further improvement in the findings when adjusting weights according to the community's opinion, compared to assigning equal weights to indicators.

To further explore the significance of this improvement (0.750437139 to 0.770762) in correlation coefficient, the *p*-value from a *t*-test is extracted in order to examine the probability that results from sample data occurred by chance (Browne, 2010). A low *p*-value indicates that data did not occur by chance; therefore, a statistically significant difference occurs between the means of the two trials.

To run the *t*-test, the experiment requires two datasets. We follow the same computational steps as described in (Roger Williams University, 2018) and outlined here for completeness as follows:

1. The two datasets are arranged in columns. The first dataset reflects the country scores that resulted in a correlation coefficient of 0.750437139 (based on equal weighting, Appendix V), and the second dataset reflects the country scores that resulted in a correlation coefficient of 0.770762 (based on community-based weights, Appendix IX).
2. Data analysis is conducted with the option "t-test: Two-Sample Assuming Equal Variances".
3. The last step is to select the alpha level. The alpha level (usually between the range of 0.01 to 0.10) is the threshold that determines whether or not the p-value is low enough to indicate a statistically significant difference between the means of two trials. Since the scope of this experiment is not strict, as there is no assumption that

the community-driven results are more accurate than the standard version results, an alpha level of 0.1 is selected.

4. The p-value is calculated at 0.097469, which is less than the alpha level of 0.1; therefore, it is assumed that there is a statistically significant difference between the means of the BRI 2021 Standard Version Rankings and the BRI 2021 Community-Driven Version Rankings.

The BRI is yet to be globally provided as a service to blockchain participants in the public and private sectors like policymakers and DeFi projects. Negativity may be received by some governmental authorities, blockchain start-ups, and investors operating in low-ranked countries or where such participants believe their country should rank higher on the BRI. However, it is assumed that the BRI versions can be helpful and adjustable to several levels of economies and sectors, regardless of the individual scores and rankings.

The limitations and areas for future developments of the finalized BRI versions are discussed in Chapter 6.

6.4 Discussion

Following the identification of the BRI indicators (with the use of Surveys) and the estimated blockchain regulatory stance per country implemented in Chapter 5 (using Web harvesting techniques (Iosif, Christodoulou and Vlachos, 2021)), this chapter focuses on the third objective set out for this research project O3: “design an index that allows a dynamic estimation of blockchain readiness per country”. The proposed BRI aims to provide useful tools to assist blockchain industry participants in their decision-making processes.

The finalized BRI versions can be useful for blockchain professionals operating in the public and private sectors, as they reflect the community’s assessments and enhance customized flexibility. The challenges identified in implementing the three finalized BRI versions were mostly regarding the identification of accurate numerical sources that reflect recent information. The identification of relevant data sources for the indicators is expected to be an ongoing challenge as currently data sources used may not be updated or seem inaccurate in future versions of the BRI.

The implementation of the finalized BRI 2021 versions was initiated with the Standard Version that follows the same methodology as its preliminary iteration of 2020. Following the update of certain indicator sources and values, findings revealed *Singapore*, *Sweden*, and *Malta* as the top-ranked countries. An interesting observation is that *Switzerland* and *Malta*, which were ranked 3rd and 4th in the preliminary BRI 2020 Version, are ranked 10th and 23rd in the BRI 2021 Standard Version. The evaluation of the proposed methodology is using the Pearson correlation coefficient given a ground truth based on experts' opinion. The results indicated an improvement in the accuracy of country scores according to the community's assessment. This improvement could be due to the inclusion of the regulatory estimation per country via web mining and other updated indicators' sources.

The BRI 2021 Community-Driven Version reflects weight adjustments of indicators per community assessment. Internet penetration, regulatory stance toward blockchain activities, and the ease of establishing business operations are the most important aspects when assessing countries' engagement according to the community. While the top-ranked countries are the same for the two BRI versions, the methodology of this version improved the rankings of developing countries *like Lesotho, Congo,* and *Antigua and Barbuda*. This can be the ideal BRI version to address the needs of industry participants that rely on the community's assessment other than their judgment. The ground truth procedure implemented via the Pearson correlation coefficient indicated an improvement in the accuracy of country scores compared to the BRI 2021 Standard Version, from 0.750437139 to 0.770762.

To address the needs of blockchain professionals in both the public and private sectors, the BRI Weights-Adjustment Version is developed with enhanced customization capabilities. The users can select any number of indicators to assess any number of countries and derive customized findings that are related to their operations. In addition, this version of the BRI enables users to choose similar countries within a region on which the values for missing indicators are estimated. It is assumed that the greater the flexibility on weights adjustment and selection of indicators, the wider the spectrum of users this BRI version will be able to accommodate. Four hypothetical scenarios are presented to demonstrate how country scores may vary when implementing different weighting strategies.

Chapter 6 provides a conclusion on the implementation of the methodology proposed in this research. The limitations of this study and future work are discussed in the following chapter.

CHAPTER 7 CONCLUDING REMARKS

7.0 Introduction

This chapter summarises the research contributions derived from this research project and discusses their fulfilment (research objectives have been set out in Chapter 1).

The findings of this research support the three main objectives and research questions set initially:

O1. Identification of the ideal indicators which the BRI shall include to address the needs of blockchain industry participants

Research question: which techniques can be used to understand the adequate BRI indicators that reflect an estimation of blockchain readiness?

- The adequate indicators were identified through studying their co-occurrence in the literature review, survey findings derived from responses by academically qualified individuals from the blockchain community and their relevancy to the scope of the BRI.

O2. Investigate a way of understanding the blockchain regulatory ecosystem per country in a numerical form

Research question: how can the regulatory ecosystem be translated in a numerical format?

- The regulatory ecosystem is translated into a numerical form by adopting a technique of extracting positive and negative signals per country from publicly available information in the WWW.

O3. Design an index that allows a dynamic estimation of blockchain readiness per country, according to the preferences of industry participants in the public and private sectors

Research question: which techniques will enable the dynamic adjustment of indicators' weights, in order to reflect an estimation of readiness based on users' preferences?

- Several techniques were used to achieve this objective. First, a technique to estimate missing indicators. Then, a technique to score country readiness based on cosine similarity with the "Ideal Country". Then, the BRI 2021 Community-Driven Version is derived from scoring country readiness based on weights determined by the crypto community. Lastly, the BRI 2021 Weights-Adjustment Version allows users to dynamically adjust weights according to their preferences.

This concluding chapter assesses the significance to potential BRI users, discussing the applicability of different BRI versions across various industries. The proposed index methodology is generic and holds the potential for further customizations. Overall, the BRI's utility as a tool for estimating cryptocurrency and blockchain readiness per country extends beyond the industries discussed in this chapter and could potentially expand further, depending on community usage rates.

The evaluation approach is based on computing the Pearson correlation coefficient considering the findings of this research and the community's assessment. The correlation of relevant values yielded positive conclusions regarding the accuracy and reliability of the proposed methodology. As already discussed, current limitations of this research are recognized mainly in the context of the accuracy and completeness of sources. Other limitations arise towards improving the indicators' context and identifying methods to source indicators' values. Some outlier values seem to exist regarding some findings. The indicators shall be revisited frequently and reconsidered in terms of relevancy and reliability. It is assumed that the potential improvement of the research's methodology may further increase the correlation coefficient between BRI findings and experts' opinions.

The acknowledgment of the above research limitations is the initial step to designing a strategy for future work. An outline of future implementations, such as the public launch of the BRI online service (refer to Appendix X) for a preliminary implementation of the proposed BRI methodology as a Web app), additional functionalities like country reports, and improvement of BRI technical components, are directions for future work.

An industry-based evaluation method is also the subject of future work as an attempt to better understand the preferences of industries exploring blockchain technology and the status of interest per country.

7.1 Fulfilment of Research Objectives and Research Questions

The first objective is set to identify the ideal BRI indicators based on existing literature, analysing the co-occurrence of indicators in scientific indexes and relevancy to the scope of the BRI. If an indicator combines its co-occurrence in several scientific indexes with the capability to be derived from numerical sources, its reliability to the scope of this research is assessed. A final list of 19 indicators is identified based on the results from a survey. The survey was shared within the blockchain community of academically certificated individuals who rated the importance of each indicator. The initial instantiation of the proposed BRI (i.e., BRI 2021 Standard Version) includes all indicators identified equally weighted, where the BRI 2021 Community-Driven Version is considering all indicators with adjusted weights based on the community voting results from the survey

Establishing the first objective enables BRI users, who could be decision-makers from the public and private sectors, to base their decisions on relevant indicators as assessed by a community of blockchain experts. According to the literature review, several scientific indexes were constructed to assist the decision-making of policymakers and private industry parties. However, existing methodologies often lack a scientific basis for the selection of indicators, which in the case of the BRI, is based on a series of factors including co-occurrence, relevancy, numerical derivation, and expert justification. It is suggested that the opinion of experts (specialized in a field) should be considered as a qualification criterion for the selection of indicators. Such a selection strategy is likely to produce the most suitable indicators and weights, as opposed to a potentially biased selection by the index's founders.

The second objective of developing a numerical technique to estimate blockchain regulatory stance per country is based on information extracted via web mining techniques. Previous estimations of the regulatory landscape of either the blockchain industry or relevant to other exponential technologies were based on manual assessment and scoring schemes. Similar to the first objective, the substitution of subjective assessment with a scientific approach is the main component of this objective. This approach considers web mining results from the entire WWW rather than individual sources like Wikipedia used in the CRI, or unknown sources, as in the case of CMPI. To the best of our knowledge the proposed methodology is the first to estimate the blockchain regulatory stance per country by considering a wide range of available online data using Web harvesting techniques.

Upon including an indication of blockchain regulatory stance per country, the BRI can assist governmental authorities in following paradigms of top-ranked countries to be established as regulatory blockchain hubs. Low-ranked countries may constitute paradigms of countries whose regulatory stance shall be avoided. Similarly, private blockchain companies can assess the regulatory approach of 194 countries worldwide and decide on operational aspects like the establishment of headquarters, company registration, and target customers.

The last objective that aims to be accomplished with the proposed methodology is the establishment of dynamic BRI features that enable country rankings and indicators' weights to reflect the preferences of end-users. The flexibility of adjusting weights alongside the appropriate selection of indicators should be able to accommodate a wide range of private-sector industries and public uses. Examples of these uses are presented as possible scenarios in section 6.2.3 – "BRI 2021 Weights-Adjustment Version – Results & Discussion". The customization capabilities of the proposed BRI, provides an additional research contribution for scientific indexes, as this is the first attempt to introduce a weight adjustment tool by a blockchain-related index. Weight adjustments with the selection of a set of countries to be considered as part of the index (with the use of "Profiles" as in Appendix X). Table 7.1 shows examples on various cases where the user is assigning greater weights to any given BRI indicator. The weight adjustment feature is not restrictive and can expand beyond the suggested examples. For example, community members can use the feature to propose weighting profiles and strategies that reflect their preferences.

Table 7.1: Uses of Weight-Adjustment Tool for Public and Private Sectors

Indicators	Weight-Adjustment in Public Sector	Weight-Adjustment in Private Sector
1) Estimation of Regulatory Approach	• Identify non-hostile countries and simulate their regulatory frameworks and guidelines • Explore synergies with countries that adopt a positive blockchain regulatory stance	• Identify non-hostile countries where company operations, like the opening of headquarters and legal registration, could be based • Understanding where the legal landscape could allow for the expansion of a company's user base
2) e-Government Development Index	• Examine attributes of a country that is competitive in establishing digitalization and e-services usage to the public	• Identify regions where the legislation and population skills are progressive in e-services and could be a base of operations or skill hunting.

3) FinTech Presence	• Assess the correlation between a progressive FinTech ecosystem and the use of blockchain technology in public services	• Understand whether a progressive FinTech landscape would favor a private blockchain organization and its operational activities to emerge
4) Internet Penetration	• Examine how likely the local population is to engage with cryptocurrency activities and blockchain services according to the internal internet penetration rates	• Identify potential target audiences that could use a company's blockchain-based services like cryptocurrency trading platforms
5) ICT Level	• Examine how likely the local population is to understand the technical terms and functionalities of blockchain applications	• Identify potential target audiences that could adopt decentralized applications and interact with other advanced blockchain activities like NFT trading
6) Innovation Level	• Examine the likelihood of a country's policies and its population capabilities to innovate procedures linked to blockchain technology	• Identify regional legal policies and skilled populations that are keen to embrace innovative technologies like blockchain

7) Mobile Subscriptions	• Understand the potential of establishing mobile-based blockchain services like decentralized applications related to sovereign identity	• Identify potential target audiences that are able to interact with cryptocurrency mobile wallets
8) Business Operations	• Assess and improve the ease of establishing a business locally that could attract overseas blockchain organizations looking for a base of operations	• Define the countries that would allow for an easy establishment of blockchain organization's business operations by streamlining processes like company registration and taxation
9) Human Development Level	• Examine the potential of a local population to adapt and be educated on blockchain technologies and applications	• Facilitate the recruitment of personnel in blockchain organizations with people that are eager to develop new knowledge and skills
10) Cryptocurrency Activity	• Follow national strategies of countries that have been successful in attracting the establishment of cryptocurrency exchanges	• Decide on the ideal locations for headquarter establishment and legal registration on behalf of a cryptocurrency exchange

11) Crypto ATMs	• Follow national strategies of countries that have been successful in attracting the establishment of Crypto ATMs	• Decide on the ideal locations for machine instalments and user adoption on behalf of a Crypto ATM manufacturer
12) Mining Operations	• Assess aspects like the policies of renewable energy consumption and electricity rates that could attract the mining industry	• Decide on the ideal locations for the construction of mining farms and related cryptocurrency activities on behalf of a mining company
13) Bitcoin Nodes	• Understand how engaged local populations are with the two bigger cryptocurrencies in total capitalization. Running a node might demonstrate a specialized interest in network maintenance • Indicators 13-19 are similar in scope as they demonstrate local users' engagement • Identifying countries whose populations are	• Identify target audiences where blockchain, Bitcoin, and Ethereum-interested users are located. The findings can assist decision-making procedures like marketing and operational strategies for blockchain organizations like cryptocurrency exchanges and DeFi projects.
14) Ethereum Nodes		
15) Interest on Bitcoin		

16) Interest on Ethereum 17) Interest on Blockchain 18) Bitcoin Core Downloads 19) Ethereum Wallet Downloads	engaged in blockchain-related services might indicate national frameworks that embrace interaction with innovative technologies. Low-ranked countries can follow the practices of high-ranked countries to engage their populations in the same spectrum of activities • Increased interest in blockchain technology could be a factor for a government to consider launching blockchain-based public services in real estate, attestation, CBDCs, and more	• Bitcoin-related indicators might indicate business opportunities for Bitcoin and trading-centric organizations like mining and crypto remittance companies • Ethereum-related indicators might indicate business opportunities for projects providing DeFi applications like staking, token generation, and NFT marketplaces • Increased interest in blockchain technology could be a factor for private non-blockchain companies to consider launching decentralized services in sectors like insurance, finance, betting, sports, entertainment, and more

7.1.1 First Contribution - Identify Index Indicators

Index indicators are allocated into four pillars according to their contextual nature. These pillars categorize the indicators under regulatory, user engagement, technological advancement, and blockchain industry presence aspects. The review of prior technological indexes combined with the assessment of the blockchain landscape guides the research towards a set of potential indicators to include in the BRI, which is a practical contribution to the community.

By surveying various users of blockchain technology, the research concludes with the importance of each indicator and possibly the decision on which and how many of them are ideal to be included in a scientific BRI. This technique contributes theoretically by suggesting that gaining signals from the blockchain community on the importance of indicators, the corresponding weights can be allocated. Alongside their co-occurrence in previous indexes and relevancy to the BRI scope, 19 indicators were selected and weighted differently in each BRI version.

Survey participants come from diverse professional backgrounds and blockchain expertise. The diversity of background assists the research in analyzing and conducting sources and opinions stemming from a wide range of business sectors.

The successful completion of this objective is expected to contribute to the establishment of the adequate indicators which a BRI shall include. It sets the scene in the community regarding which indicators to consider when governmental and private sector participants face decision-making instances.

7.1.2 Second Contribution - Define the Blockchain Regulatory Landscape in a Numerical Form

As already mentioned, the BRI aims to provide a numerical representation of blockchain engagement per country. For this to be implemented scientifically, a proper methodology must be put in place to reflect the degree of relevant legislation and regulatory guidelines numerically.

Chapter 5 describes the technique developed to establish the numerical score of each country with available information to assess. This method is based on extracting keywords and phrases from country-based results through Google Search engines, which is a technique able to convert information derived from WWW into numerical scores (Iosif, Christodoulou and Vlachos, 2021). The theoretical contribution is that this technique can be duplicated in other studies were positive and negative cues define the readiness of a given sector. Ideally, this paradigm can be followed to assess future blockchain-related regulatory frameworks and any new frameworks developed to regulate exponential technologies, which are currently advancing ahead of law enforcement (Fenwick, Kaal, and Vermeulen, 2016). Users in the future versions of the BRI may modify the positive and negative cues and constraints that act as inputs to the tool.

The regulatory pillar in the initial BRI version described in Chapter 3 includes the numerical score of legal reviews and the safety rank provided by the Cryptocurrency Regulation Analysis (Cointobuy.io, 2020). This analysis ranks countries by assessing the legality of Bitcoin, Initial Coin Offerings restrictions and locations, cryptocurrency exchange locations, and user voting. As the analysis of Chapter 6 outlines, this metric was then considered inaccurate, and therefore the need for another technique to measure regulatory readiness was needed.

The technique developed to cover the regulatory reviews of blockchain regulation can contribute practically by providing an estimation of regulatory stance to blockchain-related parties like organizations, investors and policymakers. Besides providing a numerical score for this aspect, it also aims to provide a fair assessment of the level of regulatory hostility per country. This feature can indicate to policymakers which framework paradigms shall be followed to stimulate local regulatory hubs within their regions. This technique aims to contribute to the existing literature by proposing a method to convert widely available information into numerical scores, rather than relying on human judgment and manual scoring mechanisms.

7.1.3 Third Contribution – Develop Techniques of Estimating Blockchain Readiness per Country

Besides identifying the appropriate indicators, a technique shall be developed which allows the dynamic change of scores according to new updates and developments in the landscape.

The sources are assessed and selected considering their ability to provide updated information periodically, i.e., quarterly or yearly. This requirement can present a challenging task, but it is essential to ensure the quality of this research and the index results, which are interpreted in country scores.

In addition, since the index is designed to be used by participants within a vast number of industries, the proper weighting of indicators must be considered. The launch of the BRI aims to reflect the scoring of countries by equally weighting the indicators and/or taking into account the indicator weights voted by the community. However, one of the most notable features of this index is the capability to enable weight adjustment of each indicator according to each user's needs. This is perceived as a practical contribution to the blockchain community. The weight adjustment feature points to the contribution to the community, as the index can be proven a helpful tool allowing parties from any industry to conclude on a reasonable index scoring according to their customized professional preferences. For example, an executive of a bank may select to consider the readiness of blockchain regulation and the presence of the Fintech ecosystem to a more significant extent than other irrelevant indicators to the banking industry. The BRI versions that enhance the adjustment of weights and other additional features are discussed in Chapter 4 and finalized in Chapter 6. In this chapter, the complete methodology is assessed, including all BRI versions with the addition of the regulatory readiness technique and the ground truth experiments held to validate the results. The proposed BRI is expected to influence various parties from the industry by enabling them to exploit the numerical scores for each individual measure (i.e., indicator) to improve their perspective further in a specific country concerning the development of blockchain technologies.

The methodology outlining the robust proposed model has been initially evaluated via two relevant published papers (Vlachos, Christodoulou, and Iosif, 2019) (Iosif, Christodoulou, and Vlachos, 2020).

The BRI's theoretical contribution is achieved by establishing a methodology for deriving a single score that characterizes the level of blockchain readiness per country. This research attempts to provide a framework that establishes the importance of blockchain-related indicators and a methodology for assessing data to conclude on numerical scores for each country's blockchain readiness. Such an attempt involves challenges like translating information derived from text into numerical assessment; this is the case when assessing blockchain regulatory stance per country. Several indicators are examined accordingly through research and surveys from the industry's insights. Opinions and statistics from industry professionals and academically certified blockchain individuals are taken into consideration.

7.2 Limitations

As already mentioned, the accuracy of the input data sources to the proposed BRI is critical for the calculation of the rankings. For example, data for the indicator "Mining Operations" is extracted from a visualization map[39] where information for small-sized countries like

[39] https://ccaf.io/cbeci/mining_map

Singapore and *Gibraltar* are not defined. These countries are highly scored in other BRI indicators, however due to the visualization aspect of the source, information may not exist or exist but not be extractable at this stage. Missing indicators is an issue for almost all indicators where country values are missing. Although, the proposed BRI methodology addresses this challenge with a preliminary step that estimates missing variables still having accurate data sources is essential for the estimations derived

The indicator "Cryptocurrency Activity" only assesses the presence of top–performing cryptocurrency exchanges. Ideally, this indicator shall include more country-based numerical data beyond cryptocurrency exchanges. This is currently a challenging task due to the decentralized nature of cryptocurrency activity, where the locations of users may not be easily identified (Halpin, 2021).

The accuracy of BRI indicators like "Bitcoin Nodes" and "Ethereum Nodes" depend on reachable nodes. The data source used to extract data for "Bitcoin Nodes" adopts a methodology that sends *getaddr*[40] messages to find all reachable nodes starting from a set of seed nodes. It uses Bitcoin protocol version 70001[41] therefore, nodes running an older protocol version are not included in the estimated values. Certain BRI indicators rely on other scientific indexes like eGDI (United Nations, 2020), The Global FinTech Index (Findexable, 2021), the ICT Development Index (ITU, 2019), and the Ease of Doing Business Index (Mundial, 2020). Country scores for these indicators depend on the methodology used in each of these studies. The research acknowledges this limitation but assumes that the criteria set for selecting indicators are sufficient for this research.

Ideally, the sources of all indicators shall be extracted on the same date, e.g., December 31st, 2021, to avoid inconsistencies in findings. In some cases, this is not feasible for the BRI 2021 versions due to the unavailability of recent values for indicators like "ICT Level," which extracts data from the ICT Development Index (ITU, 2019). The latest version of this index was published in 2017. By the next iterations of the BRI, the objective is to identify as more accurate and updated sources of indicators as possible.

Governmental documents outlining information regarding the blockchain regulatory stance for every assessed country are not currently (and/or made publicly) available. In order to develop an approach that yields estimations for all assessed countries, the methodology described in section 5.3 - "BRI Methodology to Estimate Blockchain Regulatory Stance",

40 https://en.bitcoin.it/wiki/Protocol_documentation#getaddr
41 https://bitcoin.org/en/release/v0.8.0

assesses data publicly available on the WWW. Since the proposed Web mining approach considers the entire corpus of available Web documents, results are depended on the query cues used and the availability of Web resources at search time.

The current evaluation scheme for regulation scores depends on a manual scoring matrix developed internally. This comes in contrast with the concept of a community-based evaluation followed in this research but should be addressed by future work.

The current Web app version of the BRI service[42] (Appendix X) is implemented with embedded customization features outlined in this research but has not yet been finalized and promoted to blockchain industry participants (as this is a Proof-of-concept implementation). A limitation of the approach that is left for future work is an automated service for dynamically updating the data sources used for the indicators (e.g. with the use of Web scrappers (Khder, 2021))

7.3 Future Work

The results from our research exploration along with the identification of possible gaps/ limitations guides the direction for future work. Results from this exploration can be used to further expand the PoC implementation with the vision to establish BRI as a useful and standardized methodology within the blockchain industry.

The assessment of the blockchain ecosystem for reliable, accurate, and updated sources of indicators will be an annual task (timeframe should sync with the release of the data sources used). Existing sources may be replaced with new ones. The context of the indicators shall also be reconsidered annually to ensure the relevancy of the BRI findings to the scope of the research. Community members from the ecosystem could also be engaged during the selection process for the indicators. Since the crypto and blockchain domain is evolving new developments are likely to result in the emergence of new sources, such as the location of cryptocurrency users and DeFi/NFT projects. In that case, the sources will be assessed according to the criteria set and may be considered for inclusion. Overall, data from input sources should be automatically inferred as numerical values, at the same timeframe, for all BRI indicators.

The research proposes the customization of the Web mining method to extract regulatory information for a given timeframe according to the users' preferences rather than all historic

[42] http://readiness.unic.ac.cy/

data. Although this feature is statically implemented as part of the source code it should be embedded in future iterations of the BRI to enhance assessment flexibility and avoid considering irrelevant information. For example, the words “ban” and “restrict” could be found on documents related to the blockchain regulatory stance of Cyprus in 2014 but could be irrelevant in 2022 e.g., in case that a new regulatory framework is established.

The evaluation of the regulatory stance per country is based on the opinions of legal experts and professionals that are aware of the blockchain ecosystem. The identification of the experts is often a challenge. This is expected to change since the space is evolving fast. Opinion from experts is essential for deriving the scoring matrix that is currently used for the evaluation of “Regulation” scores.

Our experimental evaluation with the ground truth dataset derived from the Surveys yields encouraging results regarding the accuracy of the index. The opinions of the community and blockchain experts regarding the weights and relevance of indicators shall also be gathered annually for ground truth procedures. Ideally, the blockchain community could evaluate and propose improvements to the BRI as a service. Strategic alliances with blockchain communities can be formed to develop and expand the use of the BRI service within governmental authorities and blockchain organizations.

The proposed BRI could be served as a Web service for industry participants and governmental officials assisting them in business and/or policy decision-making.

It is assumed that the users of the proposed BRI are professionals with different orientations in terms of hierarchy and expertise. Based on this assumption, the following features are proposed to inform future implementation of the BRI as a service.

a) **Pillars Insights**: Community ratings based on a liker scale regarding the importance of each of the four pillars (and their respective indicators) and a review of each pillar’s developments compared to previous years.
b) **Indicators Insights**: Access to historical numerical values, statistics, and charts derived from the index data feeds.
c) **Individual Country Reports**: Access to reports outlining analytical data for specific countries, including representation of individual SWOT schemes.
d) **Geographical Regions Rankings and Reports**: Extensive comparison of closely-related countries in continents and economic zones.
e) **Option to ask for specific reports and metrics**: Due to the obligation to annually improve the relevance and usability of the BRI service, there will be open community

discussions and reception of recommendations that may contribute to further structural developments.

f) **Option to contribute**: The BRI service shall be open to considering contributions from external researchers that may result in more accurate and broader data feeds and collaborations with local public and private sectors for evaluation purposes of the index.

g) **Web3 Login**: There will be a Web3 login enabled as an additional option on top of the conventional login with a username and password. This login method could be useful to facilitate transactions if the BRI interacts with Web 3 applications and the Metaverse in the future.

Each of the additional features may be beneficial for the internal use of an organization's workforce and its corresponding departments. For example, features (a), (b), and (c) are expected to be valuable for executives and managers responsible for making business decisions, while features (e) and (f) may be useful for academics and researchers looking to contribute and improve the assessment of BRI versions.

Finally, as part of the research exploration, the evaluation approach could follow the paths of real-life use cases by witnessing operations by organizations located in countries that are included in the rankings. Successful and/or promising advancements of startups belonging to the top-ranked countries will prove that the research has produced a valuable index and valuable research progress has been implemented. Any issues and conclusions, which will come up with this evaluation, shall assist this research empirically and direct governmental decisions.

7.4 Summary

This research presents the Blockchain Readiness Index (BRI), which is based on numerical techniques for ranking countries according to their readiness in cryptocurrencies and blockchain technology. The proposed BRI is designed to assist nations in assessing their blockchain readiness and suitability for hosting blockchain-based activities. The methodology involves techniques for identifying the indicators for the index, extracting a numerical representation of each country's regulatory stance via web mining, dealing with missing values for indicators, and different weighting strategies for indicators according to end-user preferences.

Despite the acknowledged limitations concerning data availability and accuracy for some indicators, the BRI represents a significant contribution to the field. With a vision for ongoing improvement and automation, future iterations of the BRI are expected to enhance its functionalities and broaden its usage, ultimately driving the wider acceptance and advancement of blockchain technology.

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Appendix I

Survey 1 Content

"We are a scientific team at the University of Nicosia, currently working on establishing the "Blockchain Readiness Index" – a proposed technique for estimating blockchain readiness per country.

We have created this survey with the aim to get a feel regarding to which industry aspects the "Blockchain Readiness Index" shall include. Your opinion will help us structure the most relevant index indicators, make improvements to the existing tool and prioritize new features. The index indicators are categorized under four pillars; Regulation, Technological Advancement, Blockchain Industry Presence, and Local Users Engagement.

If you have any questions about the survey, please email us: vlachos.a@unic.ac.cy."

Appendix II

Survey 1: Participants' Location

Countries	%	Response
Afghanistan	0.32%	1
Albania	0.00%	0
Algeria	0.00%	0
Andorra	0.00%	0
Angola	0.00%	0
Antigua and Barbuda	0.32%	1
Argentina	0.95%	3
Armenia	0.32%	1
Australia	1.89%	6
Austria	0.32%	1
Azerbaijan	0.00%	0
Bahamas	0.32%	1
Bahrain	0.00%	0
Bangladesh	0.00%	0
Barbados	0.00%	0
Belarus	0.00%	0
Belgium	0.63%	2
Belize	0.00%	0
Benin	0.00%	0
Bhutan	0.00%	0
Bolivia (Plurinational State)	0.00%	0
Bosnia and Herzegovina	0.00%	0
Botswana	0.00%	0
Brazil	3.79%	12
Brunei Darussalam	0.00%	0
Bulgaria	0.32%	1
Burkina Faso	0.00%	0
Burundi	0.00%	0
Cabo Verde	0.00%	0
Cambodia	0.32%	1

Cameroon	0.32%	1
Canada	2.52%	8
Central African Republic	0.00%	0
Chad	0.00%	0
Chile	0.00%	0
China	1.26%	4
Colombia	1.26%	4
Comoros	0.00%	0
Congo	0.00%	0
Costa Rica	0.63%	2
Côte D'Ivoire	0.00%	0
Croatia	1.26%	4
Cuba	0.32%	1
Curaçao	0.00%	0
Cyprus	5.68%	18
Czech Republic	0.00%	0
Democratic People's Republic of Korea	0.00%	0
Democratic Republic of the Congo	0.00%	0
Denmark	0.32%	1
Djibouti	0.00%	0
Dominica	0.00%	0
Dominican Republic	0.00%	0
Ecuador	0.32%	1
Egypt	1.26%	4
El Salvador	0.00%	0
Equatorial Guinea	0.00%	0
Eritrea	0.00%	0
Estonia	0.32%	1
Ethiopia	0.32%	1
Fiji	0.00%	0
Finland	0.00%	0
France	1.26%	4
Gabon	0.00%	0
Gambia	0.00%	0

Georgia	0.00%	0
Germany	3.15%	10
Ghana	0.00%	0
Greece	5.36%	17
Grenada	0.00%	0
Guatemala	0.32%	1
Guinea	0.00%	0
Guinea Bissau	0.00%	0
Guyana	0.00%	0
Haiti	0.00%	0
Holy See	0.00%	0
Honduras	0.32%	1
Hungary	0.32%	1
Iceland	0.63%	2
India	2.21%	7
Indonesia	0.32%	1
Iran (Islamic Republic of)	0.63%	2
Iraq	0.00%	0
Ireland	0.95%	3
Israel	0.32%	1
Italy	1.58%	5
Jamaica	0.63%	2
Japan	0.00%	0
Jordan	0.00%	0
Kazakhstan	0.00%	0
Kenya	0.32%	1
Kiribati	0.00%	0
Kuwait	0.00%	0
Kyrgyzstan	0.00%	0
Lao People’s Democratic Republic	0.32%	1
Latvia	0.00%	0
Lebanon	0.32%	1
Lesotho	0.32%	1
Liberia	0.00%	0

Libya	0.00%	0
Liechtenstein	0.00%	0
Lithuania	0.00%	0
Luxembourg	0.63%	2
Madagascar	0.00%	0
Malawi	0.00%	0
Malaysia	1.89%	6
Maldives	0.00%	0
Mali	0.00%	0
Malta	0.63%	2
Marshall Islands	0.00%	0
Mauritania	0.00%	0
Mauritius	0.32%	1
Mexico	1.26%	4
Micronesia (Federated States of)	0.00%	0
Monaco	0.00%	0
Mongolia	0.00%	0
Montenegro	0.00%	0
Morocco	0.63%	2
Mozambique	0.00%	0
Myanmar	0.00%	0
Namibia	0.00%	0
Nauru	0.00%	0
Nepal	0.32%	1
Netherlands	1.89%	6
New Zealand	0.95%	3
Nicaragua	0.00%	0
Niger	0.00%	0
Nigeria	11.04%	35
Norway	0.95%	3
Oman	0.00%	0
Pakistan	0.32%	1
Palau	0.00%	0
Panama	0.00%	0

Papua New Guinea	0.32%	1
Paraguay	0.00%	0
Peru	0.95%	3
Philippines	0.00%	0
Poland	0.32%	1
Portugal	0.63%	2
Qatar	0.32%	1
Republic of Korea	0.00%	0
Republic of Moldova	0.00%	0
Romania	0.63%	2
Russian Federation	0.32%	1
Rwanda	0.32%	1
Saint Kitts and Nevis	0.00%	0
Saint Lucia	0.32%	1
Saint Vincent and the Grenadines	0.00%	0
Samoa	0.00%	0
San Marino	0.00%	0
Sao Tome and Principe	0.00%	0
Saudi Arabia	0.32%	1
Senegal	0.00%	0
Serbia	0.32%	1
Seychelles	0.00%	0
Sierra Leone	0.00%	0
Singapore	0.63%	2
Slovakia	0.63%	2
Slovenia	0.32%	1
Solomon Islands	0.00%	0
Somalia	0.00%	0
South Africa	2.84%	9
South Sudan	0.00%	0
Spain	2.52%	8
Sri Lanka	0.32%	1
State of Palestine	0.00%	0
Sudan	0.00%	0

Suriname	0.00%	0
Swaziland	0.00%	0
Sweden	0.00%	0
Switzerland	2.52%	8
Syrian Arab Republic	0.00%	0
Tajikistan	0.00%	0
Thailand	0.63%	2
The former Yugoslav Republic of Macedonia	0.32%	1
Timor-Leste	0.00%	0
Togo	0.00%	0
Tonga	0.00%	0
Trinidad and Tobago	0.95%	3
Tunisia	0.32%	1
Turkey	0.95%	3
Turkmenistan	0.00%	0
Tuvalu	0.00%	0
Uganda	0.32%	1
Ukraine	0.32%	1
United Arab Emirates	1.26%	4
United Kingdom of Great Britain and Northern Ireland	3.79%	12
United Republic of Tanzania	0.63%	2
United States of America	9.46%	30
Uruguay	0.00%	0
Uzbekistan	0.00%	0
Vanuatu	0.00%	0
Venezuela (Bolivarian Republic of)	0.63%	2
Vietnam	0.00%	0
Yemen	0.32%	1
Zambia	0.32%	1
Zimbabwe	0.00%	0
	Answered	**317**
	Skipped	**4**

Appendix III

Survey 2 Content

"We are a scientific team at the University of Nicosia, currently working on establishing the "Blockchain Readiness Index" – a proposed technique estimating blockchain readiness per country.

We have created this survey to understand which countries you believe they are more engaged with blockchain technology and cryptocurrency activities. Feel free to consider their regulatory approach, blockchain industry presence, technological advancements, and local engagement of users. Your opinion will help us evaluate our current rankings and the set of indicators identified.

If you have any questions about the survey, please email us: vlachos.a@unic.ac.cy."

Appendix IV

Preliminary BRI 2020 Standard Version Rankings

Country	Score	Rank
Ideal Country	**1**	**-**
SINGAPORE	0.863906	1
MALTA	0.813542	2
SWITZERLAND	0.800886	3
ESTONIA	0.796134	4
CANADA	0.783324	5
LUXEMBOURG	0.782268	6
USA	0.778139	7
NETHERLANDS	0.772865	8
LITHUANIA	0.761493	9
CHINA	0.759675	10
IRELAND	0.759445	11
FINLAND	0.754264	12
UK	0.742359	13
SLOVENIA	0.741687	14
SOUTH AFRICA	0.739357	15
GERMANY	0.733747	16
AUSTRIA	0.730471	17
SWEDEN	0.730322	18
MALAYSIA	0.727725	19
NIGERIA	0.72568	20
AUSTRALIA	0.723292	21
HONG KONG	0.722	22
CYPRUS	0.721573	23
BRAZIL	0.719404	24
LATVIA	0.718619	25
FRANCE	0.714499	26
ISRAEL	0.714382	27
NORWAY	0.711903	28

HUNGARY	0.711301	29
NEW ZEALAND	0.709495	30
COLOMBIA	0.708907	31
INDIA	0.707955	32
ROMANIA	0.707332	33
PHILIPPINES	0.707149	34
POLAND	0.706938	35
VIETNAM	0.706392	36
SPAIN	0.705977	37
GREECE	0.705427	38
GHANA	0.702109	39
ICELAND	0.701666	40
PORTUGAL	0.701079	41
PERU	0.698259	42
RUSSIA	0.697897	43
ARGENTINA	0.696879	44
ITALY	0.696385	45
BANGLADESH	0.692176	46
CZECH REPUBLIC	0.689026	47
BELGIUM	0.688829	48
KOREA(REPUBLIC)	0.685664	49
UAE	0.683109	50
MEXICO	0.681782	51
JAPAN	0.680196	52
DENMARK	0.675887	53
BULGARIA	0.671863	54
ALBANIA	0.670621	55
NORTH MACEDONIA	0.665669	56
CROATIA	0.664739	57
ETHIOPIA	0.664214	58
BOTSWANA	0.66211	59
BRUNEI	0.659465	60
GEORGIA	0.658854	61

ZIMBABWE	0.657161	62
UKRAINE	0.656846	63
BOSNIA	0.656151	64
LIECHTENSTEIN	0.654878	65
CAMEROON	0.652906	66
THAILAND	0.652127	67
NAMIBIA	0.649255	68
KENYA	0.649157	69
UGANDA	0.648731	70
ZAMBIA	0.648491	71
URUGUAY	0.64803	72
CHILE	0.647293	73
INDONESIA	0.646201	74
PAKISTAN	0.643547	75
SLOVAKIA	0.640666	76
VENEZUELA	0.639661	77
LEBANON	0.638864	78
SEYCHELLES	0.638091	79
BENIN	0.637263	80
BELARUS	0.635548	81
NEPAL	0.634958	82
PANAMA	0.634222	83
EGYPT	0.633877	84
SERBIA	0.633769	85
TOGO	0.633303	86
PARAGUAY	0.632608	87
CAMBODIA	0.630174	88
MONTENEGRO	0.629776	89
MONGOLIA	0.62826	90
BURKINA FASO	0.627512	91
SAUDI ARABIA	0.626611	92
COTE d' IVOIRE	0.626486	93
IRAN	0.624969	94
ARMENIA	0.624891	95

DOMINICAN REPUBLIC	0.622682	96
TURKEY	0.621376	97
SURINAME	0.620968	98
COSTA RICA	0.620367	99
JAMAICA	0.619076	100
MAURITIUS	0.615587	101
BAHRAIN	0.614645	102
MADAGASCAR	0.614378	103
ANTIGUA and BARBUDA	0.613342	104
FIJI	0.613198	105
RWANDA	0.6117	106
MALAWI	0.607334	107
LAOS	0.606816	108
UZBEKISTAN	0.606724	109
NICARAGUA	0.605752	110
SENEGAL	0.604371	111
JORDAN	0.603483	112
QATAR	0.602287	113
ALGERIA	0.600077	114
KYRGYZSTAN	0.598587	115
AZERBAIJAN	0.597974	116
MOLDOVA	0.595901	117
BARBADOS	0.595856	118
EL SALVADOR	0.594879	119
TANZANIA	0.594722	120
OMAN	0.594582	121
MONACO	0.594409	122
MYANMAR	0.593747	123
MOROCCO	0.593481	124
HONDURAS	0.591966	125
ECUADOR	0.589788	126
KAZAKHSTAN	0.588638	127

TUNISIA	0.586794	128
BAHAMAS	0.586626	129
MOZAMBIQUE	0.586452	130
GUATEMALA	0.586145	131
BOLIVIA	0.586016	132
KUWAIT	0.583956	133
ESWATINI	0.578285	134
BHUTAN	0.577912	135
ANDORRA	0.56953	136
MALDIVES	0.568199	137
GRENADA	0.566794	138
SAN MARINO	0.566782	139
CAPE VERDE	0.565924	140
BELIZE	0.563476	141
BURUNDI	0.561289	142
ANGOLA	0.556569	143
DOMINICA	0.555996	144
AFGHANISTAN	0.555464	145
SRI LANKA	0.55511	146
GABON	0.554062	147
HAITI	0.545422	148
TAIWAN	0.540419	149
GAMBIA	0.539124	150
LESOTHO	0.536856	151
LIBYA	0.534609	152
SYRIA	0.529938	153
GIBRALTAR	0.526798	154
EQUATORIAL GUINEA	0.526387	155
SAMOA	0.524313	156
MALI	0.523786	157
MAURITANIA	0.520793	158
TAJIKISTAN	0.520725	159
CONGO REPUBLIC	0.520718	160

CUBA	0.518901	161
MICRONESIA FEDERATED STATES OF	0.515773	162
GUYANA	0.515125	163
DJIBOUTI	0.513217	164
KIRIBATI	0.512732	165
GUINEA	0.510521	166
CONGO DEMOCRATIC REPUBLIC	0.509841	167
SAINT KITTS AND NEVIS	0.507137	168
LIBERIA	0.505964	169
PAPUA NEW GUINEA	0.504533	170
SUDAN	0.504516	171
IRAQ	0.501055	172
COMOROS	0.497897	173
GUINEA-BISSAU	0.484987	174
TONGA	0.484277	175
YEMEN	0.482414	176
SAO TOME AND PRINCIPE	0.478722	177
VANUATU	0.476835	178
NIGER	0.476087	179
MARSHALL ISLANDS	0.472377	180
SIERRA LEONE	0.47108	181
SAINT VINCENT AND THE GRENADINES	0.465651	182
SAINT LUCIA	0.461677	183
BERMUDAS	0.460712	184

SUDAN SOUTH	0.449028	185
SOMALIA	0.446877	186
SOLOMON ISLANDS	0.433751	187
NAURU	0.433697	188
TURKMENISTAN	0.422353	189
TUVALU	0.416702	190
ERITREA	0.404381	191

Appendix V

BRI 2021 Standard Version Rankings

Country	Score	Rank
Ideal Country	**1**	**-**
SINGAPORE	0.73297	1
SWEDEN	0.696657	2
MALTA	0.687242	3
USA	0.684259	4
IRELAND	0.677086	5
CANADA	0.662423	6
HONG KONG	0.659005	7
NETHERLANDS	0.655115	8
FINLAND	0.651841	9
SWITZERLAND	0.641094	10
COTE d' IVOIRE	0.636538	11
UKRAINE	0.632936	12
UK	0.630973	13
ANTIGUA and BARBUDA	0.629741	14
GERMANY	0.616065	15
AUSTRALIA	0.615367	16
SLOVAKIA	0.592203	17
AUSTRIA	0.58433	18
TURKEY	0.579117	19
LUXEMBOURG	0.578752	20
BOSNIA	0.573312	21
NEW ZEALAND	0.569637	22
ESTONIA	0.560079	23
MALAYSIA	0.558504	24
PHILIPPINES	0.553274	25
BRAZIL	0.552604	26
CYPRUS	0.549001	27
KOREA(REPUBLIC)	0.544986	28

VIETNAM	0.543198	29
SLOVENIA	0.543032	30
ISRAEL	0.542518	31
LESOTHO	0.540179	32
MOLDOVA	0.539815	33
DOMINICA	0.537088	34
CHINA	0.53669	35
NORWAY	0.535154	36
ZAMBIA	0.533785	37
GREECE	0.533215	38
CONGO REPUBLIC	0.532039	39
TRINIDAD AND TOBAGO	0.529492	40
SAINT KITTS AND NEVIS	0.527678	41
ICELAND	0.527637	42
FRANCE	0.525923	43
NIGERIA	0.518787	44
RUSSIA	0.516451	45
JAPAN	0.516235	46
KIRIBATI	0.516082	47
SAINT VINCENT AND THE GRENADINES	0.511092	48
PORTUGAL	0.506849	49
MAURITANIA	0.501683	50
ITALY	0.501166	51
SEYCHELLES	0.500475	52
BAHAMAS	0.497328	53
VANUATU	0.496026	54
SPAIN	0.492767	55
TOGO	0.489507	56
CROATIA	0.488197	57
DENMARK	0.486252	58
GUINEA-BISSAU	0.48612	59
GUYANA	0.485899	60
LITHUANIA	0.482252	61

CZECH REPUBLIC	0.481512	62
ARGENTINA	0.470427	63
EL SALVADOR	0.468415	64
BERMUDAS	0.46674	65
UAE	0.466118	66
THAILAND	0.464819	67
SAO TOME AND PRINCIPE	0.462043	68
BELARUS	0.461222	69
GAMBIA	0.460287	70
ROMANIA	0.459494	71
GIBRALTAR	0.457328	72
BELGIUM	0.456925	73
JORDAN	0.451857	74
UZBEKISTAN	0.450623	75
CURACAO	0.448707	76
MICRONESIA FEDERATED STATES OF	0.447835	77
ARMENIA	0.447413	78
BULGARIA	0.445898	79
PAKISTAN	0.442716	80
HUNGARY	0.438398	81
GRENADA	0.437942	82
NAURU	0.437736	83
SOUTH AFRICA	0.435389	84
GEORGIA	0.433212	85
POLAND	0.430852	86
COSTA RICA	0.430481	87
SURINAME	0.429815	88
KENYA	0.428912	89
TANZANIA	0.423272	90
IRAN	0.417282	91
NORTH MACEDONIA	0.414863	92
COLOMBIA	0.414062	93
INDIA	0.412239	94

LIECHTENSTEIN	0.412095	95
QATAR	0.41104	96
INDONESIA	0.410702	97
PANAMA	0.41016	98
MEXICO	0.406289	99
CAYMAN ISLANDS	0.403244	100
SAUDI ARABIA	0.40165	101
BELIZE	0.394176	102
CHILE	0.391173	103
KYRGYZSTAN	0.390789	104
PERU	0.390166	105
BAHRAIN	0.389289	106
KAZAKHSTAN	0.388524	107
LEBANON	0.375503	108
IRAQ	0.375348	109
COMOROS	0.372439	110
JAMAICA	0.363097	111
URUGUAY	0.362382	112
KUWAIT	0.355296	113
SERBIA	0.354751	114
LATVIA	0.354535	115
SYRIA	0.352434	116
MAURITIUS	0.350953	117
AZERBAIJAN	0.348956	118
TAIWAN	0.342385	119
BOLIVIA	0.341276	120
ANDORRA	0.33996	121
OMAN	0.339444	122
ALBANIA	0.332588	123
BOTSWANA	0.331684	124
ESWATINI	0.33164	125
GHANA	0.329227	126
BARBADOS	0.321934	127
MOROCCO	0.321478	128

DJIBOUTI	0.310862	129
LIBYA	0.310235	130
TUVALU	0.307477	131
TUNISIA	0.304225	132
NEPAL	0.301156	133
EGYPT	0.299504	134
VENEZUELA	0.298445	135
MONGOLIA	0.297685	136
MYANMAR	0.297198	137
BANGLADESH	0.295724	138
UGANDA	0.291802	139
ERITREA	0.287272	140
SRI LANKA	0.286794	141
CAMBODIA	0.286754	142
MALDIVES	0.283594	143
CAMEROON	0.280669	144
TURKMENISTAN	0.277147	145
MONACO	0.27484	146
ETHIOPIA	0.27327	147
MALI	0.272766	148
SAINT LUCIA	0.270666	149
BRUNEI	0.269478	150
MONTENEGRO	0.26831	151
GUINEA	0.264002	152
NAMIBIA	0.259328	153
YEMEN	0.249069	154
ECUADOR	0.24802	155
MARSHALL ISLANDS	0.247695	156
ZIMBABWE	0.246259	157
DOMINICAN REPUBLIC	0.243346	158
NICARAGUA	0.237665	159
CUBA	0.235213	160
BHUTAN	0.231315	161
RWANDA	0.228061	162

SOMALIA	0.227496	163
ALGERIA	0.22542	164
PARAGUAY	0.224529	165
AFGHANISTAN	0.213431	166
SAN MARINO	0.209302	167
FIJI	0.200436	168
HAITI	0.192951	169
SUDAN	0.192417	170
BENIN	0.191366	171
SOLOMON ISLANDS	0.190417	172
HONDURAS	0.188091	173
PAPUA NEW GUINEA	0.182795	174
LAOS	0.166342	175
GUATEMALA	0.165029	176
SAMOA	0.141545	177
MOZAMBIQUE	0.13597	178
BURUNDI	0.132223	179
TONGA	0.132209	180
BURKINA FASO	0.12955	181
GABON	0.120296	182
SENEGAL	0.119959	183
CONGO DEMOCRATIC REPUBLIC	0.118133	184
CAPE VERDE	0.117559	185
SIERRA LEONE	0.108879	186
TAJIKISTAN	0.100479	187
SUDAN SOUTH	0.084564	188
MALAWI	0.078277	189
MADAGASCAR	0.066009	190
NIGER	0.05048	191
EQUATORIAL GUINEA	0.029752	192
ANGOLA	0.029439	193
LIBERIA	0.010423	194

Appendix VI

Country Scores for 2021: Indicators of the "Technological Advancement" Pillar

Country	eGDI	FinTech Presence	Internet Penetr.	ICT Level	Innovation Level	Mob Subsc.	Bus. Oper.	HDI
Ideal Country	**0.9758**	**69.1513**	**1**	**0.898**	**0.655**	**292**	**86.8**	**0.954**
SINGAPORE	0.9150	15.8284	0.877	0.805	0.578	144	86.2	0.935
SWEDEN	0.9365	13.1409	0.964	0.841	0.631	128	82	0.937
MALTA	0.8547	3.385	0.831	0.786	0.471	143	66.1	0.885
USA	0.9297	69.1513	0.940	0.818	0.613	134	84	0.92
IRELAND	0.8433	6.3565	0.919	0.802	0.507	106	79.6	0.942
CANADA	0.8420	10.2642	0.932	0.777	0.531	96	79.6	0.922
HONG KONG	0.6225	16.41	0.887	0.861	0.537	292	85.3	0.939
NETHERLANDS	0.9228	11.8726	0.956	0.849	0.586	125	76.1	0.933
FINLAND	0.9452	8.3042	0.940	0.788	0.584	129	80.2	0.925
SWITZERLAND	0.8907	14.9513	0.926	0.874	0.655	126	76.6	0.946
COTE d' IVOIRE	0.4457	2.518867	0.548	0.314	0.210	152	60.7	0.516
UKRAINE	0.7119	2.8255	0.941	0.562	0.356	129	70.2	0.75
UK	0.9358	38.7072	0.932	0.865	0.498	116	83.5	0.92
ANTIGUA and BARBUDA	0.6055	2.518867	0.808	0.571	0.328	193	60.3	0.776
GERMANY	0.8524	11.1183	0.960	0.839	0.573	128	79.7	0.939
AUSTRALIA	0.9432	13.7292	0.842	0.824	0.483	108	81.2	0.938
SLOVAKIA	0.7817	1.2353	0.849	0.706	0.402	134	75.6	0.857
AUSTRIA	0.8914	5.2474	0.876	0.802	0.509	119	78.7	0.914
TURKEY	0.7718	3.6397	0.813	0.608	0.383	97	76.8	0.806
LUXEMBOURG	0.8272	5.3288	0.978	0.847	0.490	142	69.6	0.909
BOSNIA	0.6372	3.0773	0.867	0.539	0.296	107	65.4	0.769
NEW ZEALAND	0.9339	4.5163	0.894	0.833	0.475	135	86.8	0.921
ESTONIA	0.9473	10.4462	0.979	0.814	0.499	145	80.6	0.882
MALAYSIA	0.7892	3.0442	0.890	0.638	0.419	135	81.5	0.804
PHILIPPINES	0.6892	2.2195	0.819	0.467	0.353	155	62.8	0.712
BRAZIL	0.7677	8.1635	0.748	0.612	0.342	97	59.1	0.761

CYPRUS	0.8731	4.1064	0.844	0.777	0.467	139	73.4	0.873
KOREA(REPUBLIC)	0.9560	5.2833	0.963	0.885	0.593	138	84	0.906
VIETNAM	0.6667	0.6931	0.774	0.443	0.370	143	69.8	0.693
SLOVENIA	0.8546	2.5344	0.799	0.738	0.441	123	76.5	0.902
ISRAEL	0.8361	19.405	0.797	0.788	0.534	132	76.7	0.906
LESOTHO	0.4593	3.524967	0.316	0.623	0.413	73	59.4	0.518
MOLDOVA	0.6881	1.953867	0.762	0.645	0.323	85	74.4	0.711
DOMINICA	0.6013	3.041	0.520	0.569	0.313	106	60.5	0.742
CHINA	0.8259	8.0719	0.685	0.560	0.548	118	77.9	0.758
NORWAY	0.9064	5.6358	0.986	0.847	0.504	107	82.6	0.954
ZAMBIA	0.4242	2.239267	0.522	0.254	0.198	104	66.9	0.591
GREECE	0.8021	1.415	0.729	0.723	0.363	109	68.4	0.872
CONGO REPUBLIC	0.3786	2.010067	0.158	0.155	0.334	95	39.5	0.608
TRINIDAD AND TOBAGO	0.6785	2.518867	0.758	0.604	0.248	142	61.3	0.799
SAINT KITTS AND NEVIS	0.6352	2.991067	0.849	0.580	0.335	148	54.6	0.777
ICELAND	0.9101	3.264433	0.987	0.898	0.518	123	79	0.938
FRANCE	0.8718	5.9266	0.923	0.824	0.550	111	76.8	0.891
NIGERIA	0.4406	1.46	0.730	0.260	0.201	99	56.9	0.534
RUSSIA	0.8244	6.1321	0.797	0.707	0.366	164	78.2	0.824
JAPAN	0.8989	6.0547	0.945	0.843	0.545	152	78	0.915
KIRIBATI	0.4320	1.953867	0.426	0.679	0.276	46	46.9	0.623
SAINT VINCENT AND THE GRENADINES	0.5605	0.767167	0.709	0.538	0.274	87	57.1	0.728
PORTUGAL	0.8255	4.3266	0.782	0.713	0.442	116	76.5	0.85
MAURITANIA	0.2820	0.889233	0.203	0.226	0.315	106	51.1	0.527
ITALY	0.8231	4.1538	0.925	0.704	0.457	129	72.9	0.883
SEYCHELLES	0.6920	1.2581	0.721	0.503	0.339	187	61.7	0.801
BAHAMAS	0.7017	3.604067	0.863	0.651	0.358	109	59.9	0.805
VANUATU	0.4403	1.957133	0.302	0.281	0.283	80	61.1	0.597
SPAIN	0.8801	7.67	0.925	0.779	0.454	119	77.9	0.893
TOGO	0.4302	0.788533	0.119	0.215	0.193	79	62.3	0.513

CROATIA	0.7745	1.6981	0.915	0.724	0.373	107	73.6	0.837
DENMARK	0.9758	6.0787	0.978	0.871	0.573	123	85.3	0.93
GUINEA-BISSAU	0.2316	6.635033	0.124	0.344	0.358	97	43.2	0.461
GUYANA	0.4909	0.805167	0.496	0.172	0.276	83	55.5	0.67
LITHUANIA	0.8665	11.1071	0.909	0.719	0.399	174	81.6	0.869
CZECH REPUBLIC	0.8135	3.5789	0.877	0.716	0.490	121	76.3	0.891
ARGENTINA	0.8279	2.6924	0.912	0.679	0.298	121	59	0.83
EL SALVADOR	0.5697	5.897133	0.683	0.382	0.250	161	65.3	0.667
BERMUDAS	0.8517	4.2734	0.998	0.803	0.476	103	69.7	0.889
UAE	0.8555	5.0822	1.000	0.721	0.430	186	80.9	0.866
THAILAND	0.7565	1.7197	0.836	0.567	0.372	167	80.1	0.765
SAO TOME AND PRINCIPE	0.4074	2.490667	0.286	0.755	0.396	79	45	0.609
BELARUS	0.8084	0.5503	0.828	0.755	0.326	124	74.3	0.817
GAMBIA	0.2630	3.448067	0.190	0.580	0.320	111	50.3	0.347
ROMANIA	0.7605	2.0103	0.738	0.648	0.356	117	73.3	0.816
GIBRALTAR	0.8458	4.598667	0.977	0.785	0.464	120	72.2	0.887
BELGIUM	0.8047	4.6149	0.939	0.781	0.492	99	75	0.919
JORDAN	0.5309	0.5398	0.847	0.600	0.283	68	69	0.723
UZBEKISTAN	0.6665	2.239267	0.506	0.490	0.366	100	69.9	0.71
CURACAO	0.7903	3.946733	0.918	0.710	0.429	113	67.6	0.833
MICRONESIA FEDERATED STATES OF	0.3779	0.8299	0.483	0.346	0.241	21	48.1	0.614
ARMENIA	0.7136	1.741633	0.717	0.576	0.314	118	74.5	0.76
BULGARIA	0.7980	3.6482	0.667	0.686	0.424	114	72	0.816
PAKISTAN	0.4183	0.3242	0.447	0.242	0.244	80	61	0.56
HUNGARY	0.7745	2.5335	0.890	0.693	0.427	107	73.4	0.845
GRENADA	0.5812	2.333067	0.655	0.335	0.327	104	53.4	0.763
NAURU	0.4150	0.8832	0.590	0.426	0.295	95	55.4	0.708
SOUTH AFRICA	0.6891	3.1264	0.575	0.496	0.327	162	67	0.705
GEORGIA	0.7174	0.981	0.810	0.579	0.324	128	83.7	0.786
POLAND	0.8531	4.1687	0.782	0.689	0.399	130	76.4	0.872
COSTA RICA	0.7576	1.847	0.836	0.644	0.345	147	69.2	0.794

SURINAME	0.5154	0.8832	0.658	0.515	0.295	153	47.5	0.724
KENYA	0.5326	4.4753	0.852	0.291	0.275	114	73.2	0.579
TANZANIA	0.4206	2.074	0.376	0.181	0.256	86	54.5	0.528
IRAN	0.6593	0.1752	0.918	0.558	0.329	152	58.5	0.797
NORTH MACEDONIA	0.7083	6.383767	0.793	0.601	0.341	88	80.7	0.759
COLOMBIA	0.7164	3.0666	0.751	0.536	0.317	133	70.1	0.761
INDIA	0.5964	5.8972	0.542	0.303	0.364	84	71	0.647
LIECHTENSTEIN	0.8359	2.2641	0.985	0.819	0.588	128	64.8	0.917
QATAR	0.7173	2.742467	1.000	0.721	0.315	132	68.7	0.848
INDONESIA	0.6612	3.1308	0.768	0.433	0.271	130	69.6	0.707
PANAMA	0.6715	1.629067	0.662	0.491	0.280	132	66.6	0.795
MEXICO	0.7291	4.4369	0.769	0.516	0.345	93	72.4	0.767
CAYMAN ISLANDS	0.8517	4.2734	0.865	0.803	0.476	152	69.7	0.889
SAUDI ARABIA	0.7991	0.867	0.901	0.667	0.318	124	71.6	0.857
BELIZE	0.4548	0.8439	0.715	0.371	0.331	65	55.5	0.72
CHILE	0.8259	2.9256	0.920	0.657	0.351	131	72.6	0.847
KYRGYZSTAN	0.6749	3.660867	0.471	0.598	0.245	134	67.8	0.674
PERU	0.7083	1.007	0.819	0.485	0.312	132	68.7	0.759
BAHRAIN	0.8213	4.193333	0.977	0.760	0.288	103	76	0.838
KAZAKHSTAN	0.8375	0.8575	0.772	0.769	0.286	134	79.6	0.817
LEBANON	0.4955	0.5894	0.819	0.630	0.251	63	54.3	0.73
IRAQ	0.4360	2.952933	0.643	0.586	0.350	92	44.7	0.689
COMOROS	0.2799	1.881833	0.236	0.182	0.293	54	47.9	0.538
JAMAICA	0.5392	3.845	0.538	0.484	0.296	97	69.7	0.726
URUGUAY	0.8500	6.5785	0.878	0.716	0.322	138	61.5	0.808
KUWAIT	0.7913	2.824467	0.983	0.304	0.299	159	67.4	0.808
SERBIA	0.7474	8.6538	0.737	0.661	0.350	120	75.7	0.799
LATVIA	0.7798	4.4107	0.871	0.726	0.400	109	80.3	0.854
SYRIA	0.4763	2.675667	0.435	0.334	0.356	95	42	0.549
MAURITIUS	0.7196	2.678	0.722	0.588	0.352	150	81.5	0.796
AZERBAIJAN	0.7100	1.957133	0.782	0.620	0.284	102	76.7	0.754
TAIWAN	0.4183	4.187	0.924	0.423	0.223	55	80.9	0.574
BOLIVIA	0.6129	1.9525	0.745	0.431	0.234	101	51.7	0.703

ANDORRA	0.6881	0.788533	0.945	0.771	0.207	114	54.3	0.574
OMAN	0.7749	1.5487	0.768	0.643	0.294	134	70	0.834
ALBANIA	0.7399	1.842833	0.752	0.514	0.280	91	67.7	0.791
BOTSWANA	0.5383	2.821167	0.484	0.459	0.229	162	66.2	0.728
ESWATINI	0.4938	2.449233	0.567	0.165	0.440	94	59.5	0.608
GHANA	0.5960	0.6766	0.465	0.405	0.223	130	60	0.596
BARBADOS	0.7279	3.349867	0.816	0.731	0.398	115	57.9	0.813
MOROCCO	0.5729	1.5487	0.685	0.477	0.293	134	73.4	0.676
DJIBOUTI	0.2728	2.440633	0.548	0.198	0.282	44	60.5	0.495
LIBYA	0.3743	0.8832	0.842	0.411	0.295	91	32.7	0.708
TUVALU	0.4209	0.8832	0.477	0.426	0.295	70	55.4	0.708
TUNISIA	0.6526	0.8136	0.684	0.482	0.307	126	68.7	0.739
NEPAL	0.4699	1.398033	0.738	0.288	0.225	139	63.2	0.579
EGYPT	0.5527	0.6688	0.525	0.463	0.251	93	60.1	0.7
VENEZUELA	0.5268	0.173	0.822	0.517	0.512	63	30.2	0.726
MONGOLIA	0.6497	4.570433	0.823	0.496	0.342	133	67.8	0.735
MYANMAR	0.4316	0.7166	0.521	0.300	0.301	114	46.8	0.584
BANGLADESH	0.5189	0.2549	0.705	0.253	0.202	103	45	0.614
UGANDA	0.4499	0.8849	0.393	0.219	0.200	61	60	0.528
ERITREA	0.1292	1.953867	0.069	0.445	0.276	20	21.6	0.434
SRI LANKA	0.6708	0.889233	0.371	0.391	0.251	139	61.8	0.78
CAMBODIA	0.5113	1.398033	0.734	0.328	0.228	130	53.8	0.581
MALDIVES	0.5740	3.633667	0.739	0.216	0.352	133	53.3	0.719
CAMEROON	0.4325	0.229	0.336	0.238	0.197	95	46.1	0.563
TURKMENISTAN	0.4034	1.840367	0.255	0.507	0.336	163	62.8	0.71
MONACO	0.7177	0.8832	0.965	0.805	0.295	90	55.4	0.708
ETHIOPIA	0.2740	0.1158	0.179	0.449	0.186	36	48	0.47
MALI	0.3097	0.889233	0.598	0.421	0.195	125	52.9	0.427
SAINT LUCIA	0.5444	2.645833	0.775	0.696	0.409	102	63.7	0.745
BRUNEI	0.7389	2.1565	1.000	0.675	0.282	120	70.1	0.845
MONTENEGRO	0.7006	5.484333	0.716	0.644	0.354	172	73.8	0.816
GUINEA	0.2592	2.8483	0.189	0.572	0.167	101	49.4	0.466
NAMIBIA	0.5747	2.0429	0.521	0.389	0.243	102	61.4	0.645
YEMEN	0.3045	0.695367	0.259	0.628	0.154	54	31.8	0.463

ECUADOR	0.7015	0.7657	0.802	0.484	0.254	91	57.7	0.758
MARSHALL ISLANDS	0.4055	0.8299	0.386	0.346	0.241	28	50.9	0.698
ZIMBABWE	0.5019	0.3645	0.557	0.292	0.216	89	54.5	0.563
DOMINICAN REPUBLIC	0.6782	3.823467	0.751	0.451	0.251	83	60	0.745
NICARAGUA	0.5139	0.695367	0.548	0.327	0.298	90	54.4	0.651
CUBA	0.4439	3.864533	0.580	0.291	0.409	59	71.3	0.778
BHUTAN	0.5777	2.9202	0.690	0.369	0.336	97	66	0.617
RWANDA	0.4789	1.065	0.451	0.218	0.239	82	76.5	0.536
SOMALIA	0.1293	0.2426	0.128	0.782	0.462	51	20	0.883
ALGERIA	0.5173	2.8483	0.848	0.467	0.199	104	48.6	0.759
PARAGUAY	0.6487	2.333067	0.856	0.418	0.264	110	59.1	0.724
AFGHANISTAN	0.3203	1.954833	0.184	0.195	0.253	58	44.1	0.496
SAN MARINO	0.6175	2.3078	0.596	0.586	0.313	114	64.2	0.804
FIJI	0.6585	2.354467	0.682	0.411	0.311	118	61.5	0.724
HAITI	0.2723	2.011833	0.316	0.328	0.366	61	40.7	0.503
SUDAN	0.3154	2.274433	0.292	0.255	0.315	80	44.8	0.507
BENIN	0.4039	0.423367	0.305	0.194	0.180	92	52.4	0.52
SOLOMON ISLANDS	0.3442	1.957133	0.185	0.211	0.283	71	55.3	0.557
HONDURAS	0.4486	4.914933	0.491	0.217	0.228	70	56.3	0.623
PAPUA NEW GUINEA	0.2827	0.688567	0.121	0.295	0.208	48	59.8	0.543
LAOS	0.3288	3.8125	0.521	0.291	0.293	61	50.8	0.604
GUATEMALA	0.5155	1.668267	0.506	0.178	0.241	114	62.6	0.651
SAMOA	0.4219	1.953867	0.672	0.330	0.276	64	62.1	0.715
MOZAMBIQUE	0.3564	0.8299	0.203	0.232	0.197	49	55	0.446
BURUNDI	0.3227	3.167133	0.131	0.148	0.334	56	46.8	0.423
TONGA	0.5616	1.953867	0.623	0.434	0.276	59	61.4	0.717
BURKINA FASO	0.3558	4.3039	0.214	0.190	0.205	106	51.4	0.434
GABON	0.5401	0.8832	0.600	0.259	0.295	139	45	0.702
SENEGAL	0.4210	0.5872	0.567	0.266	0.233	114	59.3	0.514

CONGO DEMOCRATIC REPUBLIC	0.2580	3.167133	0.177	0.155	0.334	46	36.2	0.459
CAPE VERDE	0.5604	2.3078	0.627	0.492	0.313	98	55	0.665
SIERRA LEONE	0.2931	2.3078	0.128	0.586	0.313	86	47.5	0.438
TAJIKISTAN	0.4649	1.516033	0.309	0.618	0.239	112	61.3	0.656
SUDAN SOUTH	0.0875	0.8299	0.079	0.346	0.241	20	34.6	0.596
MALAWI	0.3480	0.8299	0.138	0.525	0.229	52	60.9	0.485
MADAGASCAR	0.3095	0.659533	0.101	0.174	0.225	41	47.7	0.521
NIGER	0.1661	0.688567	0.134	0.295	0.178	41	56.8	0.377
EQUATORIAL GUINEA	0.2507	1.953867	0.250	0.096	0.276	45	41.1	0.588
ANGOLA	0.3847	0.8299	0.265	0.194	0.241	45	41.3	0.574
LIBERIA	0.2605	2.5787	0.147	0.168	0.342	57	43.2	0.465

Appendix VII

Indicators of the "Blockchain Industry Presence" Pillar

Country	Cryptocurrency Activity	Crypto ATMs	Mining Operations
Ideal Country	**0.000193193**	**0.000091400**	**0.00000117219**
SINGAPORE	0.000002910	0.000001540	0.00000000000
SWEDEN	0.000000000	0.000000000	0.00000011500
MALTA	0.000009060	0.000000000	0.00000000000
USA	0.000000039	0.000091400	0.00000010700
IRELAND	0.000000000	0.000007900	0.00000094800
CANADA	0.000000080	0.000059800	0.00000025300
HONG KONG	0.000000934	0.000018500	0.00000000000
NETHERLANDS	0.000000058	0.000001170	0.00000000875
FINLAND	0.000000000	0.000002890	0.00000000541
SWITZERLAND	0.000000231	0.000016400	0.00000000347
COTE d' IVOIRE	0.000000000	0.000000000	0.00000000000
UKRAINE	0.000000000	0.000001030	0.00000000297
UK	0.000000162	0.000001560	0.00000000368
ANTIGUA and BARBUDA	0.000010200	0.000020400	0.00000000000
GERMANY	0.000000024	0.000000394	0.00000005350
AUSTRALIA	0.000000078	0.000001730	0.00000000745
SLOVAKIA	0.000000000	0.000009710	0.00000000183
AUSTRIA	0.000000111	0.000015800	0.00000000222
TURKEY	0.000000059	0.000000107	0.00000000071
LUXEMBOURG	0.000000000	0.000000000	0.00000000000
BOSNIA	0.000000000	0.000001830	0.00000000000
NEW ZEALAND	0.000000000	0.000000000	0.00000000000
ESTONIA	0.000012800	0.000002260	0.00000000754
MALAYSIA	0.000000062	0.000000000	0.00000014200
PHILIPPINES	0.000000009	0.000000119	0.00000000000
BRAZIL	0.000000009	0.000000104	0.00000000231

CYPRUS	0.000000000	0.000000000	0.00000000000
KOREA(REPUBLIC)	0.000000195	0.000000000	0.00000000039
VIETNAM	0.000000021	0.000000103	0.00000000021
SLOVENIA	0.000000481	0.000010600	0.00000000000
ISRAEL	0.000000116	0.000001270	0.00000000000
LESOTHO	0.000000000	0.000000000	0.00000000000
MOLDOVA	0.000000000	0.000000000	0.00000000248
DOMINICA	0.000000000	0.000000000	0.00000000000
CHINA	0.000000004	0.000000000	0.00000000000
NORWAY	0.000000184	0.000000000	0.00000010700
ZAMBIA	0.000000000	0.000000000	0.00000000054
GREECE	0.000000000	0.000006520	0.00000000384
CONGO REPUBLIC	0.000000000	0.000000000	0.00000000000
TRINIDAD AND TOBAGO	0.000000000	0.000000000	0.00000000000
SAINT KITTS AND NEVIS	0.000000000	0.000018800	0.00000000000
ICELAND	0.000000000	0.000000000	0.00000117000
FRANCE	0.000000031	0.000000031	0.00000000306
NIGERIA	0.000000000	0.000000010	0.00000000005
RUSSIA	0.000000007	0.000000404	0.00000007700
JAPAN	0.000000063	0.000000008	0.00000000269
KIRIBATI	0.000000000	0.000000000	0.00000000000
SAINT VINCENT AND THE GRENADINES	0.000018000	0.000000000	0.00000000000
PORTUGAL	0.000000000	0.000000490	0.00000000196
MAURITANIA	0.000000000	0.000000000	0.00000000000
ITALY	0.000000017	0.000001170	0.00000000083
SEYCHELLES	0.000193193	0.000000000	0.00000000000
BAHAMAS	0.000002540	0.000005090	0.00000000000
VANUATU	0.000000000	0.000000000	0.00000000000
SPAIN	0.000000000	0.000004260	0.00000000107
TOGO	0.000000000	0.000000000	0.00000000000

CROATIA	0.000000000	0.000002680	0.00000000244
DENMARK	0.000000000	0.000000000	0.00000000000
GUINEA-BISSAU	0.000000000	0.000000000	0.00000000000
GUYANA	0.000000000	0.000000000	0.00000000000
LITHUANIA	0.000000367	0.000000367	0.00000000000
CZECH REPUBLIC	0.000000000	0.000006910	0.00000000093
ARGENTINA	0.000000044	0.000000243	0.00000000111
EL SALVADOR	0.000000000	0.000031600	0.00000000000
BERMUDAS	0.000000000	0.000000000	0.00000000000
UAE	0.000000202	0.000000101	0.00000000000
THAILAND	0.000000057	0.000000573	0.00000001420
SAO TOME AND PRINCIPE	0.000000000	0.000000000	0.00000000000
BELARUS	0.000000000	0.000000000	0.00000000106
GAMBIA	0.000000000	0.000000000	0.00000000000
ROMANIA	0.000000000	0.000006080	0.00000000312
GIBRALTAR	0.000059400	0.000000000	0.00000000000
BELGIUM	0.000000000	0.000004060	0.00000000259
JORDAN	0.000000000	0.000000000	0.00000000000
UZBEKISTAN	0.000000000	0.000000000	0.00000000149
CURACAO	0.000000000	0.000000000	0.00000000000
MICRONESIA FEDERATED STATES OF	0.000000000	0.000000000	0.00000000000
ARMENIA	0.000000000	0.000000337	0.00000000000
BULGARIA	0.000000144	0.000003890	0.00000000144
PAKISTAN	0.000000000	0.000000000	0.00000000000
HUNGARY	0.000000000	0.000005280	0.00000000207
GRENADA	0.000000000	0.000000000	0.00000000000
NAURU	0.000000000	0.000000000	0.00000000000
SOUTH AFRICA	0.000000034	0.000000236	0.00000000034
GEORGIA	0.000000000	0.000009020	0.00000004510
POLAND	0.000000000	0.000003750	0.00000000053
COSTA RICA	0.000000000	0.000001180	0.00000000000

SURINAME	0.000000000	0.000000000	0.00000000000
KENYA	0.000000000	0.000000019	0.00000000000
TANZANIA	0.000000000	0.000000000	0.00000000000
IRAN	0.000000000	0.000000000	0.00000003700
NORTH MACEDONIA	0.000000000	0.000000000	0.00000000480
COLOMBIA	0.000000000	0.000000747	0.00000000020
INDIA	0.000000003	0.000000001	0.00000000004
LIECHTENSTEIN	0.000052500	0.000000000	0.00000000000
QATAR	0.000000000	0.000000000	0.00000000000
INDONESIA	0.000000011	0.000000004	0.00000000007
PANAMA	0.000000232	0.000005560	0.00000000000
MEXICO	0.000000008	0.000000093	0.00000000062
CAYMAN ISLANDS	0.000091300	0.000000000	0.00000000000
SAUDI ARABIA	0.000000000	0.000000029	0.00000000000
BELIZE	0.000007540	0.000000000	0.00000000000
CHILE	0.000000000	0.000000157	0.00000000000
KYRGYZSTAN	0.000000000	0.000000000	0.00000000000
PERU	0.000000000	0.000000091	0.00000000000
BAHRAIN	0.000000000	0.000001180	0.00000000000
KAZAKHSTAN	0.000000000	0.000000107	0.00000096400
LEBANON	0.000000000	0.000000733	0.00000000000
IRAQ	0.000000000	0.000000000	0.00000000000
COMOROS	0.000000000	0.000000000	0.00000000000
JAMAICA	0.000000000	0.000000000	0.00000000000
URUGUAY	0.000000000	0.000000000	0.00000000000
KUWAIT	0.000000000	0.000000000	0.00000003040
SERBIA	0.000000000	0.000000572	0.00000000229
LATVIA	0.000000000	0.000000530	0.00000000000
SYRIA	0.000000000	0.000000000	0.00000000000
MAURITIUS	0.000000000	0.000000000	0.00000000000
AZERBAIJAN	0.000000000	0.000000000	0.00000000296
TAIWAN	0.000000126	0.000001050	0.00000000000
BOLIVIA	0.000000000	0.000000000	0.00000000000

ANDORRA	0.000000000	0.000000000	0.00000000000
OMAN	0.000000000	0.000000000	0.00000001170
ALBANIA	0.000000000	0.000000000	0.00000000347
BOTSWANA	0.000000000	0.000000425	0.00000000000
ESWATINI	0.000000000	0.000000000	0.00000000000
GHANA	0.000000000	0.000000032	0.00000000000
BARBADOS	0.000000000	0.000003480	0.00000000000
MOROCCO	0.000000000	0.000000000	0.00000000000
DJIBOUTI	0.000000000	0.000001010	0.00000000000
LIBYA	0.000000000	0.000000000	0.00000000146
TUVALU	0.000000000	0.000000000	0.00000000000
TUNISIA	0.000000000	0.000000000	0.00000000000
NEPAL	0.000000000	0.000000000	0.00000000000
EGYPT	0.000000000	0.000000000	0.00000000166
VENEZUELA	0.000000000	0.000000035	0.00000000000
MONGOLIA	0.000000000	0.000000000	0.00000003970
MYANMAR	0.000000000	0.000000000	0.00000000000
BANGLADESH	0.000000000	0.000000000	0.00000000006
UGANDA	0.000000000	0.000000022	0.00000000000
ERITREA	0.000000000	0.000000000	0.00000000000
SRI LANKA	0.000000000	0.000000000	0.00000000000
CAMBODIA	0.000000000	0.000000060	0.00000000000
MALDIVES	0.000000000	0.000000000	0.00000000000
CAMEROON	0.000000000	0.000000000	0.00000000000
TURKMENISTAN	0.000000000	0.000000000	0.00000000166
MONACO	0.000000000	0.000000000	0.00000000000
ETHIOPIA	0.000000000	0.000000000	0.00000000000
MALI	0.000000000	0.000000000	0.00000000000
SAINT LUCIA	0.000000000	0.000000000	0.00000000000
BRUNEI	0.000000000	0.000000000	0.00000000000
MONTENEGRO	0.000000000	0.000000000	0.00000000000
GUINEA	0.000000000	0.000000000	0.00000000000
NAMIBIA	0.000000000	0.000000000	0.00000000000
YEMEN	0.000000000	0.000000000	0.00000000000

ECUADOR	0.000000000	0.000000057	0.00000000000
MARSHALL ISLANDS	0.000000000	0.000000000	0.00000000000
ZIMBABWE	0.000000000	0.000000067	0.00000000135
DOMINICAN REPUBLIC	0.000000000	0.000001290	0.00000000000
NICARAGUA	0.000000000	0.000000000	0.00000000000
CUBA	0.000000000	0.000000000	0.00000000000
BHUTAN	0.000000000	0.000000000	0.00000000000
RWANDA	0.000000000	0.000000000	0.00000000000
SOMALIA	0.000000000	0.000000000	0.00000000000
ALGERIA	0.000000000	0.000000000	0.00000000000
PARAGUAY	0.000000000	0.000000000	0.00000002520
AFGHANISTAN	0.000000000	0.000000000	0.00000000000
SAN MARINO	0.000000000	0.000029500	0.00000000000
FIJI	0.000000000	0.000000000	0.00000000000
HAITI	0.000000000	0.000000000	0.00000000000
SUDAN	0.000000000	0.000000000	0.00000000000
BENIN	0.000000000	0.000000000	0.00000000000
SOLOMON ISLANDS	0.000000000	0.000000000	0.00000000000
HONDURAS	0.000000000	0.000000000	0.00000000000
PAPUA NEW GUINEA	0.000000000	0.000000000	0.00000000000
LAOS	0.000000000	0.000000000	0.00000000000
GUATEMALA	0.000000056	0.000000000	0.00000000000
SAMOA	0.000000000	0.000000000	0.00000000000
MOZAMBIQUE	0.000000000	0.000000000	0.00000000000
BURUNDI	0.000000000	0.000000000	0.00000000000
TONGA	0.000000000	0.000000000	0.00000000000
BURKINA FASO	0.000000000	0.000000000	0.00000000000
GABON	0.000000000	0.000000000	0.00000000000
SENEGAL	0.000000000	0.000000000	0.00000000000

CONGO DEMOCRATIC REPUBLIC	0.000000000	0.000000000	0.00000000000
CAPE VERDE	0.000000000	0.000000000	0.00000000000
SIERRA LEONE	0.000000000	0.000000000	0.00000000000
TAJIKISTAN	0.000000000	0.000000000	0.00000000210
SUDAN SOUTH	0.000000000	0.000000000	0.00000000000
MALAWI	0.000000000	0.000000000	0.00000000000
MADAGASCAR	0.000000000	0.000000000	0.00000000000
NIGER	0.000000000	0.000000000	0.00000000000
EQUATORIAL GUINEA	0.000000000	0.000000000	0.00000000000
ANGOLA	0.000000000	0.000000000	0.00000000122
LIBERIA	0.000002910	0.000000000	0.00000000000

Appendix VIII

Country Scores for 2021: Indicators of the "Local Users Engagement" Pillar

Country	BTC Nodes	ETH Nodes	Int. BTC	Int. ETH	Int. Blc.	BTC Core Downloads	ETH wallet Downloads
Ideal Country	0.000059400	0.000049700	**100**	**100**	**100**	**0.0000259000**	0.0000032000
SINGAPORE	0.000022200	0.000049700	38	60	54	0.0000051300	0.0000015400
SWEDEN	0.000008610	0.000001580	20	40	13	0.0000030700	0.0000008910
MALTA	0.000002260	0.000000000	27	44	18	0.0000067900	0.0000000000
USA	0.000005380	0.000006480	21	29	17	0.0000022700	0.0000011200
IRELAND	0.000010300	0.000024700	25	40	21	0.0000026300	0.0000002030
CANADA	0.000007790	0.000004080	33	56	29	0.0000034700	0.0000017800
HONG KONG	0.000009200	0.000011500	18	12	37	0.0000068000	0.0000020000
NETHERLANDS	0.000022100	0.000004790	43	51	21	0.0000055400	0.0000019800
FINLAND	0.000038600	0.000036500	21	32	11	0.0000030700	0.0000023500
SWITZERLAND	0.000015000	0.000005320	39	63	36	0.0000087800	0.0000004620
COTE d' IVOIRE	0.000000000	0.000000000	14	8	46	0.0000000000	0.0000000758
UKRAINE	0.000001260	0.000000526	3	7	10	0.0000020800	0.0000002740
UK	0.000003330	0.000003980	21	26	34	0.0000029300	0.0000006480
ANTIGUA and BARBUDA	0.000000000	0.000000000	20	11	35	0.0000000000	0.0000000000
GERMANY	0.000020900	0.000009350	28	47	22	0.0000071900	0.0000013100
AUSTRALIA	0.000003920	0.000003690	30	41	17	0.0000039200	0.0000009800
SLOVAKIA	0.000003660	0.000000916	17	26	6	0.0000012800	0.0000012800
AUSTRIA	0.000005110	0.000003550	36	59	24	0.0000067700	0.0000007770
TURKEY	0.000000142	0.000000071	42	66	9	0.0000029200	0.0000003790
LUXEMBOURG	0.000014400	0.000000000	26	45	40	0.0000079900	0.0000032000
BOSNIA	0.000000000	0.000000000	12	18	8	0.0000012200	0.0000024400

NEW ZEALAND	0.000004770	0.000002490	24	32	13	0.0000029000	0.0000004150
ESTONIA	0.000004520	0.000003770	22	37	21	0.0000015100	0.0000015100
MALAYSIA	0.000000402	0.000000216	13	16	13	0.0000004330	0.0000003400
PHILIPPINES	0.000000009	0.000000018	10	15	14	0.0000003190	0.0000001280
BRAZIL	0.000000202	0.000000075	13	14	7	0.0000006160	0.0000001270
CYPRUS	0.000003310	0.000000828	32	43	39	0.0000049700	0.0000008280
KOREA(REPUBLIC)	0.000001310	0.000003900	4	5	10	0.0000010500	0.0000006050
VIETNAM	0.000000082	0.000000072	7	3	14	0.0000004830	0.0000001030
SLOVENIA	0.000005770	0.000003370	38	54	16	0.0000024100	0.0000024100
ISRAEL	0.000001160	0.000000924	12	14	14	0.0000023100	0.0000000000
LESOTHO	0.000000000	0.000000000	18	15	23	0.0000000000	0.0000000000
MOLDOVA	0.000001980	0.000000000	7	9	8	0.0000012400	0.0000007440
DOMINICA	0.000000000	0.000000000	21	0	0	0.0000000000	0.0000000000
CHINA	0.000000080	0.000000113	10	14	48	0.0000001810	0.0000001120
NORWAY	0.000005530	0.000002580	18	25	14	0.0000040600	0.0000005530
ZAMBIA	0.000000000	0.000000000	7	2	11	0.0000000000	0.0000001090
GREECE	0.000000480	0.000000768	10	19	12	0.0000016300	0.0000004800
CONGO REPUBLIC	0.000000000	0.000000000	7	0	27	0.0000000000	0.0000000000
TRINIDAD AND TOBAGO	0.000000000	0.000000000	13	10	22	0.0000000000	0.0000021400
SAINT KITTS AND NEVIS	0.000000000	0.000000000	22	0	0	0.0000000000	0.0000000000
ICELAND	0.000023400	0.000000000	24	28	19	0.0000029300	0.0000000000
FRANCE	0.000008760	0.000002900	10	16	14	0.0000031100	0.0000003980
NIGERIA	0.000000000	0.000000000	46	21	100	0.0000000873	0.0000001310
RUSSIA	0.000001180	0.000000425	4	5	7	0.0000015600	0.0000003020
JAPAN	0.000000933	0.000001160	1	1	1	0.0000002850	0.0000000553
KIRIBATI	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
SAINT VINCENT	0.000000000	0.000000000	11	0	0	0.0000000000	0.0000000000

AND THE GRENADINES							
PORTUGAL	0.000002260	0.000000686	16	22	20	0.0000016700	0.0000003920
MAURITANIA	0.000000000	0.000000000	6	5	11	0.0000000000	0.0000000000
ITALY	0.000001030	0.000000298	13	14	15	0.0000014400	0.0000008270
SEYCHELLES	0.000010200	0.000000000	8	0	0	0.0000000000	0.0000000000
BAHAMAS	0.000000000	0.000000000	17	18	21	0.0000000000	0.0000000000
VANUATU	0.000000000	0.000000000	8	0	0	0.0000000000	0.0000000000
SPAIN	0.000001450	0.000000449	21	21	16	0.0000027400	0.0000003420
TOGO	0.000000000	0.000000000	25	19	86	0.0000002420	0.0000001210
CROATIA	0.000002920	0.000003900	23	28	13	0.0000017100	0.0000002440
DENMARK	0.000003110	0.000000691	15	17	17	0.0000020700	0.0000003450
GUINEA-BISSAU	0.000000000	0.000000000	3	16	0	0.0000000000	0.0000000000
GUYANA	0.000000000	0.000000000	9	3	8	0.0000025400	0.0000000000
LITHUANIA	0.000018400	0.000005140	15	21	15	0.0000018400	0.0000007350
CZECH REPUBLIC	0.000006630	0.000001680	21	23	12	0.0000032700	0.0000001870
ARGENTINA	0.000000376	0.000000022	18	25	11	0.0000012200	0.0000000443
EL SALVADOR	0.000000000	0.000000000	100	10	15	0.0000004630	0.0000000000
BERMUDAS	0.000000000	0.000000000	42	43	30	0.0000000000	0.0000000000
UAE	0.000000202	0.000000607	21	27	28	0.0000019200	0.0000010100
THAILAND	0.000000215	0.000000186	7	5	12	0.0000005730	0.0000002870
SAO TOME AND PRINCIPE	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
BELARUS	0.000000635	0.000000106	1	3	6	0.0000031700	0.0000000000
GAMBIA	0.000000000	0.000000000	9	6	0	0.0000000000	0.0000000000
ROMANIA	0.000001720	0.000000468	15	16	15	0.0000021300	0.0000004680
GIBRALTAR	0.000059400	0.000000000	29	31	36	0.0000000000	0.0000000000

BELGIUM	0.000002670	0.000001640	24	35	20	0.0000025900	0.0000004310
JORDAN	0.000000000	0.000000000	7	8	8	0.0000002940	0.0000000000
UZBEKISTAN	0.000000000	0.000000000	3	4	7	0.0000002090	0.0000000000
CURACAO	0.000000000	0.000000000	41	37	19	0.0000000000	0.0000000000
MICRONESIA FEDERATED STATES OF	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
ARMENIA	0.000000337	0.000000000	9	14	9	0.0000013500	0.0000003370
BULGARIA	0.000005760	0.000000720	14	21	12	0.0000018700	0.0000008640
PAKISTAN	0.000000009	0.000000009	20	20	22	0.0000000996	0.0000000724
HUNGARY	0.000002280	0.000000621	13	18	9	0.0000020700	0.0000004140
GRENADA	0.000000000	0.000000000	11	9	0	0.0000000000	0.0000000000
NAURU	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
SOUTH AFRICA	0.000000219	0.000000067	23	21	15	0.0000002870	0.0000002360
GEORGIA	0.000000000	0.000000251	14	16	18	0.0000030100	0.0000020100
POLAND	0.000000978	0.000000528	13	22	7	0.0000019000	0.0000001060
COSTA RICA	0.000000393	0.000000000	16	12	17	0.0000015700	0.0000001960
SURINAME	0.000000000	0.000000000	12	8	17	0.0000000000	0.0000000000
KENYA	0.000000000	0.000000000	16	13	23	0.0000002050	0.0000001860
TANZANIA	0.000000000	0.000000000	8	5	15	0.0000000000	0.0000000000
IRAN	0.000000060	0.000000000	3	3	6	0.0000000000	0.0000000000
NORTH MACEDONIA	0.000000000	0.000000000	22	67	19	0.0000004800	0.0000014400
COLOMBIA	0.000000118	0.000000000	12	11	10	0.0000003930	0.0000000983
INDIA	0.000000012	0.000000008	11	12	14	0.0000000848	0.0000000710
LIECHTENSTEIN	0.000026200	0.000000000	52	100	69	0.0000000000	0.0000000000
QATAR	0.000000000	0.000000000	12	15	13	0.0000010400	0.0000000000
INDONESIA	0.000000004	0.000000015	6	4	6	0.0000002600	0.0000000512
PANAMA	0.000000000	0.000000000	11	11	13	0.0000002320	0.0000000000
MEXICO	0.000000062	0.000000008	7	7	5	0.0000002950	0.0000001010

CAYMAN ISLANDS	0.000000000	0.000000000	42	79	44	0.0000000000	0.0000000000
SAUDI ARABIA	0.000000000	0.000000000	4	6	6	0.0000004600	0.0000002300
BELIZE	0.000000000	0.000002510	8	6	3	0.0000000000	0.0000000000
CHILE	0.000000262	0.000000105	9	9	6	0.0000004180	0.0000004180
KYRGYZSTAN	0.000000153	0.000000000	2	4	5	0.0000004600	0.0000001530
PERU	0.000000000	0.000000000	8	8	8	0.0000001820	0.0000000000
BAHRAIN	0.000000000	0.000000000	14	22	14	0.0000005880	0.0000000000
KAZAKHSTAN	0.000000053	0.000000213	2	4	6	0.0000019200	0.0000000000
LEBANON	0.000000000	0.000000000	20	29	24	0.0000010300	0.0000004400
IRAQ	0.000000000	0.000000000	3	3	4	0.0000000994	0.0000000000
COMOROS	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
JAMAICA	0.000000000	0.000000000	9	8	20	0.0000003380	0.0000000000
URUGUAY	0.000000576	0.000000000	10	10	7	0.0000008640	0.0000000000
KUWAIT	0.000000234	0.000000000	10	6	6	0.0000004680	0.0000000000
SERBIA	0.000000572	0.000000343	12	38	9	0.0000008010	0.0000011400
LATVIA	0.000003710	0.000001060	12	18	13	0.0000037100	0.0000000000
SYRIA	0.000000000	0.000000000	3	3	3	0.0000000000	0.0000000000
MAURITIUS	0.000000000	0.000000000	11	13	22	0.0000000000	0.0000000000
AZERBAIJAN	0.000000197	0.000000000	7	9	7	0.0000000986	0.0000000000
TAIWAN	0.000000798	0.000000840	2	2	5	0.0000011800	0.0000001680
BOLIVIA	0.000000000	0.000000000	6	4	6	0.0000000000	0.0000000000
ANDORRA	0.000000000	0.000012900	26	32	82	0.0000259000	0.0000000000
OMAN	0.000000000	0.000000000	7	9	11	0.0000005870	0.0000001960
ALBANIA	0.000000000	0.000000000	22	30	34	0.0000024300	0.0000003470
BOTSWANA	0.000000000	0.000000000	24	8	44	0.0000004250	0.0000000000
ESWATINI	0.000000000	0.000000000	17	16	5	0.0000000000	0.0000000000
GHANA	0.000000000	0.000000000	20	8	82	0.0000000644	0.0000001290
BARBADOS	0.000000000	0.000000000	13	10	20	0.0000000000	0.0000000000
MOROCCO	0.000000000	0.000000000	7	9	15	0.0000007040	0.0000000542
DJIBOUTI	0.000000000	0.000000000	12	7	0	0.0000000000	0.0000000000

LIBYA	0.000000000	0.000000000	3	4	8	0.0000004370	0.0000004370
TUVALU	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
TUNISIA	0.000000000	0.000000000	9	6	15	0.0000005920	0.0000002540
NEPAL	0.000000000	0.000000000	11	9	12	0.0000000343	0.0000001370
EGYPT	0.000000000	0.000000000	3	3	6	0.0000001370	0.0000000782
VENEZUELA	0.000000035	0.000000000	20	18	21	0.0000002460	0.0000001410
MONGOLIA	0.000000000	0.000000000	16	17	27	0.0000003050	0.0000000000
MYANMAR	0.000000000	0.000000018	5	4	9	0.0000000368	0.0000000000
BANGLADES H	0.000000000	0.000000000	5	4	12	0.0000000121	0.0000000182
UGANDA	0.000000000	0.000000000	8	5	10	0.0000000219	0.0000000874
ERITREA	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
SRI LANKA	0.000000000	0.000000000	9	6	13	0.0000005600	0.0000001870
CAMBODIA	0.000000120	0.000000000	8	8	13	0.0000000598	0.0000000000
MALDIVES	0.000000000	0.000000000	20	24	9	0.0000018500	0.0000000000
CAMEROON	0.000000000	0.000000000	23	8	60	0.0000000000	0.0000000377
TURKMENIS TAN	0.000000000	0.000000000	6	5	4	0.0000000000	0.0000000000
MONACO	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
ETHIOPIA	0.000000000	0.000000000	9	3	29	0.0000000087	0.0000000087
MALI	0.000000000	0.000000000	5	3	11	0.0000000000	0.0000000000
SAINT LUCIA	0.000000000	0.000000000	12	20	0	0.0000000000	0.0000000000
BRUNEI	0.000000000	0.000000000	14	18	12	0.0000000000	0.0000000000
MONTENEG RO	0.000001590	0.000000000	12	23	14	0.0000079600	0.0000000000
GUINEA	0.000000000	0.000000000	3	1	5	0.0000000000	0.0000000000
NAMIBIA	0.000000000	0.000000000	36	20	23	0.0000003940	0.0000003940
YEMEN	0.000000000	0.000000000	2	1	4	0.0000000335	0.0000001010
ECUADOR	0.000000170	0.000000000	7	5	8	0.0000002270	0.0000001130
MARSHALL ISLANDS	0.000000000	0.000000000	20	0	0	0.0000000000	0.0000000000
ZIMBABWE	0.000000000	0.000000000	17	8	41	0.0000000000	0.0000007400
DOMINICAN REPUBLIC	0.000000000	0.000000000	10	8	13	0.0000003690	0.0000003690

NICARAGUA	0.000000000	0.000000000	6	3	3	0.0000000000	0.0000000000
CUBA	0.000000000	0.000000000	22	9	15	0.0000000000	0.0000000000
BHUTAN	0.000000000	0.000000000	19	19	46	0.0000000000	0.0000000000
RWANDA	0.000000000	0.000000000	9	5	22	0.0000000000	0.0000000000
SOMALIA	0.000000000	0.000000000	11	9	15	0.0000000000	0.0000000000
ALGERIA	0.000000000	0.000000000	3	4	6	0.0000000684	0.0000000228
PARAGUAY	0.000000000	0.000000000	9	8	4	0.0000000000	0.0000002800
AFGHANISTAN	0.000000000	0.000000000	11	7	17	0.0000000000	0.0000001030
SAN MARINO	0.000000000	0.000000000	10	0	0	0.0000000000	0.0000000000
FIJI	0.000000000	0.000000000	7	4	3	0.0000011200	0.0000000000
HAITI	0.000000000	0.000000000	8	6	6	0.0000000000	0.0000000000
SUDAN	0.000000000	0.000000000	3	3	6	0.0000000000	0.0000000000
BENIN	0.000000000	0.000000000	28	15	63	0.0000000825	0.0000000825
SOLOMON ISLANDS	0.000000000	0.000000000	8	0	0	0.0000000000	0.0000000000
HONDURAS	0.000000000	0.000000000	7	4	7	0.0000001010	0.0000000000
PAPUA NEW GUINEA	0.000000000	0.000000000	18	5	20	0.0000000000	0.0000004470
LAOS	0.000000000	0.000000000	9	6	20	0.0000001370	0.0000000000
GUATEMALA	0.000000056	0.000000000	6	4	4	0.0000002790	0.0000000000
SAMOA	0.000000000	0.000000000	7	0	0	0.0000000000	0.0000000000
MOZAMBIQUE	0.000000000	0.000000000	6	3	17	0.0000000000	0.0000000320
BURUNDI	0.000000000	0.000000000	14	0	28	0.0000000000	0.0000000000
TONGA	0.000000000	0.000000000	0	0	0	0.0000000000	0.0000000000
BURKINA FASO	0.000000000	0.000000000	13	8	37	0.0000000478	0.0000000000
GABON	0.000000000	0.000000000	7	5	22	0.0000000000	0.0000000000
SENEGAL	0.000000000	0.000000000	7	7	27	0.0000000000	0.0000000000

CONGO DEMOCRATIC REPUBLIC	0.000000000	0.000000000	5	3	22	0.0000000112	0.0000000112
CAPE VERDE	0.000000000	0.000000000	11	0	0	0.0000000000	0.0000000000
SIERRA LEONE	0.000000000	0.000000000	6	2	0	0.0000000000	0.0000000000
TAJIKISTAN	0.000000000	0.000000000	3	2	4	0.0000000000	0.0000001050
SUDAN SOUTH	0.000000000	0.000000000	7	0	0	0.0000000000	0.0000000000
MALAWI	0.000000000	0.000000000	9	3	15	0.0000000000	0.0000000000
MADAGASCAR	0.000000000	0.000000000	14	10	18	0.0000000000	0.0000000361
NIGER	0.000000000	0.000000000	8	0	20	0.0000000000	0.0000000000
EQUATORIAL GUINEA	0.000000000	0.000000000	6	0	0	0.0000000000	0.0000000000
ANGOLA	0.000000000	0.000000000	6	2	10	0.0000000000	0.0000000000
LIBERIA	0.000000000	0.000000000	9	3	0	0.0000000000	0.0000000000

Appendix IX

BRI 2021 Community-Driven Version Rankings

Country	Score	Rank
Ideal Country	**1**	**-**
SINGAPORE	0.707807	1
SWEDEN	0.679499	2
MALTA	0.672318	3
USA	0.657401	4
IRELAND	0.643962	5
HONG KONG	0.631292	6
COTE d' IVOIRE	0.622988	7
NETHERLANDS	0.619742	8
CANADA	0.61752	9
FINLAND	0.616684	10
UKRAINE	0.613248	11
ANTIGUA and BARBUDA	0.612885	12
SWITZERLAND	0.603831	13
UK	0.601551	14
AUSTRALIA	0.58176	15
GERMANY	0.57194	16
SLOVAKIA	0.558053	17
BOSNIA	0.550936	18
TURKEY	0.548625	19
AUSTRIA	0.539943	20
LESOTHO	0.539115	21
NEW ZEALAND	0.538679	22
CONGO REPUBLIC	0.538446	23
LUXEMBOURG	0.537306	24
MALAYSIA	0.530122	25
BRAZIL	0.529504	26
DOMINICA	0.529346	27
PHILIPPINES	0.529272	28

KOREA(REPUBLIC)	0.523471	29
VIETNAM	0.522879	30
ESTONIA	0.518946	31
ISRAEL	0.518338	32
MOLDOVA	0.515365	33
CHINA	0.514848	34
ZAMBIA	0.514456	35
SAINT KITTS AND NEVIS	0.512671	36
KIRIBATI	0.511401	37
CYPRUS	0.507702	38
TRINIDAD AND TOBAGO	0.503075	39
GREECE	0.500947	40
JAPAN	0.500061	41
NORWAY	0.497388	42
SLOVENIA	0.495985	43
MAURITANIA	0.495862	44
SAINT VINCENT AND THE GRENADINES	0.495553	45
FRANCE	0.493539	46
ICELAND	0.492668	47
NIGERIA	0.492265	48
RUSSIA	0.488774	49
VANUATU	0.486602	50
GUINEA-BISSAU	0.483706	51
SEYCHELLES	0.480335	52
BAHAMAS	0.4736	53
PORTUGAL	0.472364	54
TOGO	0.466992	55
GUYANA	0.465875	56
ITALY	0.465849	57
SAO TOME AND PRINCIPE	0.465402	58
BERMUDAS	0.457848	59
SPAIN	0.455513	60
DENMARK	0.45399	61

CROATIA	0.449024	62
GAMBIA	0.448125	63
GIBRALTAR	0.444949	64
CZECH REPUBLIC	0.440621	65
CURACAO	0.438687	66
ARGENTINA	0.437678	67
LITHUANIA	0.436483	68
BELARUS	0.435393	69
EL SALVADOR	0.434782	70
THAILAND	0.434316	71
MICRONESIA FEDERATED STATES OF	0.433484	72
UZBEKISTAN	0.429871	73
NAURU	0.428196	74
JORDAN	0.425209	75
UAE	0.423388	76
ROMANIA	0.418509	77
ARMENIA	0.415942	78
GRENADA	0.415748	79
BELGIUM	0.41347	80
SURINAME	0.404549	81
PAKISTAN	0.404467	82
BULGARIA	0.400688	83
HUNGARY	0.398008	84
COSTA RICA	0.397172	85
SOUTH AFRICA	0.396409	86
TANZANIA	0.394865	87
POLAND	0.393432	88
KENYA	0.392485	89
IRAN	0.388341	90
GEORGIA	0.384179	91
CAYMAN ISLANDS	0.382713	92
INDONESIA	0.380884	93
QATAR	0.380662	94

COLOMBIA	0.379911	95
PANAMA	0.377758	96
INDIA	0.377401	97
MEXICO	0.374908	98
NORTH MACEDONIA	0.370886	99
SAUDI ARABIA	0.37076	100
LIECHTESTAIN	0.368372	101
BELIZE	0.362976	102
KYRGYZSTAN	0.362892	103
PERU	0.358405	104
BAHRAIN	0.358134	105
CHILE	0.355878	106
IRAQ	0.3544	107
COMOROS	0.35424	108
KAZAKHSTAN	0.353489	109
LEBANON	0.332475	110
JAMAICA	0.329744	111
URUGUAY	0.328198	112
SYRIA	0.325596	113
KUWAIT	0.324861	114
TAIWAN	0.321931	115
AZERBAIJAN	0.319524	116
MAURITIUS	0.317298	117
LATVIA	0.313814	118
BOLIVIA	0.311793	119
SERBIA	0.310209	120
OMAN	0.306156	121
ESWATINI	0.299041	122
ANDORRA	0.298964	123
BOTSWANA	0.294681	124
GHANA	0.290888	125
ALBANIA	0.290468	126
TUVALU	0.28976	127
BARBADOS	0.288619	128

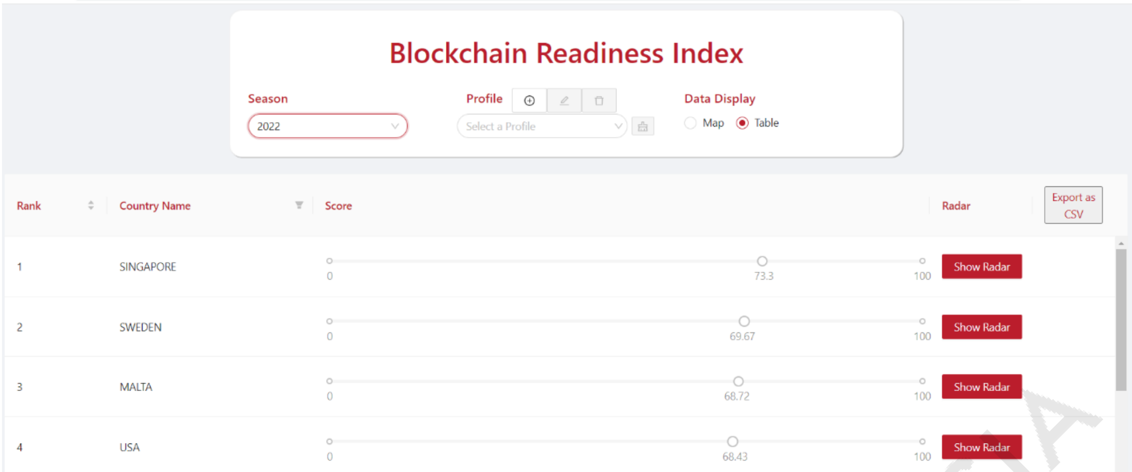
MOROCCO	0.287206	129
DJIBOUTI	0.28078	130
LIBYA	0.275246	131
ERITREA	0.268485	132
NEPAL	0.26704	133
TUNISIA	0.265987	134
EGYPT	0.265408	135
BANGLADESH	0.262658	136
MYANMAR	0.262186	137
MONGOLIA	0.259612	138
VENEZUELA	0.257635	139
UGANDA	0.256574	140
MONACO	0.254005	141
CAMBODIA	0.253527	142
SRI LANKA	0.24974	143
TURKMENISTAN	0.249347	144
MALDIVES	0.244838	145
MALI	0.243081	146
CAMEROON	0.23988	147
SAINT LUCIA	0.239081	148
BRUNEI	0.236684	149
ETHIOPIA	0.235951	150
GUINEA	0.234851	151
MONTENEGRO	0.225328	152
YEMEN	0.220508	153
MARSHALL ISLANDS	0.21888	154
NAMIBIA	0.216887	155
ECUADOR	0.214541	156
DOMINICAN REPUBLIC	0.207617	157
NICARAGUA	0.205993	158
ZIMBABWE	0.203358	159
CUBA	0.202012	160
ALGERIA	0.196201	161
BHUTAN	0.19506	162

RWANDA	0.194008	163
SOMALIA	0.192676	164
PARAGUAY	0.190737	165
SAN MARINO	0.175381	166
AFGHANISTAN	0.173626	167
FIJI	0.16859	168
SUDAN	0.156414	169
SOLOMON ISLANDS	0.156332	170
HONDURAS	0.156081	171
HAITI	0.154825	172
BENIN	0.153056	173
PAPUA NEW GUINEA	0.145844	174
GUATEMALA	0.133876	175
LAOS	0.131413	176
SAMOA	0.114675	177
TONGA	0.105972	178
MOZAMBIQUE	0.103513	179
BURUNDI	0.094546	180
BURKINA FASO	0.094036	181
SENEGAL	0.089746	182
GABON	0.089209	183
CAPE VERDE	0.087297	184
CONGO DEMOCRATIC REPUBLIC	0.080107	185
SIERRA LEONE	0.07644	186
TAJIKISTAN	0.071482	187
SUDAN SOUTH	0.052811	188
MALAWI	0.048171	189
MADAGASCAR	0.032535	190
NIGER	0.025013	191
EQUATORIAL GUINEA	0.002393	192
ANGOLA	0.002168	193
LIBERIA	0.001888	194

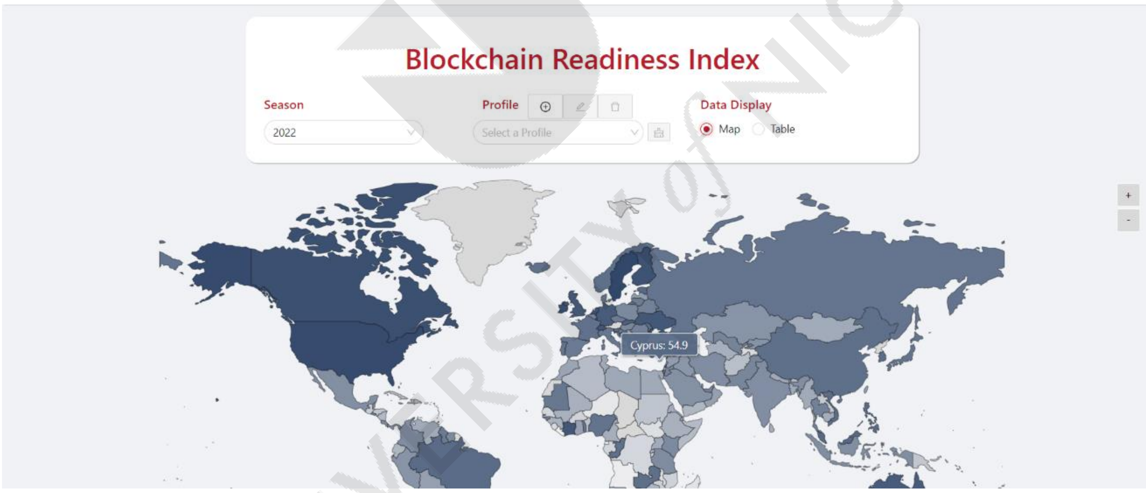
Appendix X

BRI Online Tool Demonstration

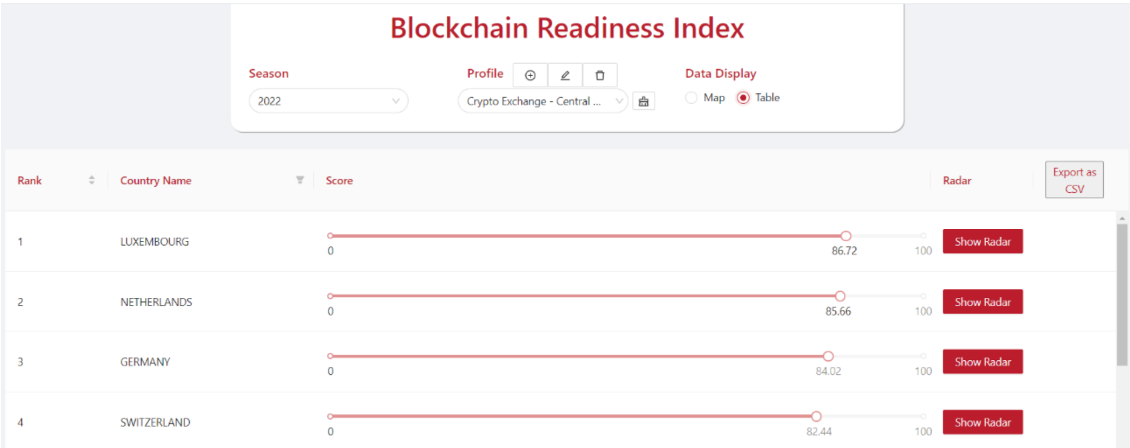
BRI 2021 Standard Version Rankings (Table View)



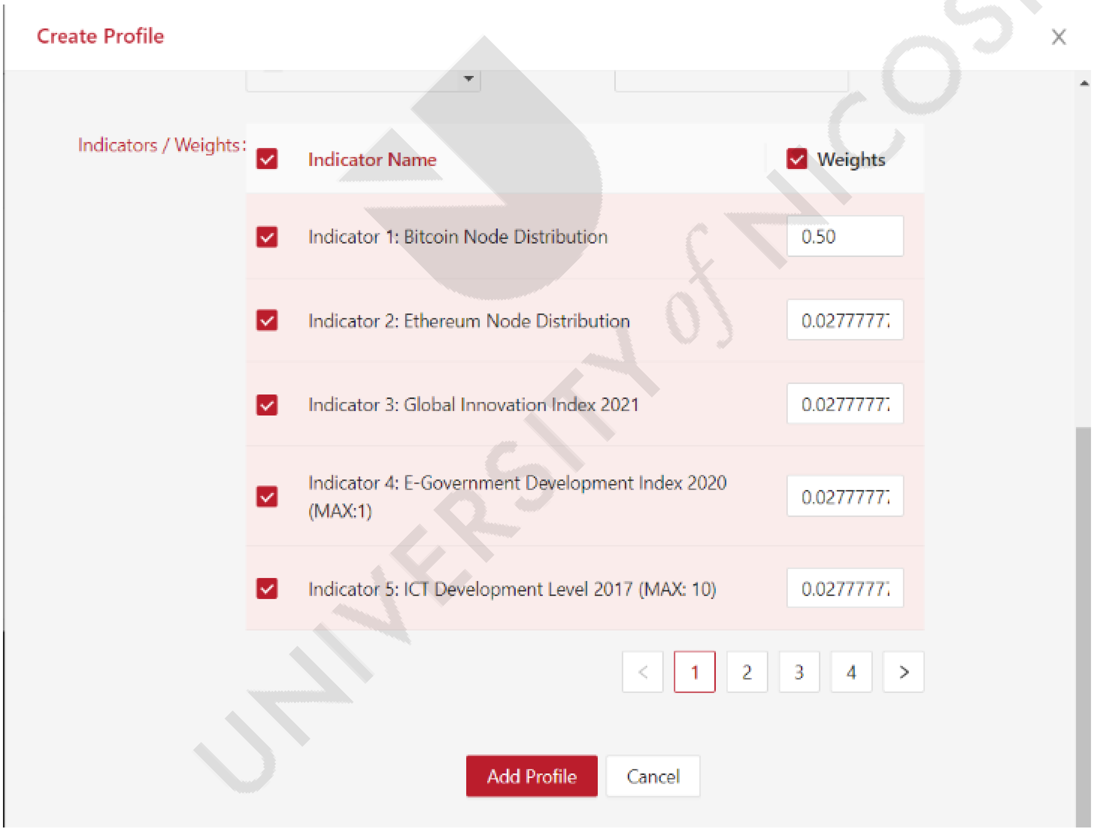
BRI 2021 Standard Version Rankings (Map View)



Rankings for "Scenario 1 - Cryptocurrency Exchange looking to establish headquarters in Central Europe" (Table View)



Dashboard to adjust selection and weights of Indicators



Radar of Singapore's normalised score per indicator according to BRI 2021 Standard Version Rankings