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TECH POLICY DESIGN CENTRE

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CENTRE FOR COMMUNICATION GOVERNANCE

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Mapping the Blockchain Ecosystem in India and Australia

Research Report

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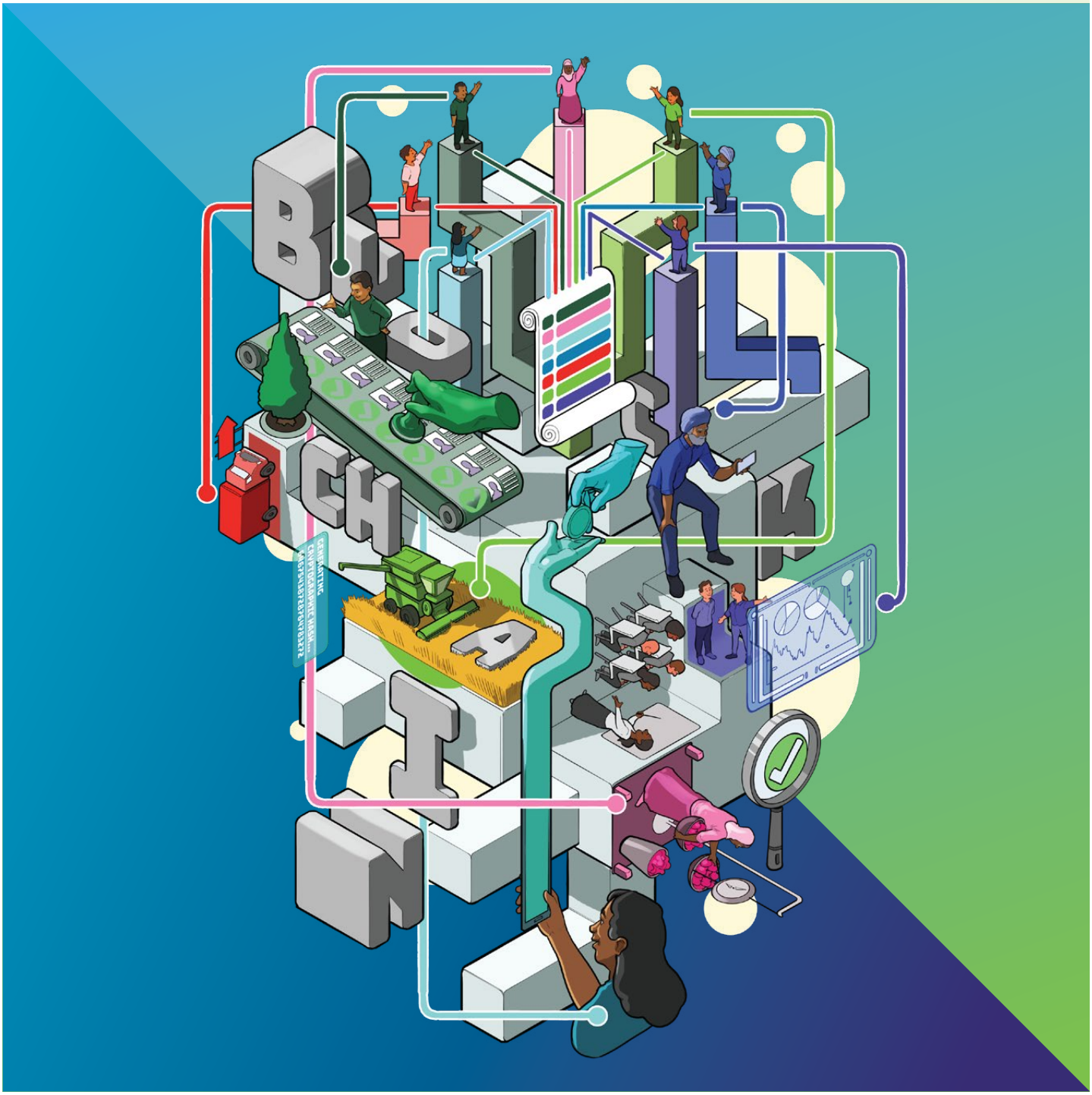

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Glossary

AI	Artificial Intelligence
ANSI	American National Standards Institute
ANZSIC	Australian and New Zealand Standard Industrial Classification
BIS	Bureau of Indian Standard
CBDC	Central Bank Digital Currencies
DAO	Decentralised Autonomous Networks
DApps	Decentralised Application
DLT	Distributed Ledger Technology
DON	Decentralized Oracle Networks
EU	European Union
FTA	Free-Trade Agreements
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IoT	Internet of Things
IP	Intellectual Property
ISO	International Standardization Organization
ISO/TR	International Standardization Organization Technical Report
ISO/TS	International Standardization Organization Technical Standard
ITU	International Telecommunication Union
NASSCOM	National Association of Software and Services Companies
NIST	National Institute of Standards and Technology
NFT	Non-Fungible Token
NPCI	National Payments Corporation of India
RBI	Reserve Bank of India
RTO	Registered Training Organisations
UN	United Nations
WEF	World Economic Forum
WTO	World Trade Organisation

Definition of Terms

Blockchain: A shared, immutable ledger that enables the recording of transactions and tracking assets in a network.

Chit fund: A chit fund is a financial instrument in India that combines savings and borrowings through a rotating savings scheme.

Data security: The practice of protecting digital information from unauthorised access, corruption, or theft throughout its entire lifecycle

Disintermediation: The removal of intermediaries from a supply chain to provide users with direct access to a transaction, product or service.

Distributed ledger technology: Technological infrastructure and protocols that allows for real-time access, validation, and recording of information in an immutable manner across a network spread across multiple entities or locations.

Headless platforms: An approach to e-commerce architecture where the front end (the presentation layer customers interact with) and the functionality of the back end (background processes such as pricing and security) of the system are separated.

Industrial metaverse: The industrial metaverse is a reconstruction of physical industrial applications, objects or experiences through simulations in the virtual world before transposing them to the real-world.

Interoperability: The ability of computer networks, devices, systems or programs to be compatible and exchange information with one another.

Internet of Things: A network of physical objects that utilises embedded sensors and softwares to exchange data with various devices and systems connected through the internet.

Right to be forgotten: Affiliated with people's right to privacy and commonly featured in data protection regulations, this right allows individuals to have publicly available personal information removed from the internet, search, databases, websites or any other public platforms. This right can be activated once the personal information in question is no longer necessary, or publicly relevant.

Scalability: The ability of a network to cope with the computational work produced by the users of that network. This work normally comes in the form of transactions, or computations, for a blockchain network where the blockchain can only handle a certain amount of transactions/computations per second.

Single point of failure: A single point of failure (SPOF) refers to a sole/singular fault or malfunction that disrupts, or causes an IT system to stop operating. This single point of failure can be a person, facility, piece of equipment, application or any other resource.

Smart Contract: Programs stored on a blockchain that execute instructions when predetermined conditions are met. They automate agreement execution so that all participants are certain of the outcome, without any intermediary's involvement.

Standardisation: The process of developing and implementing technical standards based on the consensus of relevant stakeholders which include firms, users, interest groups, standards organisations and governments.

Public non-market international standard-setting: It is executed via (1) ad hoc agreements; (2) transgovernmental collaboration among specialised regulatory agencies; or (3) new or existing international (governmental) organisations (IOs).

Private non-market standard setting involves deliberate rule-making through international non-governmental organisations. These organisations often receive tacit or explicit endorsement from governments. International Organisation for Standards (ISO) and International Electrotechnical Commission (IEC) are the most prominent examples of this category.

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Introduction

This report is the first in a series written for the research project *Shaping blockchain technical standards consistent with Australia and India's shared vision for an open, free, rules-based Indo-Pacific.*

It presents the results and findings of the first stage of the project, providing a baseline understanding of the non-financial blockchain ecosystem in India and Australia. With a relevant focus on stakeholder awareness and attitudes towards technical standards (baseline knowledge of) and significant blockchain use cases that will be the focus of future project reports.

For the purpose of this report, blockchain (or block chain) is understood to be a system of electronic record keeping, supported by a consensus maintaining distributed database using distributed ledger technology (DLT).[1] There are now many different blockchain implementations, some of the most common being Bitcoin and Ethereum. The report's focus is on non-financial use of blockchain and relevant standards, particularly on applications in the non-cryptocurrency space.

The report is organised into three sections:

1. an overview of the blockchain landscape;
2. interviews with identified key stakeholders; and
3. a comparative case study.

Project Overview

The purpose of this collaborative and cross-disciplinary project is to (1) research trends shaping the global blockchain marketplace, (2) assess the opportunities and effectiveness of existing blockchain standards, and (3) make recommendations to encourage the development of blockchain standards (Box 1). Filling a gap in existing scholarship, this project focuses on non-financial applications of blockchain.

Box 1: Why are technical standards important?

There are three reasons why technical standards are important. All are closely linked and overlap.

1. **Practical (interoperability and consumers):** Standards facilitate interoperability ensuring that new technologies can work anywhere in the world, regardless of national borders. This means domestic consumers can purchase innovative technologies from overseas with confidence that the technology will work, and companies can export technology to customers overseas without having to adjust the technical specifications of each country.

2. **Commercial (economic):** The interoperability conferred by standards drives economies of scale and opens new markets. Many standards also embed Intellectual Property (IP), which (as the standards are adopted globally) can be very lucrative to the IP owners. Shaping standards to meet the needs of domestic industry and markets also delivers a commercial benefit by minimising manufacturing and compliance costs.

3. **Strategic (security and values):** By setting technical specifications, standards embed approaches to security, safety, privacy, data protection etc. into technology. There are widely varied views as to what these standards should be (compare, for example, a technical specification crafted within a liberal democratic approach to security or privacy, with an autocratic countries approach to the same). Countries and companies that dominate standards discussion will see their views are reflected in the agreed technical specifications. When agreed, standards confer international legitimacy on the technical specifications and, in turn, the approaches to security and values embedded in the technology via the standards. As the technology is exported and embedded into societies globally, the technology (reflecting the agreed standard which, in turn, is embedded with values) shapes the societies into which the technology is woven. Technical standards, therefore, are not just technical; they shape the very fabric of our societies.

Over the course of the project, researchers at the Centre for Communication Governance at National Law University Delhi (CCG NLUD) and the Australian National University Tech Policy Design Centre (ANU TPDC) will assess the opportunities and effectiveness of existing technical standards, build collaborations between researchers, business, and government in India and Australia, encourage meaningful engagement in standards discussions, and undertake research to make recommendations that encourage the development of technical standards that align with Australia and India's interests. Those recommendations, as well as the network and community built through this project, will enable more meaningful engagement in international standards discussions.

The project is organised into four stages (Figure 1). This report, which presents the results and findings for Stage One, provides a baseline awareness assessment of blockchain applications and technical standards by stakeholders in India and Australia. To achieve this, the project teams in India and Australia mapped stakeholders in each country's blockchain ecosystem (industry/businesses, government, academia, and civil society) and interviewed key individuals and organisations to understand use cases for non-financial applications of blockchain, as well as to assess stakeholder awareness (baseline knowledge of) and attitudes towards blockchain technical standards.

The project aims to prioritise emerging blockchain-based solutions that:

1. add societal, security, and economic benefit
2. support gender equality and women's empowerment
3. are scalable and replicable in other parts of the Indo-Pacific region.

Figure 1: Description of Project Stages 1 to 4

Stage 1 Baseline awareness	Mapping stakeholders in Australia and India. Interviewing key stakeholders to gauge awareness.
Stage 2 Market analysis	Identifying use cases and standards in Australia, India and internationally.
Stage 3 Gap analysis	Interviews and analysis, test whether existing standards are sufficient.
Stage 4 Standards	Prepare report on standards development in blockchain.

Roundtable Outcomes

This research has involved extensive outreach and relationship building activities with stakeholders in India and Australia, culminating in a roundtable held at New Delhi on 5 September 2022. The roundtable saw participation from a diverse range of stakeholders across both the geographies and international organisations that included industry, government, standard setting bodies, academia, and civil society. The roundtable provided an introduction to the project and research findings from the first phase including case studies on food security. Building on this, the discussions touched upon various technological, regulatory and economic considerations around the development of blockchain technology and role and relevance of technical standards. The following were the key takeaways and insights from the discussions:

1. In addition to discussions on new and emerging blockchain use cases in the Indo-pacific region, stakeholders highlighted the importance of carrying out a cost-benefit analysis before deploying blockchain technology for a particular use case. Some of the key use cases discussed were around e-voting, digital identity solutions, smart governance, land registry, healthcare records, supply chain, and provenance of digital art.

2. Contextualising use cases such as land records and identity management systems, stakeholders highlighted challenges and limitations of implementing blockchain solutions. They pointed to issues around corruption, lack of trust in technology, data quality and digitisation as non-technical barriers for blockchain adoption.

3. On the issue of standardisation, a few involved with standards discussions at the ISO level mentioned that the understanding around the need for standards will evolve as the ecosystem matures with an increase in the number of use cases implemented/deployed.

4. Discussions also noted how standardisation of databases will help create a pathway for blockchain adoption. Within the blockchain ecosystem, the role of standardisation to facilitate interoperability between systems was particularly highlighted. Stakeholders also spoke about the need to formulate standards which imbibe ethical and sustainable values. Overall, stakeholders expressed willingness in being part of standards-development processes and were interested in learning more about relevant forums for discussion.

Key Findings

The non-financial blockchain ecosystem represents an emerging area of opportunity in both India and Australia. Stakeholder mapping revealed an ecosystem that has grown substantially over the last five years, with a diverse range of activity for social, economic and security benefits across multiple sectors. Stakeholders interviewed expressed optimism for the opportunities that the technology offered, while also cautioning against trying to solve every problem with a blockchain solution.

The significant non-financial blockchain use cases identified in stakeholder interviews were similar in both India and Australia. The application of the use cases that were considered most significant for this report varied to highlight applications that attempt to address different problems arising from country specific circumstances (For example, food security applications in India focus on the issues of climate change and insurance, while in Australia, food security applications are concerned with the supply chain for the purposes of ensuring the quality of exported products).

With regard to technical standards, the ecosystem's diversity presents both a challenge and opportunity. While all stakeholders interviewed were aware of blockchain (financial or non-financial) technical standards either specifically or generally, their understanding of and attitudes towards them varied. Regulation, policy and technical protocols were often conflated with technical standards. Some viewed standards as providing positive benefits through transparency, scalability, and interoperability, while others worried that standardisation would create a barrier to innovation – seeing the diversity of applications as an important strength. Findings from interviews with stakeholders suggest that to understand the role of technical standards requires consideration of the technology and the motivations behind blockchain applications. Stakeholders pursuing specific applications or encouraging innovation held more reservations about the positive role of technical standards compared with those involved exclusively in standards making.

It is notable that few stakeholders interviewed were involved in standard setting and that some questioned the value in participation. Particularly when time frames of standard setting processes are long and drawn out. The detailed knowledge of specific technical standards across interviewees was extremely limited. Most interviewees were only able to talk in general, or conceptually, about technical standards and could not identify specific technical standards relevant to blockchain.

Stakeholder mapping revealed that only a limited number of stakeholders (less than 20%) were able to demonstrate evidence of diversity and inclusion based on an assessment of publicly available information, which included women in senior leadership positions, explicit diversity and inclusions policy or initiatives, and participation in awareness raising events. Some stakeholders interviewed thought that the blockchain ecosystem had greater women participation and is developing in a more balanced way as compared to the broader technology ecosystem. On the contrary, some were of the opinion that focus on issues such as diversity, ethics, sustainability was secondary to developing an application/use case.

The findings presented here provide an informed baseline for the next phases of the project.

1 Blockchain Landscape

Stakeholder Mapping

To understand the baseline awareness of technical standards, the first step involved mapping the non-financial blockchain ecosystem in India and Australia.

The project teams in India and Australia mapped a total of 509 stakeholders in the non-financial blockchain ecosystem (190 stakeholders were identified in India and 319 in Australia). The stakeholder mapping drew on publicly available data from a wide range of sources to identify blockchain ecosystem stakeholders. The sources are listed in Table 1 below.

The stakeholders mapped were organisations, government bodies and individuals operating in the respective countries. Broadly, the mapping looked for applications with a social, economic or security focus in the non-financial space. Attention was paid to the age, size, type, collaborations, and ownership of stakeholders, the sector in which they operated, and any observable diversity and inclusion characteristics.

Notably, despite using the same categories the data available in each country did differ. Where comparisons are presented, care has been taken to ensure that comparisons are made like for like such as the age, size, and ownership. Sectors were less easy to compare and here an exploratory approach has been taken by each team to examine the kinds of sector categories present in the data and to classify stakeholder involvement based on their stated aims and objectives.

The rest of this section presents a summary of key findings from both India and Australia, followed by a description of the stakeholder mappings for each country. Annexes 1 and 2 provide further details to support the mappings presented here.

Table 1: Sources of data used to map blockchain ecosystem stakeholders in India and Australia.

Patents, trademarks, and tenders	Universities and research	Business and organisations
Membership of peak bodies	Reports and literature	Government directories

Summary of key findings

Maturity: The blockchain ecosystems in India and Australia are at a similar stage in terms of the development and stakeholder characteristics. Data from the stakeholder mapping reveals that many new, small and medium sized[2] organisations have entered the blockchain ecosystem in the last five years, and that they are predominantly in industry, with few academic, civil society, and government stakeholders emerging. Though the industry is a dominant stakeholder in both the geographies, there is evidence of growing interest and participation amongst policy makers and thinkers and civil society organisations to engage with the sector. Interestingly, most of the stakeholders mapped operate in their countries of origin, India and Australia respectively. Few could be classified as purely international in their operation and ownership. Thus, the ecosystem is still emergent and, reflects a diversity of blockchain applications, issues, and stakeholders.

Influence: The hype around cryptocurrency has led stakeholders in both countries to explore the underlying blockchain technology for economic, security, and societal benefits.

Multi-Sector: Stakeholders in the blockchain ecosystem are spread across a wide range of sectors, with many operating in at least two or more areas. The data shows that stakeholders operate across a diverse range of sectors usually related to their blockchain application or use case.

Applications: While most blockchain applications could be categorised as having social and/or economic purposes, security applications were less obvious and depended on how 'security' was defined. By broadening the definition beyond a focus on national strategic interests to related purposes, such as resilience, sovereign capability, or critical technology, an increase in the range of applications for the purpose of security is observed. Food security is an example expanded on later in this report.

Categories: Three categories of stakeholder emerged from the mapping:

1. Stakeholders that provide a range of blockchain solutions across sectors such as agriculture and those that target niche issues such as tracking the provenance of digital fish or authenticity of specific products.

2. Stakeholders that legitimised the ecosystem through national collaborations or support and membership in institutions established by the industry or government organisations.

3. Stakeholders that produce research and provide inputs on associated law and policy issues.

These stakeholders were present in the data for both India and Australia. This is examined further in the next section.

Diversity and Inclusion: A limited number of stakeholders (less than 20%) were able to demonstrate evidence of diversity and inclusion based on an assessment of publicly available information. The evidence assessed included women in senior leadership positions, explicit diversity and inclusions policy or initiatives, and participation in awareness raising events.

Stakeholder Mapping India

The stakeholder mapping for India identified and profiled stakeholders who work on a diverse range of non-cryptocurrency blockchain applications which impact economic, societal, and security areas. The mapping was conducted through a preliminary scoping of various existing and potential applications of blockchain technology in India. This aided in identifying relevant stakeholders who drive blockchain use-cases across various sectors such as healthcare, agriculture, governance, banking and finance[3], and education (Figure 2).

The stakeholder mapping limited itself to two categories of stakeholders (including foreign companies):

i. those having registered offices in India or

ii. having a business address/operating office in India.

Consequently, foreign companies offering blockchain services in India but without operating offices were excluded. Further, those companies that offer cryptocurrency related services but also provide significant non-cryptocurrency related blockchain services have been included. Companies that are exclusively related to and primarily cryptocurrency applications were completely excluded from the stakeholder list. Any reference made to blockchain solutions through the analysis here excludes non-cryptocurrency blockchain applications.

The stakeholder mapping identified 190 stakeholders across India's non-cryptocurrency blockchain ecosystem. In our survey, we profiled varied stakeholders and categorised them under six broad headings: (i) industry, (ii) government, (iii) civil society, (iv) legal advisory, (v) academia, and (vi) independent experts. The key findings rely on data and analysis from tables and figures in the appendix.

The category of industry (78%) includes private companies of different sizes, private collaborations, start-ups, and industry bodies. Private companies consist of 6% of foreign stakeholders having operating offices in India. Government (7%) as a category included relevant departments engaging with

emerging technologies like blockchain and government initiatives with private companies such as academic initiatives like the centres for excellence (7%).

Civil society (3%), legal advisory (3%), and academia (4%) featured as separate categories. Academia includes premier public institutions such as the Indian Institutes of Technology, as well private technological and management universities. Finally, the mapping identified individual experts (5%) as a distinct category. Compared to industry and government (85%), the remaining categories (15%) comprise a very small portion of the stakeholders mapped.

It is important to note that in trying to identify the level of gender related diversity amongst stakeholders, it was only feasible to map women in top positions within industry as information on involvement of women at various levels within private companies and other categories of stakeholders was not readily available. Hence, based on available information on private companies, the number of women that featured within the mapping, only made up 14%. On this note, it was difficult to find statistical insights on the level of gender diversity among persons who don't identify themselves as men or women.

The majority of stakeholders fell within the range of small and medium sized organisations (40%). Large sized organisations (36%) mainly included multinational companies, government bodies/departments and educational institutions (Table 9). The size of remaining stakeholders was unknown (24%). With respect to blockchain solutions, the mapping demonstrates that the Indian blockchain ecosystem has heavy involvement of stakeholders from industry across all sectors. However, we noted stakeholders having "influence" and considered as "leading players" (19.5% / 37 out of 190) also included government and academia and were not limited to just industry. Within industry, the cohort was diverse ranging across multinational corporations to thriving startups.[4] More than half the "influential" stakeholders fall within the category of "highly influential" stakeholders in the ecosystem.

Our stakeholder mapping observes an accelerating trend of blockchain adoption where the majority of industry stakeholders have established themselves and commenced operations within the last five years (refer to Table 7 of Annex 1). This insight highlights a growing vibrancy and viability to India's blockchain ecosystem where more people are pursuing commercial opportunities over time.

India is cultivating the world's 3rd largest startup ecosystem[5] supported by strong government prioritisation demonstrated by collaborations fostered across different state governments and the centre along with other key stakeholders.

Besides collaborations initiated by the government, the stakeholder mapping showed an almost equal number of partnerships (12) existing between industry stakeholders across multiple sectors such as retail, banking and finance, and supply chain management.

The mapping indicates that many stakeholders identified offer blockchain services and solutions in addition to cryptocurrency/digital currency and general IT based services. The shift towards designing blockchain based solutions may be attributed to a high level of technical know-how of the technology underlying cryptocurrency i.e., blockchain technology.

These blockchain-based services are offered across sectors such as agriculture, healthcare, education, real estate banking and finance, retail, supply chain management, and telecom. Among these solutions addressing land records management and education certificate management, have received greater attention owing to government interest in embedding trust, transparency, accountability and improving overall inefficiency in e-governance services. The sectors that have the least stakeholder involvement appear to be telecom (despite being early adopters of the technology in the context of unsolicited spam calls), cybersecurity and the broader security realm.

Stakeholder Mapping Australia

The stakeholder mapping focused on Australian owned and operating entities. Also included were multinational companies with a significant in-country presence or evidence of a use case (potential case study) that would be applicable to the Indo-pacific region and met one of the parameters of security, economy, or society. A detailed description of the approach taken along with the insights gained is expanded on in Annex 2, this section presents a summary of the results and key findings.

The non-financial Australian blockchain eco-system is an emerging marketplace led by a significant drive from industry.[6] Stakeholder mapping using publicly available data sources identified 319 stakeholders across the Australian eco-system with only 4% being individual stakeholders. A hundred and two (51 high, 36 medium and 15 low) key stakeholders were identified as prominent players in the eco-system, judged on evidence as to their influence a key player, decision authority, expert, or potential disrupter.

40 stakeholders (12.5%) exhibited evidence towards diversity initiatives, ranging from women in senior leadership positions, to an explicit diversity and inclusions policy or initiative, to participating in awareness raising events.

The eco-system is young and developing. The majority (80%) of stakeholders are less than 10 years old, and 57% have been established within the last 5 years. Despite the youth of the eco-system, entities are highly innovative, disparate and growing rapidly. Industry led (84%, academia 11%, government 6%) small-medium enterprises (92%)), are dominant in Australia, with few international collaboration connections (13%). Multinational owned companies were more likely to be larger than industry organisations suggesting that size is a factor in ability/to enable for international collaboration and connection.

Most stakeholders in the ecosystem operate in at least two or more sectors. Stakeholders were categorised into a series of ten blockchain specific technology sectors that emerged from the mapping data, these categories provide a more nuanced description than the standard Australian and New Zealand Standard Industrial Classification (ANZSIC) system.

The categories that emerged were:

- Provenance, supply chain, distributed ledger, digital platform, security, audit
- Smart contracts, smart titles, digitised assets, identity management, records, digital certificates
- Agriculture, food, beverages, critical minerals, environment, energy or healthcare
- NFT, gaming, entertainment, music, books, media
- Developers, software, DApps, Web3, DAO, IoT, sensors, telecommunications, technical (doers - creating solutions)
- Legal, Governance, Training, IP, copyright, risk management, cyber security
- Consultancy, research, marketing & PR
- FinTech, finance, bitcoin, cryptocurrency, trading, brokerage, wallets, investment, lending
- Financial sector only

Early applications of blockchain technology originally stemmed from FinTech, bitcoin and cryptocurrency and its brokerage. The eco-system activity remains dominated (46%) by the financial sector with under a third of all stakeholders working exclusively in the financial sector. Excluding the financial sector, the largest area of activity is the blockchain creators (25%) – the developers and technical experts – that create and enable blockchain solutions across broader industry sectors.

The application of blockchain technology (excluding financial sector) is dominated by the ‘provenance, supply chain and secure digital tracking’ sector (17%) and the broader ‘gaming, NFT, media and entertainment’ (13%), followed by ‘digital assets, records and smart contracts’ (11%).

Emerging industries are not just limited to the development and application of blockchain technology. The eco-system has significant activity in what we can describe as the ‘enabling experts’ those that provide a service to the blockchain sector be it through legal, governance, cyber security advice, IP, copyright and risk management, training (17%) or as a connector through consultancy, research, marketing and PR advice (14%).

The smallest sector captured (9%) relates to the industry use or application of blockchain within existing industry segments including; agriculture, food, beverages, natural resources and critical minerals, environment and energy management, and healthcare. The greatest evidence of use was seen in seeking supply chain efficiencies and provenance in sectors such as ‘agriculture, food, beverages’ which are significant Australian export industries that are increasingly vulnerable to climate, market and supply chain changes. Less adoption of blockchain technology can be seen in the industry segments that experience less economic pressure from these external vulnerabilities, particularly natural resources and critical minerals – a key, significant and strong Australian export industry.

It is important to note, due to the limitations of publicly available information, the potential underrepresented activity of the defence, communications, and space sectors.

Endnotes

1 Alexandra Bratanova, Dinesh Devaraj, Joanna Horton, Claire Naughtin, Ben Kloester, Kelly Trinh, Ingo Weber and David Dawson, *Blockchain 2030: A Look at the Future of Blockchain in Australia*, CSIRO Data 61, April 2019, accessed September 27, 2022, file:///Users/u4847416/Downloads/ACS-Data61-Blockchain-2030-Report.pdf

2 India: Small and medium (0-200) and Australia: Small (0-5) Medium (5-200)

3 The report focuses on the non-financial applications of blockchain. That being the case, applications of a non-financial nature do overlap into finance and banking in areas such as governance or regulation and in both India and Australia stakeholders only saw a clear point of difference when talking about crypto or non-crypto applications.

4 The cohort of leading players was identified on the basis of the following criteria: the relevance and stage of blockchain solutions they were involved with, potential benefits accruing from these solutions, and the nature and type of collaborating partners.

5 Nikhil Patwardhan, "Economic Survey: India becomes third-largest startup ecosystem in the world," mint, last updated January 31, 2022, accessed September 30, 2022, https://www.livemint.com/economy/economic-survey-india-becomes-third-largest-startup-ecosystem-in-the-world-11643626506129.html

6 Alexandra Bratanova, Dinesh Devaraj, Joanna Horton, Claire Naughtin, Ben Kloester, Kelly Trinh, Ingo Weber and David Dawson, Blockchain 2030: A Look at the Future of Blockchain in Australia, CSIRO Data 61, April 2019, accessed September 27, 2022, file:///Users/u4847416/Downloads/ACS-Data61-Blockchain-2030-Report.pdf

2 Stakeholder Interviews

Introduction

Following the completion of stakeholder mapping, interviewing for the project took place between June – August 2022. In June, a sample of individuals and organisations was drawn from lists of stakeholders identified by the project teams in India and Australia during the stakeholder mapping exercise. The sample consisted of around 90 stakeholders in India and 110 in Australia. Stakeholders were selected based on their perceived significance in the blockchain ecosystem, and each sample included a mixture of stakeholders from academic, industry, civil society and government.

Identified stakeholders were invited to take part in a semi-structured interview of 30-45 minutes in length. Interviews were conducted on the basis that anonymity would be preserved for those that chose to participate. Stakeholders that volunteered to participate in an interview were given the option to take an interview in-person, via video conference, or over the phone.

The project teams in India and Australia interviewed a total of 50 blockchain stakeholders, 25 with stakeholders in Australia and 25 with stakeholders in India (Table 2).

Each team took a slightly different approach towards interviewing and gathering responses to the interview questions. However, this did not affect the outcomes of the interviews which broadly followed the same line of questioning. Analysis of anonymised interview transcripts was conducted by each team using an inductive-thematic approach. Details of the methodology followed for interview data collection and analysis are presented in Annex 3 for India and Annex 4 for Australia.

The rest of this section presents the findings and results of the interview analysis for India and Australia.

Table 2: Summary of stakeholders interviewed in India and Australia by the type of organisation or entity.

Type of organisation/entity	India	Australia
Academia	2	3
Academia/Industry	1	6
Industry	6	3
Industry/Start-up	4	6
Civil Society	5	3
Legal advisory	1	-
Government	4	1
Expert	2	3

Summary of key findings

A summary of findings emerging from analysis of the interviews with stakeholders in India and Australia are reported under four broad headings that align with the interview questions asked: Outside of the financial sector, exciting emerging opportunities for non-financial applications of blockchain (Question 1), the most influential factors influencing the development of blockchain use cases (Question 2), the role of technical standards (Questions 3), and the awareness of standards including standards bodies and engagement by stakeholders with standards setting bodies (Questions 4, 5 and 6).

Exciting emerging opportunities for non-financial applications of blockchain

Stakeholders interviewed highlighted a wide range of areas where blockchain presented existing and emerging opportunities, often these were to solve a perceived problem or add value to existing systems and processes (Table 3). Records management was the common underlying theme for building non-financial blockchain based solutions for streamlining credential verification, identity management and supply chains. Stakeholders found it difficult to distinguish and articulate the economic, security and social benefits of non-financial blockchain applications as separate concepts (using those terms).

The use cases identified by stakeholders align with existing understandings of blockchain applications. While not always novel, the range of use cases highlighted suggests that stakeholders had a good understanding of the ecosystem in their respective countries. Some stakeholders expressed reservations about blockchain being considered a technological panacea, but most agreed that it offered positive benefits.

Table 3: Areas of opportunity arising from stakeholder interviews, organised in order of significance (top being most significant, bottom least significant).

India	Australia
Supply chain management, particularly in the pharmaceutical industry	Supply chain, including agriculture and food industries
Land record management	Creative industries, including art and music where products have value as digital assets
Educational certificate management	Licensing and credentials, including for titles and resource management
Digital identity management	Identity management
Trade finance	Insurance
Health record management	Medical and healthcare applications

Factors influencing the development of blockchain use cases

Stakeholders interviewed identified positive and negative factors that they perceived to influence the evolution of the blockchain ecosystem in India and Australia. The factors identified were broadly technological, economic or market, and institutional in nature.

For stakeholders in India these factors included: trust, disintermediation, conductive regulatory environment, cryptocurrency hype, and funding. For stakeholders in Australia factors identified were less specific but consistently decentralisation, immutability and efficiency were raised as the most influential factors influencing the development of blockchain use cases.

The sustainability and ethics of blockchain solutions was also raised as a specific barrier by a few stakeholders in both countries, energy consumption and climate change were identified as key challenges. Some stakeholders argued that the design of technology and technical standards should incorporate values related to sustainability and ethics.

A few stakeholders in both countries also pointed out that the ways in which the technology is applied, rather than anything inherent in the technology, facilitates the benefits ascribed to blockchain in the use cases identified.

The role of technical standards

The role of technical standards in shaping the evolution of blockchain was a complex subject that received a diversity of responses from stakeholders interviewed in India and Australia.

On one hand, stakeholders saw value in technical standards, they enabled scalability, transparency, and interoperability in blockchain applications, provided safety and privacy for those using the technology and could be seen as an indicator of trustworthiness.

On the other hand, stakeholders expressed reservations about the application of standards cautioning that it is too early in the ecosystems development to introduce standards in the blockchain ecosystem, and that imposing standards could lead to technology being developed around standards and thus inhibiting innovation.

Awareness of standards, standards making bodies, and engagement

All stakeholders interviewed demonstrated some level of awareness regarding technical standards, and there was near unanimous support for standardisation in both India and Australia. Yet, few stakeholders were able to mention specific areas of technical standards or were involved with standards making bodies.

Several reasons were provided for this lack of engagement, ranging from time and patience, to resources, and a lack of technical knowledge leading to inequitable representation. Generally, interviewees that were not involved in standards making did express interest in learning about them and engaging with them.

Based on their responses, stakeholders interviewed can be grouped into one of three categories:

- those involved in developing a specific blockchain application,
- those involved in the blockchain ecosystem in an enabling capacity such as leading a research and development organisation; and
- those involved in standards, regulation or policy making but with limited involvement in enabling or applying blockchain technology.

These categories are useful for thinking about how technical and standards-based knowledge is related. Stakeholders involved in specific blockchain applications tended to demonstrate a high level of technical knowledge but limited knowledge of standards. While those involved in standards making demonstrated some technical knowledge, they lacked the same depth as those involved in developing applications. Those involved in an enabling capacity had varying levels of technical or standards-based knowledge.

Stakeholders in both countries pointed to perceptions of lobbying, long drawn-out bureaucratic procedures, and lack of monetary support as challenges to engagement in standards setting processes. Some viewed industry-based standard setting bodies, consortium-led groups, and other private associations as more effective forums for formulating efficient and expedient standards.

Stakeholders in both countries also highlighted the need for a supportive regulatory environment for emerging technologies like blockchain to develop. Uncertainty in this regulatory environment could prompt stakeholders to be over-cautious and impede adoption. Further, some stakeholders suggested that broad principles instead of designing granular provisions, should be the focus when formulating standards.

Interview Analysis India

A total of 25 individuals from the blockchain ecosystem in India were interviewed. The pool of interviewees had a healthy mix of stakeholders from government, industry, start-ups, civil society, legal advisories, and academia. The cohort included senior-level professionals, computer network engineers or technical solutions architects, blockchain consultants and advisors, directors and CEOs of private companies, independent experts, professors, research fellows, and policy advisors. Most of these have been actively involved in the blockchain ecosystem in India since the last four years. Nearly half of the interviewees had direct involvement with development of blockchain applications and technical expertise or knowledge on the subject.

Interview questions were designed to gauge the level of awareness and knowledge on non-cryptocurrency blockchain use-cases and levels of technical standards engagement. Thematic codes were used to assess the interviewees' awareness, knowledge, experience, objective, tonality, perspective, sentiments, attitudes, values and familiarity with respect to blockchain use-cases and related standards development processes and institutions. The key emergent findings and insights from responses to each question are elucidated below.

Research Question 1: Outside of the financial sector, what are the most exciting emerging use cases for blockchain (that offer economic, security, and social benefits)?

All the interviewees, except one, were able to identify at least three non-cryptocurrency-centric blockchain use-cases. A total of **36 unique use-cases across sectors were identified** in total. Certain use-cases were referred to as “apt for blockchain adoption”, others were thought to have “significant potential”, and a few were described as being in “pilot or testing phases”. Following are some of the most interesting use-cases highlighted by interviewees (listed in descending order of frequency):

- Supply chain management, particularly in the pharmaceutical industry
- Land records management
- Digital credentials for education
- Self-sovereign digital identity
- Trade financing
- Health records management

Besides these, other emerging use-cases that were highlighted by interviewees include Central Bank Digital Currencies (CBDC’s), e-voting (in corporate and political environments), chit funds,[1] cybersecurity, smart cities and industrial metaverse.[2]

Ecosystem level awareness: More than half of all interviewees (56%) had peripheral awareness of existing and/or potential use-cases outside their respective sectors. One-fifth of the interviewees described in detail the benefits of adopting blockchain based solutions to solve social, economic, technical and security related problems. A few interviewees, directly involved in the technical development of blockchain applications, deconstructed the dynamics and distinctive features of the technology leading to social, economic and security benefits.

Knowledge of technologies involved: In the context of these identified use-cases, interviewees discussed the value of integrating smart contracts with blockchain in automating transactions and increasing accountability and transparency, especially for payment related transactions, and in designing solutions for trade financing, insurance, and banking sectors. Several interviewees highlighted the benefits of using blockchain as a tool for enabling product authenticity, verification and credibility of information and goods in the context of drug supply chains, land registries, and educational certificates. From a security perspective, some interviewees highlighted that blockchains minimise single point of failure risks[3] and have the potential to advance cybersecurity.

Pre-conditions for use-case adoption: In general interviewees had a pragmatic perspective on adopting blockchain solutions and highlighted challenges with blockchain adoption/implementation. A few interviewees, largely comprising individual experts, expressed scepticism about blockchain being considered a technological panacea. They acknowledged blockchain’s potential for economic and security benefits but highlighted the need to make detailed and careful assessments of whether a particular solution would benefit from the use of blockchain prior to its adoption. One interviewee highlighted efforts being made towards designing assessment frameworks for industry and other stakeholder categories to help them develop fit for purpose blockchain solutions.

Use-case specific challenges: Some interviewees highlighted barriers to implementation of blockchain solutions. Regarding records management, particularly in the case of land registries, inaccurate data and a lack of digitisation of records and information were mentioned. Enhancing digital access and digital literacy levels of all concerned stakeholders,

including government functionaries at all levels and marginalised communities, was emphasised as important factors for designing inclusive blockchain solutions such as subsidy delivery and climate insurance. A few interviewees highlighted the need to build blockchain trust and raise digital literacy skills among disadvantaged sections to help them embrace tech services.

Notably, no interviewee was able to categorise the impact of blockchain applications solely under one benefit category, namely social, economic, and security. Almost all interviewees were cognisant of the benefits accruing at different levels - individual, societal, national, regional, and international - enhancing social cohesion, economic resilience, and security parameters.

Research Question 2: What are the three most influential factors influencing the development of these blockchain use cases?

Interviewees offered varied perspectives on what they perceived as influential factors and/or trends, shaping the evolution of blockchain in India. Their responses were possibly influenced by their background/area of work. The nine factors mentioned below were recurring across several interviews. They have been listed in descending order of frequency.

- Trust based network
- Disintermediation or removal of middlemen
- Conducive regulatory environment
- Impact of data protection regulation
- Transparency/traceability of records and processes
- Cryptocurrency hype
- Inaccurate conflation of cryptocurrency with blockchain technology
- Availability of funding
- Systemic governance challenges

The above factors have been categorised under three broad themes, namely, technological, market, and institutional.

Technological factors: 56% of all interviewees considered the unique features of blockchain technology such as trust, transparency, and disintermediation, as the main driving factors influencing interest in blockchain development. This was expressed primarily by interviewees from the industry.

Trust: Half of the above interviewees considered trust as a key influential factor as it created an element of trust through a decentralised and transparent network. A government representative specifically pointed out the value of trust-based networks in ensuring security and authenticity of data in the context of data sharing among stakeholders. Interviewees from industry also recognised the role of trust in facilitating vast and rapid data exchange between large networks of different actors. Indicating that transparency and trust go hand in hand, one interviewee from industry mentioned the benefits of transparency in addressing data breaches in real time.

Disintermediation: Disintermediation was also considered by half of these interviewees as an important factor as it helps remove intermediaries, facilitates seamless data exchange, reduces transaction costs, and improves overall efficiency. An individual expert emphasised the role of disintermediation in furthering trust and allowing for increased automation, transformation, and 'headless' platforms[4] using AI and simplified code.

Economic or market factors: 28% of all interviewees, largely from industry, discussed funding and investments as a key factor driving development in the blockchain ecosystem. Interviewees held different perspectives on the use, growth, and decline of funding. For instance, one interviewee from industry highlighted that large private companies channelise funds towards financing their own in-house research and development centres.

Cryptocurrency hype: In general, interviewees believed that the overall hype around cryptocurrency and the large-scale funding it received in its early years propelled the development of blockchain solutions for different sectors and use-cases. Three interviewees specifically pointed out that as a result of this hype, blockchain technology has been inaccurately conflated with cryptocurrency resulting in adoption of blockchain applications without assessment of need and consequences. Two interviewees from civil society also cautioned against indiscriminate use of blockchain applications to solve existing societal challenges. An interviewee from industry believed that disillusionment surrounding cryptocurrency has resulted in a decline in funding available for blockchain solutions.

Institutional factors: 40% of all interviewees across all categories of stakeholders observed government support and a conducive regulatory environment as factors for the burgeoning technology. Half of these interviewees from

industry and government recognised that there is a steady appreciation for blockchain for governance purposes. They highlighted that few states in India have introduced blockchain policies and supported public-private partnerships to incentivise the use of blockchain making such states more conducive to blockchain development than others. On the other hand, many states and government departments have reservations about blockchain adoption due to low digitisation, inadequate level of digital literacy and familiarity, reduced opportunities for corruption, and apprehensions of job loss. An industry expert further pointed out that uncertainty in the current regulatory environment can prompt stakeholders to be over-cautious, impeding adoption of new and emerging technologies including blockchain.

Data protection regulation: Additionally, 28% of all interviewees discussed blockchain's interaction with data protection and privacy. In the context of India's upcoming data protection regulatory framework, two interviewees within civil society emphasised the need for the enactment of data protection laws to ensure the protection of individuals from potential risks in the blockchain ecosystem. They specifically highlighted the challenges with blockchain storing data permanently and its interaction with the right to be forgotten. Few interviewees from industry clarified that blockchain technology is adaptable to comply with privacy regulations. They noted that businesses with cross border operations already adhere to the General Data Protection Regulation's (GDPR) fairly stringent requirements. Additionally, on the presumption of conflict between blockchain's immutability and the right to be forgotten, two interviewees explained the mechanism for complying with the right, stating that permissioned blockchain ecosystems can be tailored to amend storage and access to existing information.

Research Question 3: What role do technical standards play in shaping the evolution of blockchain?

Interviewees were consistent – with near unanimous consensus – on the need for technical standards for the development of blockchain. Of those unaware of standardisation, only two interviewees with non-technical background expressed reservations, stating that the technology is not at a stage of maturity to necessitate developing technical standards. Another interviewee, with expert level awareness on blockchain applications, supported standardisation as it helps technology scale faster.

Principle-based approach to standardisation: Some interviewees with technical expertise, proposed that standardisation at this stage should set broad principles instead of designing granular conditions. For example, one interviewee pointed to concerns around incorporating specific cryptography functions as a particular standard, as they are ever evolving. These interviewees argued that any formulation of standards for emerging technologies like blockchain must adopt proportionate and risk-based approaches which set minimum baseline standards in a manner that does not disincentivise innovation and economic growth at scale.

Sector Specific Approaches: Some of these interviewees noted that standards development should be informed through learnings after the implementation of specific blockchain use-cases situated within a particular sector. They recommended this approach since different applications of blockchain may pose novel questions and specific governance challenges. These challenges may require curated standardisation solutions, even on functions (such as data collection, storing, sharing) which are ancillary to the particular blockchain use-case. One such issue for ancillary standardisation is data standardisation that includes collection and sharing at the primary level. This stance was supported by interviewees working across a range of industry sectors. An interviewee working on agritech solutions argued that without getting these foundational elements (outside of blockchain) standardised; adoption and proliferation of blockchain would be delayed.

Benefits of Standardisation: Few interviewees were of the view that standards can facilitate transparency, security, and scalability for blockchain solutions. Over one-third of all interviewees noted interoperability and harmonisation of technology as the key benefits of technical standards for blockchain technology. Interviewees shared the sentiment that interoperability through standardised protocols will allow businesses to scale blockchain based solutions. Amongst these, three interviewees noted that standards development can help arrive at common nomenclatures, vocabulary, terminology and identified protocols.

Global privacy regulations and scalability: At least a quarter of the total interviewees expressed concerns on the impact of global privacy regulations on the scalability of blockchain solutions. One interviewee working on supply chain solutions described the lack of privacy laws in India and its ensuing inconsistency with the 'adequacy' requirements under the European Union's GDPR, as an impediment in deploying these technologies. A few others expressed difficulty in grappling with the variance of privacy regulations around the globe for blockchain applications. However, another interviewee, representing a global business which is GDPR compliant stated that they were ahead of the curve and hence confident of adhering with any compliance arising out of a forthcoming domestic privacy regulation. Some interviewees suggested that common privacy standards could mitigate concerns of irregular compliance arising from differing privacy and data protection standards within each country.

Consideration around ethics and sustainability: There were also insights on the socio-ethical role of standards. An inter-

viewee with technical expertise noted that standards development influences the design of technologies, and any development of technical standards for blockchain should embed and reflect ethical values. Few others with high awareness levels on blockchain use-cases, echoed this and added that technical standards must have broad baseline principles to allow for flexibility and space for the technology to develop organically. Another interviewee with a technical background but without direct experience working in blockchain highlighted concerns around the energy consumption of proof-of-work verification systems and its consequent environmental impact.

Research Question 4: What are the most significant technical standards for blockchain?

A consistent observation across all interviews was the limited specificity with which interviewees were able to identify or describe technical standards for blockchain. While most interviewees described broad principles of standardisation, over a quarter of the total interviewees mentioned areas that required standardisation. Amongst these, three interviewees, are part of various committees and working groups at the national (BIS) and international level (ISO) standards organisations. While two interviewees identified some of the standards, one interviewee was able to identify all 8 published standards of the ISO.

These three interviewees identified the following key standards at the ISO level:

ISO 22739:2020 - Blockchain and distributed ledger technologies — Vocabulary

ISO 23257:2022 - Blockchain and distributed ledger technologies — Reference architecture

ISO/TS 23258:2021 - Blockchain and distributed ledger technologies — Taxonomy and Ontology

ISO/TR 23455:2019 - Blockchain and distributed ledger technologies — Overview of and interactions between smart contracts in blockchain and distributed ledger technology systems

Four interviewees identified standards at the level of industry-led bodies or consortium-led groups. These interviewees were unaware or not particularly conversant with standards being developed at the ISO and ITU level. Some of the industry specific standards mentioned were the Hyperledger Project started by Linux Foundation, protocols developed by the World Wide Web Consortium, and the Ethereum Improvement Proposals developed by the Ethereum community. One interviewee with technical expertise highlighted the importance of defining sector-specific ancillary standards around data security, identity management, payments, and risk management.

Research Question 5: What technical standards bodies engage in blockchain standards setting?

Approximately a quarter of the total interviewees were unable to name standard setting bodies for blockchain. Of the remaining interviewees, the most common bodies identified were the International Standards Organisation (ISO), Institute of Electrical and Electronics Engineers (IEEE), the Bureau of Indian Standard (BIS), and the International Telecommunication Union (ITU).[5] Over a third of all interviewees mentioned the National Institute of Standards and Technology (NIST), American National Standards Institute (ANSI) and Internet Engineering Task Force (IETF) as relevant national and international bodies engaged in the development of blockchain standards.

Overall, a large number of interviewees were of the view that the standards development process is tedious and a resource intensive exercise for stakeholders. The respondents here included both members that are part of standards discussions at the ISO level and those aware of the standard setting bodies.

A significant number of stakeholders from industry and academia viewed industry consortiums as relevant bodies for designing effective standards required for the deployment of blockchain technology. This was a recurring sentiment communicated by interviewees over multiple questions. Two interviewees, directly involved with the governance of blockchain applications, also made a more general observation that in areas where no standards existed domestically, developers and projects often place reliance on prominent national standardisation bodies in other countries such as the US' NIST which is affiliated with the US Department of Commerce.

Research Question 6: Do you engage in these discussions? Why/Why not?

60% of all interviewees reported non-engagement with standards discussions. Although the remaining 40% of interviewees were members of standards setting bodies spread across different levels - industry, national and international - many reported declining interest and/ or engagement due to reasons detailed below. Of those interviewees involved with standards discussions, 80% engage with standards discussion at BIS/ISO level. The remaining 20% of interviewees were directly engaging in standardisation discussions at industry specific standard setting bodies, while a few others were aware of these forums. Similarly, one interviewee reported being a participating member of the IEEE, and a few others were aware of the body.

Notably, almost all interviewees from the civil society and academia reported non-engagement with standards setting processes. Interviewees not engaging with standards discussion (60%) were nevertheless contributing to the development of the blockchain ecosystem in India through their roles as professors, policy researchers, founders of start-ups, technical experts, representatives of large private companies and government officials.

Reasons for low engagement or non-engagement: Interviewees provided similar reasons for either a lack of engagement or a decline in engagement with standards setting processes. The most common reasons included lack of time and resources for engaging with long drawn bureaucratic procedures in formulating standards. Some cited issues stemming from lobbying as disincentivising their participation. One interviewee pointed to the lack of monetary support for the participation of independent experts at standard setting bodies, as one of the factors that results in inequitable representation.

Engagement with industry specific standard setting bodies: Some individuals, working on development of blockchain solutions, expressed that industry-based standard setting bodies, consortium-led groups, and other private associations are more effective at formulating efficient and expedient standards. These interviewees located greater value in engaging with bodies like Enterprise Ethereum Alliance, Hyperledger Fabric, W3C, Linux Foundation, and International Traffic in Arms Regulation for timely and industry-wide adoption of standards.

Additionally, few interviewees reported alternative routes of engagement with standardisation in blockchain. These other avenues of engagement included standards related discussions at domestic bodies such as the National Association of Software and Services Companies (NASSCOM), the National Payments Corporation of India (NPCI) and the Reserve Bank of India (RBI). They also mentioned institutions at intergovernmental levels such as the World Trade Organisation (WTO) and non-governmental international groups like the World Economic Forum (WEF). These kinds of engagement in standards discussions can be understood as complementary to formal technical standards discussions that take place at national and international standard setting bodies. Moreover, it also reveals that technical standardisation is a layered phenomenon which takes place at several different levels and institutions which co-exist and operate at the same time.

In this context, all interviewees engaged with standards discussion at industry level bodies acknowledged and valued the efforts of those engaging with standards setting processes at national and international levels. Regardless of the level at which an individual was engaging with standard setting processes, they acknowledged the value of standardisation in providing a solid foundation for development of blockchain applications. In particular they stated that standards help advance interoperability and scalability of blockchain applications.

Role of government in standards formulation: Almost all interviewees from government emphasised the importance of an 'enabler' role that the government must play in the development of standards. They highlighted the role of the government in facilitating a conducive regulatory environment. Providing clarity on impending data protection laws and associated privacy mechanisms were cited as examples in this regard. Regarding standard setting discussions, these interviewees acknowledged stakeholders having technical expertise and knowledge to be the main drivers for formulating standards.

In general, interviewees who had no awareness about standards discussions expressed interest in learning about them as well as engaging with them.

Research Question 7: Who are the significant stakeholders domestically in the blockchain ecosystem?

A majority of interviewees (56%) expressed the need for multistakeholder involvement in development of the blockchain ecosystem. The term "multistakeholder" was understood by interviewees as broad categories of stakeholders involving government, industry, and academia. It is important to note the absence of explicit usage of the terms "standards bodies" or "civil society" in all interviews when referencing key stakeholders in the blockchain ecosystem. Most interviewees recognised the unique role and activities performed by different stakeholders in advancing India's blockchain ecosystem. Interviewees discussed the following key stakeholders:

- **Industry:** 60% of all interviewees enumerated various entities that can be classified as stakeholders within the broader classification of industry. These included blockchain solution providers (e.g. Software as a Service companies and tech start-ups), private businesses, investors, funding organisations, enterprises, web 3.0 developers, hackers, technology evangelists and experts, and the FinTech sector. A few interviewees specifically identified banks as significant stakeholders (engaged in implementing blockchain solutions at scale) for understanding challenges and gaps in scaling blockchain technology.

- **Government:** 52% of all interviewees highlighted the relevance of various ministries and departments in the blockchain ecosystem. They specifically mentioned the Ministry of Electronics and Information Technology, the Ministry of Finance, the Reserve Bank of India, state governments (specifically for deployment of blockchain based e-governance solutions), regulatory bodies and policymakers as significant stakeholders. One interviewee, a government representative, stressed the importance of strong and lasting public-private partnerships for development of the blockchain ecosystem.

- **Academia:** 32% of all interviewees recognised the expertise that educational institutions, professors, PhD students and policy thinkers bring to the development of blockchain. A few interviewees explained the need to harness the potential of technical universities such as the IIT's,[6] IIIT's,[7] and IISc,[8] to further knowledge-sharing amongst various stakeholders in the ecosystem.

- **Citizens and End-Users:** 20% of all interviewees highlighted the importance of citizens and end-users as key stakeholders in the blockchain ecosystem. Two interviewees stressed the need for designing blockchain solutions that integrate or accounts for various existing and emerging rights and other intangible elements such as equality and accessibility.

Summary

The interviews generated the following key findings and takeaways on blockchain use-cases and standardisation:

1. All interviewees were supportive of adopting blockchain solutions and 36 unique use-cases were identified across sectors. The application of blockchain solutions to records management was highlighted as especially beneficial due to the verifiability, transparency and authenticity of information on the blockchain.

2. Some interviewees were cautious of the challenges that implementation of blockchain solutions need to overcome in the Indian context. The feasibility of deploying blockchain solutions in remote areas and among demographics with low levels of digital literacy was highlighted.

3. Interviewees identified technological, institutional and economic factors as central to the development of blockchain technology. They also viewed industry, government, academia, and citizens or end-users as the key stakeholders in the development of the blockchain ecosystem.

4. While there was near unanimous support for standardisation, very few were able to mention specific areas for technical standards on blockchain. Some of the interviewees qualified their support for standardisation as it may impede the rapid pace at which the technology is evolving.

5. Despite being aware of standardisation activities at ISO, ITU and IEEE, most stakeholders viewed industry consortiums, such as the Hyperledger Fabric and community developed relevant bodies for standards development.

6. Engagement with standards discussions was limited with 60% of interviewees reporting non-engagement. Interviewees who are involved in standards setting processes were of the opinion that current procedural mechanisms at standard-setting bodies such as the ISO are cumbersome and resource intensive.

Interview Analysis Australia

Interviews were held with members of the Australian blockchain community exploring awareness of and views on blockchain standards. Twenty-five individuals participated, reflecting a wide range of demographic variability, across gender, sector, role, and experience with blockchain at a practical and technical level. There was consistency across interviewees regarding both awareness of application of blockchain across a range of sectors, and the factors influencing uptake of blockchain. Interviewee's knowledge of blockchain technical standards ranged from very limited through to proficient/expert. Support for the development and application of blockchain technical standards was similarly variable, ranging from it is unnecessary to strong support. Attitudes regarding support for blockchain standards did not appear associated with level of knowledge of standards (e.g., high knowledge did not always equal high support). Some interviewees expressed support for technical standards as a generally good idea, this support was qualified by concerns that there are technical or bureaucratic obstacles to achieving an effective process for developing technical standards that could be practically applied.

Research Question 1: Outside of the financial sector, what are the most exciting emerging use cases for blockchain (that offer economic, security, and social benefits)?

Most interviewees were able to identify two or three specific industries or sectors where blockchain is being used, outside of the financial sector. Some interviewees provided detailed descriptions or gave several examples of applications of blockchain use in their industry or sector. They also identified the use of smart contracts, which was identified as a non-industry specific use for blockchain. Overall, to understand the range of use cases that interviewees were able to describe we grouped them into six categories.

The six categories are:

- Supply chain, including agriculture and food industries, and inclusive of product distribution and freighting;
- Creative industries, including art and music where products have value as digital assets (primarily via non-fungible tokens (NFTSs);
- Licensing and credentials, including for titles and resource management for both government and private industry;
- Identity management;
- Insurance; and
- Medical and healthcare applications.

Those individuals more directly involved with either industry or education about blockchain tended to see the application of blockchain occurring now across all industries and government sectors, noting that the speed of development and adoption may vary considerably within and across sectors.

The economic, security and social benefits of blockchain were difficult for interviewees to distinguish and articulate as separate concepts (using those terms); interviewees explained why they thought blockchain could be useful to different sectors, and this utility encapsulated a variety of benefits that were use-specific. For example, discussion of supply chain uses, particularly in agriculture and food industries, identified provenance and quality assurance as critical (e.g., economic, security benefits).

Supply chain management for freight and other products where tracking, traceability and other ethical factors are high stakes issues, were expressed in terms of improving efficiency (e.g., economic, security, social benefit).

A summary of interviewee-identified benefits across interviewee-identified use cases is provided in Table 4.

Table 4: Blockchain benefits identified by interviewees, for use cases identified by interviewees.

Sector	Benefit Category		
	Economic	***Security***	***Social***
Supply chain	Yes	Yes	Yes
Creative industries	Yes	Yes	Yes
Licencing and credentials	Yes	Yes	Yes
Identity Management	Yes	Yes	Yes
Insurance		Yes	Yes
Medical and healthcare		Yes	

Research Question 2: What are the three most influential factors influencing the development of these blockchain use cases?

Interviewees provided additional insight regarding factors influencing the development of blockchain across the sectors they identified. Interviewees who were more familiar with blockchain were consistent in their understanding and expression of factors influencing the expanding applications of blockchain, across the use-cases identified. Interviewees who were less familiar with blockchain were still able to identify factors influencing its development, but with less specificity.

Factors that were consistently identified by interviewees can be considered most influential. The three most consistently identified factors are decentralisation, immutability and efficiency.

Decentralisation: The primary factor influencing development of blockchain use is its decentralised nature: no single entity owns or is in control of the data. Rather, blockchain data 'belongs' to all the agents in the blockchain, removing the need for middlemen or brokers in processes of exchange.

Immutability: The safety, transparency and unalterableness of blockchain chain data are important factors, particularly for sectors where authenticity and proof of provenance is highly valued (supply chain, titles, credential sectors) or where counterfeiting or fraud is a concern.

Efficiency: The clarity provided by information being verifiable and visible to all actors in a process, at all stages, facilitates its uptake and improves the speed at which information relating to real and digital assets and resources is able to move. In some cases, blockchain removes the physical 'middlemen' or brokers required to execute transactions.

Some expert interviewees with direct involvement in industry and research areas were able to reflect more specifically on the ways in which the *application of the technology,* rather than anything inherent in the technology itself, enabled or facilitated the benefits ascribed to blockchain. That is, these interviewees focused on the way various human agents or actors in a particular context choose to use and apply blockchain to bring about certain benefits. In particular, the collective nature of the data use and sharing and the shared establishment of rules and use of smart contracts promotes greater trust and higher level of compliance than conventional processes.

Research Question 3: What role do technical standards play in shaping the evolution of blockchain?

Those with no or very little technical knowledge of blockchain were largely unaware of the existence or development of standards. However, this did not prevent them from expressing a more general view that the development and expanding use of any new technology should go hand in hand with some focus on standards. The main reason for supporting standards, despite limited technical knowledge, was that standards ensure the safety of those using the technology as it replaces existing systems of data collection, use, and sharing of information. For these interviewees, adherence to standards could be considered an indicator of trustworthiness, for a system they do not technically comprehend.

Approximately a quarter of interviewees had knowledge of existing technical standards that have been developed or are under development with regards to blockchain. One stakeholder questioned the framing of the discussion around regulatory technical standards, observing that the standards that do exist are not able to be mandated in any way but are suggested technical standards that participating countries and organisations could contribute to and choose to adhere to.

A few interviewees expressed a view, one quite strongly, that it was too early or not necessary to introduce standards to the use of this technology whose application is still in a somewhat nascent state. The stated concern is that by imposing standards, the technology will develop around the standards rather than in more organic ways, inhibiting innovation and potential.

Regardless of their knowledge of blockchain or technical standards, around three quarters of the interviewees were generally of the opinion that technical standards development of some kind was a good idea. The reasons given were that standards serve to clarify and ensure safety and privacy for users and their data and provide quality assurance of the system development. Some interviewees mentioned assurance in the context of many members of the public and prospective industry users still having little knowledge of blockchain and how it operates. These individuals need to be convinced of the potential benefits and applications blockchain has and that it will be safe to use.

Some interviewees, while generally supportive of technical standards for the reasons stated above, qualified their support noting that there were technical and bureaucratic obstacles that might prevent the effective development of standards that could be easily applied in a global context. This included the observation that industry was moving faster than government and the regulatory bodies in developing and upscaling the use of blockchain. Notwithstanding these issues, some interviewees emphasised that, given the global nature of the applications of blockchain, recognition of the need for consistency in understanding and use of terminology was required. This will help to avoid potential miscommunications or problems in collaborating effectively across different jurisdictions or platforms (see below for specific reference to standards on terminology).

One interviewee, with expert knowledge of blockchain development and application but with less technical expertise, expressed the view that a lot of energy, time, and cost was being exerted in the development of technical standards by various technical committees and working groups. While they respected the expertise and commitment of those involved, they suggested that the application of blockchain might be better dealt with under existing regulatory frameworks developed for particular sectors, instead of focusing on technology-specific standards. This view was echoed by another interviewee who felt that regulations were more effectively applied on an industry or sector basis, rather than a technology basis. This approach does, however, require those with expertise in a given sector to become familiar with the standards needed to apply blockchain effectively within that sector.

Research Question 4: What are the most significant technical standards for blockchain?

The detailed knowledge of specific technical standards across interviewees was extremely limited. Most interviewees were only able to talk in general, or conceptually, about technical standards and could not identify specific technical standards relevant to blockchain.

Those with the most knowledge around technical standards appeared to have obtained this knowledge via direct involvement with the organisations developing the standards. These interviewees identified three ISO standards as the most significant because they address general concepts such as privacy, security and risk that are particularly important across emerging technologies. The three standards identified are:

ISO 23257:2022 - Blockchain and distributed ledger technologies — Reference architecture

ISO/TR 23244:2020 - Blockchain and distributed ledger technologies — Privacy and personally identifiable information protection considerations

ISO 22739:2020 - Blockchain and distributed ledger technologies — Vocabulary

At least one interviewee expressed some scepticism about the ISO standards and their business model of being a paid, private enterprise.

Research Question 5: What technical standards bodies engage in blockchain standards setting?

Although only a few interviewees were able to talk in detail about technical standards, several more were able to talk with some knowledge about standards-setting bodies. These interviewees identified four key organisations or entities involved in setting standards, operating and influencing at the global level. These organisations are almost exclusively referred to via their acronyms. The organisations, listed in the order of most frequently identified by interviewees, are:

ISO – The International Organisation for Standardisation, an independent, international, non-governmental organisation with a membership of 167 national standards bodies (both government and non-government bodies);[9] Standards Australia represents Australia on the ISO and offers perspectives regarding standards development.

IEEE – the Institute for Electrical and Electronics Engineers, an international body whose mission is to foster technological innovation and excellence;[10]

NIST – the National Institute of Standards and Technology within the US Department of Commerce, which promotes innovation and industrial competitiveness and sets standards for the United States;[11] and

ITU – International Telecommunication Union, the United Nations specialised agency for information and communication technologies.[12]

A few interviewees mentioned that some technical standards are set by particular blockchain based software platforms, such as Ethereum, to ensure the operability and security of their own systems. One interviewee commented that government has more of a role to play in providing a regulatory framework for technology use rather than in developing the technical standards themselves, which should be managed by industry. Another interviewee was also of the view that governments were most useful in developing accompanying policy instead of directly developing technical standards.

Research Question 6: Do you engage in these discussions? Why/Why not?

Noting that interviews were mostly with individuals engaged in applying blockchain in the Australian context, there was generally limited involvement with standards-setting discussions, at the national, regional or international level.

Less than a quarter of interviewees have been active members on the committees and working groups of the ISO. This means they have at some point been directly involved in working on the technical standards themselves or on the supporting framework for the standards that are designed to have global reach and input from many participating countries. Less than a quarter of interviewees have had peripheral involvement with the IEEE but not substantive direct involvement with the development of the detail of the IEEE standards.

More than half of the interviewees have been more actively involved with industry applications of blockchain, research and development or education and training. These individuals are only involved peripherally (if at all) in the development or debate around technical standards. Their focus and activity are targeted towards raising greater awareness about the benefits of applying blockchain in various sectors.

Their activities include:

- teaching or training sessions at university level or on accredited courses delivered by RTOs;
- attending and speaking at conferences, including those that are blockchain specific, more generally IT focused or industry specific such as agricultural or other business-oriented conferences; and
- critical thinking and knowledge sharing, through the publication of books, academic research papers and media presentations.

The few interviewees who had little or no substantive knowledge about blockchain, beyond knowing that it was starting to be talked about in their industry sector, were not yet involved in discussions or activities around blockchain but requested further information as a result of the interview process and research project information.

Summary

Overall, there was large variation in response depth and breadth, and perspectives shared, across the interview cohort, and very few trends were discernible based on demographic characteristics such as role, industry or experience. Despite this variability, interviewees did express a relatively consistent understanding of the blockchain environment.

There was consistency in awareness of the growth in use of blockchain across a range of sectors, particularly for supply chain, creative industries and for licencing/credentialling sectors. Factors of decentralisation, immutability and efficiency were also consistently identified as influencing development of blockchain use.

In contrast, information emerging from the discussions of technical standards was much more fractured, with levels of knowledge, and strength of opinions varying markedly. What is striking here, is that technical standards were not a major consideration for many of the interviewees who are very actively involved in developing applications for blockchain, be that in an industry sector or as part of a research industry or government partnership. Many regarded technical standards as something to explore on an as-needs basis.

Perspectives regarding the overall need for standards also varied, ranging from a belief there is sufficient self-regulation in the technology itself and therefore externally developed and applied standards are not necessary or potentially even detrimental in a rapidly evolving technological environment. In contrast, others were more supportive of continued ongoing development of standards for blockchain in the same way that there are with any other new technologies informed by the aim of providing safety and privacy and ensuring maximum benefit for all stakeholders. Between those perspectives, about half of the interviewees held more mixed views including support but tempered by the knowledge that blockchain technology is relatively new and developing quicker than government and regulatory bodies are able to keep pace with.

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2 Considered a backbone for the concept of "digital twins", the industrial metaverse is a concept which pursues the objective of simulating industrial applications or experiences in the virtual world before transposing them to the physical world. Theoretically, the "industrial metaverse" has the potential to transform the manner in which physical assets such as buildings, planes, robots, etc. are created, built and eventually operated. Such systems sit at the intersection of technologies like blockchain, artificial intelligence, virtual reality, mixed reality, augmented reality and the Internet of Things (IoT).

3 A single point of failure (SPOF) refers to one fault or malfunction that can cause an entire IT system to stop operating. This could be a person, facility, piece of equipment, application or any other resource. For example, an SPOF in a data centre or any other IT environment can compromise the availability of information in the entire data centre, depending on the location and interdependencies involved in the failure.

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3 Preliminary Case Study - Food Security

Side by side

Stage Two of the project will examine the development of use-case studies and related technologies and technical standards involved. The stakeholder mapping and interviews with key stakeholders in India and Australia undertaken in Stage One revealed a range of potential use-cases for examination. These are listed in Table 5. The potential use-cases have been selected based on the potential significance of the application/s of blockchain and their alignment to the project's key objectives.

The purpose of presenting these preliminary case studies along with the results of Stage One in this report is to reinforce a key emerging observation. While the blockchain ecosystems in India and Australia share many similar characteristics, particularly in terms of the issues, applications pursued, and the maturity of these activities; there are certain differences which reveal intriguing complementarities.

Take for example food security. We observe diverse use cases under this issue across both countries, where significant activity takes place in addressing layered challenges impacting food security including the complex value chain, natural and man-made disasters, biosecurity, fraud, spoilage, waste, and inequity. Both countries contribute significantly to global food security.

The complementarity which is interesting is that food-security related blockchain use-cases across both countries can be viewed collectively to address both high-level and on-ground issues. In India, while there are a considerable number of applications addressing supply chain related issues in agriculture, some are attempting to solve for food security in a bottom-up manner. To boost India's potential towards global food security, there is a need to build climate resilience for small and marginal farmers– who serve as the backbone of India's agricultural sector.

On the other hand, prominent use-cases in Australia are concerned with ensuring the quality and authenticity of its food exports, being ranked as one of the world's most food secure countries Australia exports around two-thirds of its agriculture production. While climate change poses a risk to the supply chain in both countries, the type of blockchain solutions which emerge are curated to local economic and social realities.

The rest of this section presents evidence for the two use-cases for India and Australia.

Table 5: Significant blockchain case studies identified for India and Australia.

Case studies identified	
India	**Australia**
Climate risks insurance and food security	Supply chains and food security
Credit lending for self-help groups	Cultural provenance
Land records management	Land registration
Drug and vaccine distribution	Water security and trading
Digital identity verification and certification	Identity and credentials

Climate Risks Insurance and Food Security in India

In 2020, approximately 45.6% of India's workforce was employed within the agricultural sector.[1] Rooted in history and tradition, this sector continues to be the main source of income, employment, and livelihood for a majority of people in India and developing countries. People working in this sector are increasingly vulnerable to climate change with the rise in frequency and severity of natural disasters and extreme weather conditions. Small and marginal farmers, that form 86.2% of all farmers in the country,[2] are especially affected by such events.

Climate change significantly impacts agricultural productivity, due to India's vast agro-ecological diversity and its dependence on optimal and predictable rainfall for cultivation.[3] India's annual average crop losses due to extreme weather events is estimated at around 0.25% of India's GDP.[4] India plays a significant role in global food security through humanitarian aid and exports (in the form of grains, wheat, rice, etc.) during crises and conflicts.[5] In FY2022,[6] India's food grain production was 316 million tonnes,[7] which represented a significant increase from the prior year amidst COVID induced inflation and the Russia-Ukraine crisis. In the same period, India also exported more than 7 million metric tonnes of food grain, a 250% growth from the previous financial year.[8] In this regard, India is one of the world's largest agricultural product exporters and recorded US$ 49.6 billion in total agriculture exports in 2020-21.[9]

These factors create a pressing need to establish infrastructure which mitigates disaster risks and strengthens the economic resilience of small and marginal farmers. Measures which protect vulnerable groups from climate shocks also align with a central objective of the United Nations for the Indo-Pacific region . An insurance product like parametric insurance can meet these objectives and become a game changer for the Indo-Pacific region,[10] which faces the full force of cascading climate risks and associated national, economic, and human security challenges.

While India has an insurance culture, traditional insurance systems and flagship government schemes[11] are compliance heavy, centralized, unaffordable and often inaccessible for farmers residing in remote areas.[12] Moreover, farmers face undue delays in release of claim payments, undermining the objective of extending relief via insurance schemes.[13] India reportedly has US$ 413 million pending in crop insurance related payment failures and delay in state level subsidies.[14]

Climate change also threatens the lives of small and marginal farmers. In 2015, 19% of farmer suicides were due to crop failure in the aftermath of a natural calamity, and 39% took their own life due to debts—the repayment of which is impacted by adverse weather events and faulty insurance repayment systems.[15]

Reliable insurance systems help insulate farmers from the volatility of climate change and create greater sustainability within the agricultural sector. Adoption of parametric insurance or index-based insurance systems, that compensate policyholders when predetermined thresholds and conditions are met, can alleviate the burden on farmers to prove losses in the aftermath of a climate disaster. Climate change not only poses significant threats to vulnerable farmers at a micro level, but also has an impact on India's agricultural economy in the long run. Given the impact of climate change on global food security, human security, and national security, it is imperative to identify solutions which ensure timely and accessible financial assistance which secures the livelihood and resilience of small and marginal farmers.

The Challenge

Traditional insurance systems in India lack the structure, resilience and risk management strategies required to withstand climate change risks. They are obstructed by payment failures due to inaccurate beneficiary data, delays in release of funds, and fraudulent claims. Two systemic challenges are important to contextualise:

Assessment Delays and Bias: Release of payments are generally contingent on detailed inspections carried out by in-person surveyors to assess crop losses and damages, caused by natural disasters and adverse weather incidences. Deployment of surveyors to the field is expensive for insurance companies and often delayed by several weeks after the occurrence of a disaster. This delay exacerbates losses suffered by the farmers since it negatively impacts both the perception and actual assessment of damages. These verification processes embed subjectivity and bias, leading to disputes between farmers, surveyors, insurance providers and/or governments about the extent or qualification of damages. This results in the pay-outs being released 3-6 months after extreme weather incidents, decreasing the utility of financial assistance being provided to farmers.

Challenges Stemming From Data: A lack of "damage assessment data" and subsequent delays from governments to insurance providers have been cited as a primary reason for non-payment of claims by insurance companies.[16] Traditional insurance systems use centralized and disaggregated databases to store necessary data (e.g. transaction and risk-related data, farmers personal data, and policy conditions). However, for insurance systems to work effectively, different entities require dynamic access to these databases for verification and traceability of data. The integrity of insurance data is also essential to avoid fraud and exploitation of marginalised communities. For farmers who are already in precarious circumstances, technological infrastructure related complexities further weaken their resilience against the distress of natural disasters and climate vagaries.

The Opportunity

The Indian government aims to accord top priority to small and marginal farmers in forthcoming agricultural policies.[17] The adoption of blockchain technologies can advance this objective by enhancing the efficacy, transparency and accountability in pay-outs made by governments and insurance companies towards small and marginal farmers. Alternate insurance mechanisms such as parametric insurance are a potential use-case in which blockchain technology may address issues like (a) timely disbursals and (b) removal of human/surveyors' bias.

Salient Features

Trust in "Data" and Payments Automation: Cryptography on the blockchain embeds data security and integrity in insurance processes, while protecting vulnerable communities' privacy. Blockchain applications to parametric insurance systems involve predetermined thresholds which are encoded and triggered through smart contracts enabling the automation of claim payments to farmers. Governments and/or insurance providers can help determine these thresholds.

Accountability and Objectivity: Distributed ledger technology will enhance the accountability of insurance systems by making information on liability for pay-outs publicly available and verifiable. As technology improves the accuracy of real-time weather data and predictions of natural disasters, human level interventions can also be minimised to allow for objective threshold-based rollouts of claims to farmers.

Smart Contracts and Oracle Networks: Smart contracts can help actualise the potential of parametric insurance for farmers such that if X weather related event occurs, Y claim payments are automatically executed. Cyclone wind-speeds, earthquake magnitudes and rainfall measurements are examples of objective metrics that can be verified by "oracles", neutral third parties such as start-ups, private entities or national meteorological centres, to trigger corresponding claims which can be integrated on the blockchain via Decentralized Oracle Networks (DON).

Democratisation Via Blockchain: The use of blockchain for parametric insurance will help drive citizen-centric governance and resilient climate change policies for the future. In streamlining a proactive and localised financial assistance solution, blockchain can help advance a human security approach[18] to protect the livelihoods of vulnerable farmer communities.

Ancillary factors essential towards scaling the solution:

1. Digitisation of land documents, weather data quality, risk correlation or basis risk,[19] and accuracy of farmer's personal data.

2. Digital literacy levels, on-ground tech support and farmer sensitisation and trust in adopting the technology.

3. Identification of village level governance bodies and local farmer's cooperatives that can encourage the adoption and implementation of blockchain solutions.

Key Benefits of Blockchain-Based Parametric Insurance for Farmers Include:

- Increased resilience to climate change.
- Predetermined thresholds eliminate subjectivity and prolonged on-ground assessments.
- Faster and transparent claim settlement processes
- Fraud identification
- Trust and predictability for farmers
- Operation and actuarial cost reduction

Technologies involved:

- Smart contracts
- Distributed ledger
- Real time satellite imaging
- Digital identity
- Mobile payments or UPI
- Decentralised Oracle Networks (DON) and Decentralised Autonomous Organisations (DAO)

Supply Chains and Food Security in Australia

Australia is renowned for its strong reputation for food safety, underpinned by robust frameworks, regulations, and quality assurance systems.

Australia's food supply chain is also a world leader in food quality giving local food producers a vital competitive advantage in markets where consumers insist that stringent biosecurity, authenticity, and quality standards are met.

Global demand for Australian produce is high. Australia's reputation as a supplier of quality safe foods is integral to the nation's ongoing economic sustainability with the sector delivering $49B in annual exports.[20]

Australia ranks 12th as one of the most food secure nations in the world, with over two-thirds of Australia's agricultural production exported.[21] However, the same cannot be said about our Indo-pacific neighbours where food security is among the most significant challenges facing the region.[22] COVID-19 and climate events have only compounded the problem, leading to disrupted food systems.[23]

In the global marketplace, Australia's competitive advantage will be the transparency, safety, and efficiency of its food industries.[24] New blockchain technologies that enable greater transparency, accountability, efficiency, and trust to food supply chains to enhance food traceability will secure both Australia and our Indo-pacific neighbours' future prosperity.

The Challenge

Food security and safety is a multifaceted problem where the challenges faced in Australia are not the same as those faced by our Indo-pacific neighbours. However, similarities can be drawn between domestic and regional food networks where greater certainty, transparency, accountability, trust, and security across the food supply system would benefit all.

The drive for food security and safety, coupled with the pressure of COVID-19 restrictions, has made the real-time availability and integrity of information more important than ever. The food security system faces several challenges including:

- Complex and fragmented value chains
- Resilience to disasters
- Biosecurity
- Certification and provenance
- Contamination spoilage and waste
- Inequity
- Import and export dependency

Complex and fragmented value chains

Food system value-chains are highly complex, fragmented and diverse. This is particularly evident in Indo-pacific regions where there are local, short value chains among small landholders and communities that rely on the trading of fresh fruits, vegetables, meat and fish to much more complicated value chains in Australia with 13 free-trade agreements (FTAs) and Australia's strict biosecurity and control regulations. Current inefficiencies in the supply chains amount to 55% of production costs.[25]

Resilience to climate, natural disasters and health shocks

Current food systems are ill-equipped to manage complexities that climate change generates and adapt after natural disasters and health shocks.

Extreme weather events and natural disasters, such as drought, bushfires and floods, have had a significant impact on the livestock, aquaculture and agriculture sectors. Farmers and producers experienced significant losses and were unable to access materials needed to rebuild, resulting in consumers shortfalls.[26] The disruption of supply chains leads to food shortages, increased spoilage and waste, as existing products cannot be efficiently deployed to where they are needed.[27]

Environmental changes compound these impacts on the system by driving the geographical spread of pests and disease, further threatening food safety.[28]

Biosecurity

Biosecurity threats remain a persistent challenge impacting human, animal and plant health. Biosecurity regulations in many countries have been drafted within disciplinary silos with limited to no collaboration across each of these domains. Australia has one of the strongest biosecurity systems in the world, protecting environmental assets worth $6.5B.[29] This system is amplified by our island status which in the past has provided a level of protection from exotic pests and diseases. However, an increase in international trade coupled with a higher volume of threats predicted over the coming decade[30] are expected to apply more pressure than the current system is able to handle.

Certification and provenance

Appetites are changing. There is a growing demand from consumers to know where their food comes from, how it has been produced and its authenticity.[31] This ranges across organic certification, ethically sourced, fair trade, free-from foods, premium goods, quality, freshness and provenance.

Fraud, contamination spoilage and waste

Food and wine fraud costs Australians $2.3B annually, and the global industry $40B annually.[32] Tracking down the source of contaminated food can take weeks and months, costing millions and eroding brand value and consumer trust.[33] Food spoilage and waste alone costs the Australian economy $36.6B cost to the Australian economy.[34] Globally food spoilage and contamination impact nearly 600 million people worldwide who become ill after eating contaminated food.[35] Supply chain inefficiencies in Australia result in a 20% loss of product value equating to $9.8B largely felt by farmers.[36]

Inequality

Failure of the food supply system further amplifies existing social, economic and gender inequalities. The impacts are unevenly felt with the elderly, people living with a disability, the poorest, women, girls and other vulnerable groups the most likely to be disadvantaged.[37]

Import and export dependency

Indo-pacific regions are highly dependent on imported foods for between 15% - 60% of calorific intake. This makes them particularly vulnerable to surges in international food prices or supply chain failures.[38] In contrast, Australia is highly dependent on food exports for economic security: $49B approximated 11% of total goods and services exports in 2018-19 equating to 2.2% GDP and 2.6% employment.[39]

A more resilient, transparent, trusted, coordinated and collaborative food supply system would deliver greater food security and safeguard Australia's economic prosperity. Being able to provide real-time data on where a product has come from and how it has been managed along the supply chain will become increasingly important to farmers, producers, retailers and consumers, especially in export markets such as ours.

The Opportunity

Transparent, accountable, trusted, safe and secure food supply chains, can be created through blockchain technology. Agricultural and aquaculture products, from production to consumer can be tracked through credentialing to ensure their provenance, quality, and authenticity.

Every product is registered and coded with a digital authenticity token. The information recorded in the tokens is unique to the product, be it livestock, fisheries, or crop lifecycles. The token can record information such as feed, growing conditions, organic and ethical source status, and quality assessment. Tokens are registered in a digital platform that is accessible to all parties along the supply chain, enabling efficiencies in transport and logistics to maximise quality, shelf-life and access. Smart contracts embedded into the system enable automated activities in line with agreements and regulations. The system provides real-time data on where a product has come from and how it has been managed along the supply chain, an important attribute for producers, retailers and consumers, especially in export markets.

Integrating data and quality assessments along the supply chain enable all stakeholders place high trust in a secure, centralised system which provides instant traceability, auditability, and performance.

A blockchain-enabled food system will be immutable, providing a single source of truth. Transactions cannot be altered or hidden as every change is tracked, recorded, and displayed to the entire network of users. The decentralised nature of data storage removes the need for a central authority to mediate between parties by creating a radically transparent, trusted environment that puts the power in the hands of the user.

Benefits delivered include:

- High trust in safe, quality and secure food
- Reduced tampering, contamination, spoilage, and wastage
- Visibility, authentication, provenance across the entire product's life
- Increased efficiencies in supply chains
- Increased efficiencies for producers
- Increased access to high quality food
- Enhanced biosecurity risk management
- Resilient and adaptable supply chains that can respond to disruptions
- Verifiable certification of organic, fair-trade, and ethical origins of products

Technologies involved:

- Digital authenticity tokens
- Smart contracts
- Distributed ledger
- Digital platform
- Real-time monitoring
- IoT and sensors
- Audit & verification

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4 Annexes

Annex 1 Stakeholder Mapping Approach and Results India

Framework established detailing organisation attributes and metrics including:

Organisation metrics & contact details	Business name
	Individual or organisation
	Name CEO / Senior Project Leader
	Contact email / LinkedIn profile
	Website
	Ownership (Sovereign or Multinational)
	Organisation Type (Industry, Industry bodies, Government, Civil Society, Legal advisory, Independent experts)
	Size (S and M up to 200 employees or L over 200 employees)Size (S up to 20 employees, M up to 199 or L over 199 employees)
	Year established (to determine organisation age)
Diversity	Demonstrable inclusion of women, consumer experience and accessibility.
Offerings	Blockchain technology services(s)
	Evidence of being influential and a leader in the field – the relevance and stage of blockchain solutions they were involved with, potential benefits accruing from these solutions, and the nature and type of collaborating partners (judgement assessment ranking L, M, H)
Collaborations	Evidence of public or private collaboration
	Comment on products, collaborators, or media reports
Blockchain applications	Potential and existing applications of blockchain that offer societal, economic and security benefits within India and applicable in the Indo-pacific region

Online search terms and criteria

The online search included a general search of applications of blockchain technology along with the search keywords detailed below.

- The primary search terms used were “blockchain” and “blockchain solutions.”
- The search identified stakeholders from reviews of existing media articles, policy documents, press releases, government websites, blockchain influencer lists such as Inc42 blockchain tracker, Outlook’s Famous Blockchain Development Companies, Fintech News’ India’s Top 30 Blockchain Influencers, and LinkedIn.
- The search terms included numerous groupings of the following terms - company, supply chain, healthcare, finance, insurance, banking, education, climate change, law enforcement, agriculture, vaccine, drug administration.

Manual search techniques such as searchable keywords and phrases and search criteria of diversity and inclusion were used while creating the stakeholder map to identify potential individuals for interviews. Dimensions of diversity included identifying women stakeholders, user experience and accessibility, and scale and prominence.

Parameters used to exclude stakeholders

Companies that engage in primarily cryptocurrency related activities were completely excluded from the stakeholder list. Additionally, companies with blockchain offerings in India but no operating offices were excluded.

Stakeholder Map Analysis

Observations – all stakeholders included in mapping

- A total of 190 stakeholders were identified in the Indian blockchain ecosystem.
- Majority of stakeholders fall within industry (78%) while academia (4%) and civil society (3%) have the lowest numbers.
- Out of 78% industry stakeholders, 6% include foreign based companies.
- All legal advisory and academia related stakeholders mapped had a dedicated focus on technology prior to their involvement in blockchain which might indicate proclivity toward such emerging technologies.
- From the 190 stakeholders, a total of 37 were leading players divided amongst industry including multinational corporations and prominent startups, government departments, bodies and think tanks, and academia. More than half of them (20) fell within the bracket of highly influential players. The remaining belonged to a medium (12) and low (5) influence category. The cohort of leading players was identified based on the following criteria: the relevance and stage of blockchain solutions they were involved with, potential benefits accruing from these solutions, and the nature and type of collaborating partners.
- Mapping of stakeholder organisations’ age was conducted specifically for industry, indicating varied durations. 51 stakeholders are within the 0 - 5 years category, 37 for 6 - 10 years and 41 for 10+ years.
- Accurate and complete information on women in the ecosystem was difficult to identify. As a result, the mapping was carried out for only women in top positions within industry resulting in only 14% of 129 stakeholders.
- With respect to the size of stakeholders, a majority are small and medium sized organisations (43%). Large sized organisations (32%) comprise mainly multinational companies, government bodies/departments and educational institutions. An interesting finding to note is that Indian multinational companies that originally existed in more traditional sectors have expanded to have dedicated departments on technology. The size of remaining stakeholders was unknown (24%).

Figure 2: Sectors of operation.

Sectors	Use-cases
Governance	Land records, subsidy delivery
Healthcare	Drug certificates, vaccine distribution
Agriculture	Seed distribution, climate risk insurance
Banking and Finance	Credit rating, insurance claims
Education	Educational loans and certification

Table 6: Categories of stakeholders.

Private Companies/ Start-ups	Private Collaborations	Government	Civil Society/Not for Profit	Legal advisory	Educational Institutions	Industry bodies	Independent experts	TOTAL
129	**12**	**13**	**6**	**5**	**8**	**8**	**9**	**190**

Table 7: Age of stakeholder organisations.

Category of Stakeholder*	0-5 years	6-10 years	10+ years
Industry	51	37	41
Industry Bodies	4	0	4
Government	0	0	13
Legal Advisory	0	1	4
Civil Society	2	0	4
Educational Institutions	0	1	7
Total	57	39	73

*Total of 169 stakeholders - does not include individual experts and private collaborations.

Table 8: Stakeholder entity ownership.

	Ownership	
Category of Stakeholder	**India**	**Foreign**
Industry	133	8
Industry Bodies	8	0
Government	13	0
Civil Society	6	0
Legal Advisory	5	0
Individual Experts	9	0
Educational Institutions	8	0
Total	182	8

Table 9: Organisation size by type of Indian-owned stakeholders*

Organisation Size	Industry	Industry Bodies	Government	Civil Society	Educational Institutions	Law firms
Small and medium (0-200 employees)	56	1	-	4	5	5
Large (200+ employees)	41	3	9	2	2	-
Unkown	32	3	3	-	-	-

*Total of 169 stakeholders - does not include individual experts and private collaborations.

Annex 2 Stakeholder Mapping Approach and Results Australia

This annex presents the approach and results of the stakeholder mapping for Australia.

Established framework criteria

Framework established detailing organisation attributes and metrics including:

Organisation metrics & contact details	Business name
	Individual or organisation
	Name CEO / Senior Project Leader
	Contact email / LinkedIn profile
	Website
	Ownership (Sovereign or Multinational)
	Organisation Type (Industry, Industry bodies, Government, Civil Society, Legal advisory, Independent experts)
	Size (S and M up to 200 employees or L over 200 employees)
	Year established (to determine organisation age)
Diversity	Demonstrable inclusion of women, consumer experience and accessibility.
Research strength	Blockchain technology services(s)
	Technology readiness level
	Evidence of being a leader in the field – key player, decision authority, expert, potential disruptor (judgement assessment ranking L, M, H)
Trademark / Patent(s)	Trademark date
	Patent(s) date
	Patents(s) names
	Patent status
	Inventor(s)
Collaboration	Evidence of international collaboration
	Comment on products, organisational links, collaborators, alliances, affiliations, investors or media reports
Case Study	Potential case study examples, including active or past projects that have delivered benefits within Australia and applicable in the Indo-pacific region across one of the three criteria of security, economic & equity.
Search criteria used	Search category (Trademark, Patent, Tender, Blockchain Australia Member, CRC, Top Dev Company, Roadmap Steering Committee, University, Government, Government Report, Representative Body, Other)

Search criteria

Named manual searching method was used commencing with key industry leaders, with the search criteria recorded as part of the stakeholder map. The primary search terms used were “blockchain” and “block chain”.

The search included the following broad stakeholder groupings, undertaken in the following order. Where a stakeholder sits across multiple stakeholder groups they have been categorised by the preceding initial category.

Search Category	Number of identified stakeholders
Blockchain Australia Members	116
Patent(s)	162 (14)
Trade Mark	47
Tender	6
Cooperative Research Centres (CRC)	12
Australian Government including; Industry Growth Centres, Government Research Organisations	4
Australian Government Report including; The national blockchain roadmap: Progressing towards a block-chain-empowered future; Blockchain Innovation: A patent analytics report; Blockchain Challenges for Australia: An ACS technical white paper; Blockchain 2030: A look at the future of blockchain in Australia;	12
Australian Government National Blockchain Roadmap Steering Committee	10
Universities	12
Top Development Companies for 2022 – as listed on Clutch	38
Representative Bodies	2
Other*	46
Total number of ‘active stakeholders’ identified (excluding extraneous patent numbers)	319

*Stakeholders identified under the ‘other’ category occurred by using a snowballing data gathering technique. This method, also referred to as chain or referral sampling, is where additional stakeholders are identified by referral, connection or mentions in conjunction with the original stakeholder under assessment.

Expanded search terms

In some instances, a further search term of “digital solutions” or “digital” were used to illicit deeper insights, namely for organisations that were identified as part of the snowball search (referenced by a previous stakeholder as a collaborator) yet had not obvious blockchain research, products or collaborations.

Parameters used to exclude stakeholders

Multinational companies with no significant or strong Australian connection were excluded from the stakeholder list with the following exceptions: if they were a member of Blockchain Australia, or if they had a significance Australian presence, or evidence of a use case (potential case study) that would be applicable to the Indo-pacific region and met one of the parameters of security, economy, or equity. Multinational companies with a sector profile restricted only to the fintech sector were excluded from the stakeholder list altogether.

Stakeholder Map Analysis

A total of 319 stakeholders were identified. The level of detail available for each stakeholder varies, and as a consequence the n for the tabulations and analysis varies (those with no data for a variable are excluded). For ease of reading, percentages are reported as whole numbers.

Observations – all stakeholders included in mapping

- Majority of stakeholders are organisations with only 4% individual stakeholders identified (11 of n=319).
- Equal share of small and medium organisations (43% each) with 14% of organisations being large (n=249)
- There are 24 stakeholders with international connections and collaborations.
- 40 stakeholders exhibited evidence towards diversity initiatives, ranging from women in senior leadership positions, to an explicit diversity and inclusions policy or initiative, to participating in awareness raising events.
- Based on the project aims, a judgement assessment was made to identify key stakeholders in the field including prominent players, decision authorities, experts or leaders in their field, or potential disrupters. 51 stakeholders were identified as high influencers, 36 as medium and 15 and low.
- Almost half of stakeholders (46%) were operating in the Fintech sector (Table 10).
- Stakeholder organisations were mostly less than 10 years old (80%). 31% of stakeholder entities were 4 or 5 years old (established in 2017 and 2018), with one quarter younger than that (0-3 years: 26%) and the remainder older (6-9 years: 23%; 10 years+: 20%) (Table 11).
- Where sufficient information was available, stakeholder organisations were assessed for maturity using the Technology Readiness Scale (n=227). 65% of stakeholders achieved scores of 9 (system proven and ready for full commercial development) and a further 25% achieved a score of 8 (System incorporated in commercial design).

Observations – stakeholders with Australian ownership or operating location

- Most stakeholders with a significant or strong Australian connection were Australian-owned and had their primary operating location based in Australia (81%) (Table 12).
- Australian-owned stakeholders were predominantly of small and medium size, and most were industry organisations (84%) (Table 13).
- All non-Australian owned stakeholders with size information available (n=34) were industry organisations, with the greatest proportion in the medium-sized category (small: 24%; medium: 41%; large: 35%).
- Of stakeholders with a specified primary operating location in Australia (n=239), the greatest proportion were located in NSW (36%) and Victoria (30%). QLD has the most stakeholders operating in non-capital cities (Table 14).

Graphs and Tables

Table 10: Proportion of all stakeholders operating in different blockchain technology sectors. The total % is greater than 100% which reflects that fact that many stakeholders operate in more than one sector.

Sector (many in two sectors)	%
Agriculture, food, beverages, critical minerals, environment, energy or healthcare	9%
Smart contracts, smart titles, digitised assets, identity management, records, digital certificates	11%
NFT, gaming, entertainment, music, books, media	13%
Consultancy, research, marketing & PR	14%
Legal, Governance, Training, IP, copyright, risk management, cyber security	17%
Providence, supply chain, distributed ledger, digital platform, security, audit	17%
Creators: Developers, software, DApps, Web3, DAO, IoT, sensors, telecommunications, technical	25%
Financial sector only	28%
FinTech, finance, bitcoin, cryptocurrency, trading, brokerage, wallets, investment, lending	46%

Table 11: Age of stakeholder organisations by industry sector (the total reflects stakeholders where this information was available).

Years	Academic	Government	Industry	Grand Total
less than 1 year	1		4	5
1	1		16	17
2	1		17	18
3	4		15	19
4	4		25	29
5	4	1	38	43
6	1	1	17	19
7			10	10
8			10	10
9			15	15
10-19 years	1		20	21
20+ years		5	20	25
Grand Total	17	7	207	231

Table 12: Stakeholder entity ownership and operating location (n-290).

	Primary Operating Location		
Ownership	***Australia***	***Not Australia***	***Grand Total (n=290)***
Australia	81%	1%	81%
Not Australia	4%	14%	19%
Grand Total	84%	16%	100%

Table 13: Organisation size and type Australian-owned (sovereign owned) stakeholders (n-198).

	Organisation Type			
Ownership	***Academic***	***Government***	***Industry***	***Grand Total (n=198)***
Small (0-19 employees)	6%	0%	41%	47%
Medium (20-199 employees)	5%	2%	39%	45%
Large (200+ employees)	0%	4%	4%	8%
Grand Total (n=198)	11%	6%	84%	100%

Table 14: Australian-based stakeholders by state and location.

	Organisation Location				
State	***Capital City***	***Non-capital city***	***Rural***	***Grand Total***	***% Grand Total***
NSW	82	3	2	87	36%
VIC	70	1	1	72	30%
QLD	28	8	2	38	16%
SA	15		1	16	7%
WA	13			13	5%
ACT	12			12	5%
TAS		1		1	0%
Grand Total	220	13	6	239	100%

Annex 3 Interview Methodology and Results India

In total, 90 stakeholders were shortlisted for interview from the larger stakeholder database (Refer to Annex 1 Stakeholder Mapping Approach and Results India) using criteria such as scale, prominence, types of blockchain solutions offered, regional diversity, collaborations, size, and membership in standards bodies. Stakeholders were invited for interviews to share their understandings and insights on trends, factors, applications, use-cases, and standards relating to India's blockchain ecosystem. Of the 90 stakeholders invited, we were able to schedule 22 interviews with 25 individuals. Of these, 21 individuals were interviewed through an online medium and four in-person in New Delhi, India.

In addition to stakeholders who did not respond to our interview request, a few declined to participate expressing lack of awareness and/or expertise on the subject matter of blockchain.

In total, 25 individuals were interviewed between 21st June and 19th August 2022. Both online and in-person interviews typically lasted between 40 and 60 minutes, with a few lasting up to 2 hours. In addition to the 90 stakeholders invited, referrals made by interviewees during the interview process were also approached with a request for an interview.

Each interview had at least three members of our team present to facilitate comprehensive live data collection. This enabled review and cross-verification of responses during the internal aggregate data analysis. Responses for each interview were transcribed verbatim and all personally identifiable data collected from interviews was treated as confidential. The data from interviews was aggregated and examined using a qualitative interview analysis method to identify emerging key themes. Interview responses were assigned interpretative thematic codes and categorised accordingly. The thematic coding analysis was based upon stakeholders' awareness, knowledge, experience, objective, tonality, perspective, sentiments, attitudes, values and familiarity about blockchain use-cases and related standards development processes and institutions.

Prior to analysing interview data, each interviewee was assigned a stakeholder category (refer to Table 16 below). Two interviewees fell within more than one stakeholder category. However, for the purposes of data analysis, we considered their primary stakeholder category.

Demographics

This section utilises common deductive and emergent coding techniques to categorise interviewees by (a) impact area, (b) stakeholder category, and (c) specific sector of work or type of institution. Regarding stakeholder categories, interviewees represented seven categories namely, (i) industry, (ii) government, (iii) civil society, (iv) start-ups, (v) legal advisory, (vi) individual experts, and (vii) academia (see Table 16). The pool of interviewees largely comprised senior-level professionals, computer network engineers or technical solutions architects, blockchain consultants and advisors, individual experts, directors and CEOs of private companies, professors, research fellows and policy advisors (see Table 17).

a. **Impact area:** The impact area of interviewees' work was determined on the basis of the type of impact (society, economic and/ or security) resulting from their primary professional roles (see Table 15). The nature of most interviewees' work covers more than one impact area. For instance, some of those working on addressing societal challenges through blockchain solutions were assigned dual categories of society and economic impact. As a result, we have categorised 16 out of 25 interviewees under **more than one impact area** in Table 15. This helps provide a more accurate depiction of the scope and cross-cutting impact of people working in India's blockchain ecosystem. For texture, we have interpreted "security" as an impact area holistically to include several dimensions namely: technological, strategic, national, and social. No interviewee was engaged in work which directly impacted strategic or national security. Under this impact area most interviewees' work aimed at addressing technological architecture security (i.e. cybersecurity). A few interviewees worked on advancing food security.

Table 15: Number of interviewees by impact area (deductive). The total number of interviewees exceeds 25 due to applicability of more than one area of impact to some interviewees.

Impact area	Number of interviews working in that area*
Society	18
Economy	16
Security	10

b. **Stakeholder category (deductive):** A majority of interviewees are observed to fall within the category of industry and start-ups. Nevertheless, we interviewed a healthy mix of representatives across civil society, academia, and government stakeholders engaging with India's blockchain ecosystem (Table 1). While many interviewees are engaging with more than one role and performing a range of activities, only two interviewees are 'actively' working with more than one type of stakeholder organisation/ institution and hence have been assigned dual stakeholder category. This is to accurately showcase that interviewees hold additional positions in the blockchain ecosystem aside from their primary roles. For instance, apart from their primary professional roles in the blockchain ecosystem, some interviewees run their own start-ups that offer blockchain solutions or have visiting faculty roles on blockchain courses at universities. Table 16 displays the breakdown of all 25 interviewees across stakeholder categories.

Table 16: Number of interviewees by stakeholder category (deductive). The total number of interviewees exceeds 25 due to dual categorisation of stakeholder category for 2 interviewees.

Catergory of Interviewee	Number of interviewees working
Industry	8
Government	4
Civil Society	5
Start-ups	4
Academia	3
Individual Expert	2
Legal Avisory	1

c. **Sector/ Type of institution (emergent):** Interviewees also shared more specific details about the type of institutions they work in and their roles and functions at their respective organisations. These emergent findings have been showcased in Table 17 below. Our findings reveal considerable heterogeneity within each stakeholder category participating in different types of institutions. This communicates a vibrant ecosystem wherein at an overall level stakeholders are engaging in a range of activities and performing diverse roles and functions to harness the value of blockchain. Notably, one-third of this cohort, with several senior-level professionals or industry veterans, engage with standards discussions at the BIS/ ISO level.

Table 17: Number of interviewees by specific sector/ type of institution (emergent). The total number of interviewees exceeds 25 due to dual categorisation of stakeholder category for 2 interviewees.

Catergory of Interviewee	Number of interviewees working in a sector	Sectors/Type of Institution
Industry/Start-ups*	12	Private and multinational companies across sectors such as agriculture, healthcare, insurance, technology, aviation, IT services and consulting, supply chain assurance/ transparency, credential verification, and cybersecurity
Civil Society	5	Private think tanks, and public policy organisations
Government	4	Central Government Departments, State Government departments, government think tanks, and statutory standard setting bodies
Academia*	3	Private and publicly funded technical educational institutions and liberal arts universities
Individual Expert	2	Technology & systems design, digital transformation advisory on BFSI, E-Commerce, Manufacturing, Healthcare, Energy
Legal Advisory	1	Advisory and consulting on technology law and policy, Data Policy

Stakeholder roles and functions: The group of 25 interviewees were observed to be working in the following professional positions or organisational roles:

- Business professionals with designations such as Director/ Vice President/ Founder/ CEO
- Software Developer/ Technology Design Architect/ Technology Advisor
- Civil servants, Government officials and Government advisors
- Academic researcherv
- Legal and Policy professionals
- Professors

Size of organisation: A majority of the interviewees (60%) worked within this report's categorisation of small[1] and medium[2] organisations. Only one interviewee represented a large private technology solutions company (200+ employees). Other interviewees were largely university professors, technology entrepreneurs, and independent technical or policy consultants.

Gender diversity: The range of gender diversity among inteviewees was low and limited to 4 women representatives across government, civil society and industry. At the organisational level, most interviewees were able to provide estimates of the total number of women working at their organisations or companies. Women representation stands at 37%, based on the data gathered from the 18 interviewees across sectors. A few interviewees highlighted the importance of diversity and inclusion related policies at their organisations, and other initiatives in the Indian blockchain ecosystem that encourage and support greater participation of women. 28% of the interviewees were unable to provide data on the number of women working in their organisations. One woman interviewee believed that India's blockchain ecosystem has greater gender inclusivity as compared to the broader information technology ecosystem in the country.

1 0-19 people

2 20-199 people

Experience leves of interviewees: Table 18 tabulates the number of years interviewees' have been working within their respective sector or industry as a proxy to map their level of professional experience. In this regard, 80% of all interviewees have in-depth experience (over 7 years) in their respective sectors. Several of these interviewees have either two decades of professional experience or more (see Table 18). This cohort spreads out over different levels of experience with regard to work experience in the blockchain domain (see Table 19). Notably, the average length of work experience across all interviewees in their respective sectors is fourteen years.

Table 18: Length of time interviewees have been working in their respective industry or sector.

Number of years	Number of interviewees working in industry/sector
0-2 years	1
2-4 years	1
4-7 years	3
7+ years	20

The Indian blockchain ecosystem is young and developing with a majority of interviewees (60%) falling within the range of 0-4 years of experience in the blockchain domain. These include 8 new entrants (0-2 years) and 7 at a relatively early stage (2-4 years) of experience in the blockchain domain (see Table 5). The ecosystem can be considered to be developing at a good pace with more than one-third of interviewees, only a couple of years away from crossing the 7-year mark of experience in the blockchain domain (see Table 5).

Table 19 demonstrates the growing enthusiasm around blockchain having many new and young entrants (0-4 years) along with a third passing through the developing stage (4-7 years). The growth in this sector is possibly due to low entry barriers, low regulatory compliance, political support for innovation and growth, access to capital, a skilled demography, and policies supporting technology infrastructure.

Table 19: Length of time interviewees have been working in the blockchain domain.

Number of years	Number of interviewees working with blockchain
0-2 years	8
2-4 years	7
4-7 years	9
7+ years	1

Interviewees reporting less than two years of experience with blockchain, had stakeholders mainly from civil society, government or academic institutions. This possibly demonstrates a growing interest amongst legal advisors and policymakers, civil society organisations, and policy thinkers and shapers to engage with the subject of blockchain. The promise of blockchain is attracting actors across sectors to explore its potential. 40% of interviewees, with an average of 17.5 years of sector-specific experience, have been engaging with blockchain for the last five years or more across stakeholder categories, namely industry and start-up , academia, individual experts, and legal advisory. A majority of them are directly engaging with standards discussion at ISO level as well. It could indicate that those interviewees that have spent considerable amounts of time working in their sector as well as blockchain understand the value of engaging with standards discussions.

Direct involvement: 64% of the total interviewees, involved in developing and implementing non-crypto blockchain solutions, were categorised as those having "direct experience". These were mainly from the industry. The remaining comprising stakeholders across academia, government, and civil society had 'indirect experience' with the non-crypto blockchain ecosystem.

Their engagement with the blockchain ecosystem was largely through research related activities. Only one interviewee had no experience with blockchain technology but was familiar with blockchain in the context of cryptocurrency.

Technical expertise: 48% of the total Interviewees were currently engaging with technical aspects of blockchain technology having a technical background. They were categorised as having "technical expertise". This section of interviewees represents start-ups, large private organisations or technology solutions companies. Of these, several interviewees reported working with blockchain for the last 3 or 4 years. It is interesting to note that more than one-third of the total interviewees are 'directly involved' with blockchain solutions and have 'technical expertise'.

Annex 4 Interview Methodology and Results Australia

Individuals/organisations were invited to participate in an interview to explore awareness of and views on blockchain standards. Invitees were identified through stakeholder mapping and accounting for sector, diversity, blockchain application and relevance to the project goals, as well as known/established industry contacts.

Twenty-two semi-structured interviews comprising 25 individuals were conducted by telephone or online video calls (Zoom, Teams) across the interview period of 19 July through 25 August 2022. Most interviews were between 30-40 minutes in length, however a few interviewees were highly engaged, and discussions lasted more than one hour.

Verbatim and/or paraphrased responses to interview questions were captured live for analysis in a data collection tool, similar to a survey. With permission, interviews were also recorded to enable review of responses and for project record-keeping.

Interview responses from the data-collection tool were analysed from an interpretive perspective drawing upon methods of qualitative content analysis. Responses were examined and then coded thematically, allowing key themes to emerge in an unrestricted way from the interview data. Analytic dimensions included consideration of awareness/knowledge and perceptions/attitudes about blockchain and blockchain standards.

Demographics

Australian interviewees were currently working across a variety of sectors, including civil society, government, and academia. No interviewees were working in the security sector. Some interviewees could not be isolated to a single, specific category e.g., those academics employed in a government or industry backed research and development partnership.

The impact area of those interviewees who were currently involved in blockchain development and application was identified and categorised using common (Australian) deductive codes (Table 20).

Again, using common, deductive codes, the work sector for Australian interviewees were classified in a more granular way (Table 21).

Emergent coding (categories derived through Australian interview responses) reveals that amongst Australian interviewees, more than half were working in industry or other non-government sector such as peak bodies involved with development of blockchain or standards (Table 22). This also reflects the current status of blockchain as more prevalent in civil and industry sectors and, to date, less widely used or present in government and academic sectors.

Table 20: Number of interviewees by impact area.

Impact area	Number of interviewees working in that area*
Security	2
Societal	12
Economic	6

*Not all interviewees were able to be classed into the three areas of impact.

Table 21: Number of interviewees, by sector (deductive coding).

Sector	Number of interviewees working in that sector
Civil Society	3
Civil Society/Law Firm	Nil
Academia/Industry	8
Industry/ Start-up	6
Academia	3
Government	1
Industry	3
Expert	3

Table 22: Number of interviewees, by sectors (emergent coding).

Sector	Number of interviewees working in sector	Specific sectors interviewees worked in
Civil society/industry	13	Non-government bodies, peak bodies, business including Agri-food, transport, software and app development
Government	4	Government R & D bodies
Academia/education	6	Academia, CRCs, Training and education
Security	2	Cybersecurity, product authentication, identity management

Represented **role categories** were:

- CEO/business industry leader, founder
- Software developer/technical expert
- Research and Development
- Support roles – non-technical (industry, non-government peak bodies)
- Project Managers
- Educators

Interviewees worked in a mixture of smaller and larger organisations, with the majority working in what could be considered smaller (0-19 people) or medium (20-199 people) sized organisations.

More than two thirds of interviewees had been working in their industry, either blockchain or other industry sector, for more than 4 years (Table 23). For those working in particular industry sectors, academia or government, the length of time reported for working in their industry was often much longer than the time reported working with blockchain. For example, some had been working more than 7 years in their industry, but only relatively recently, in the last 2 years started working with blockchain. Only those working in an exclusively blockchain focused business or role reported the same amount of time working in both their industry and on blockchain.

Table 23: Length of time interviewees have been working in their sector.

Number of years	Number of interviewees working in industry/sector
0-2 years	2
2-4 years	6
4-7 years	8
7+ years	7

Most interviewees did not know much about blockchain technology before they began working with it. At least two interviewees had only encountered blockchain via their work roles relatively recently and admitted to very limited understanding of how it worked.

A few interviewees had early awareness of blockchain from about 2010, with most hearing about it in relation to bitcoin from about 2013 onwards. Amongst those with early awareness of blockchain, it was generally sometime later that they developed a more in-depth knowledge and understanding of blockchain, usually as they encountered it applied in other settings.

At the other end of the spectrum were a few people employed in sectors that have only had to recently engage with blockchain or seen blockchain applied and started to learn about blockchain only in the last 2 years. Those not counted were those who have yet to engage with blockchain in any capacity in their workplace.

Almost all of the 25 interviewees had some degree of experience working directly or indirectly with blockchain in recent years and only a few had no experience at all though were aware of the existence of blockchain applications in their own industry sector. Fourteen interviewees said they were directly involved in working with blockchain in some way, and eight said they were indirectly involved. The remaining interviewees were not working with blockchain at all and were only aware of its use elsewhere in their industry

Approximately a third of interviewees had been involved, either directly or indirectly, in working with blockchain for between 2 and 4 years and another third for between 4 and 7 years (Table 24). This level of experience reflects the fact that those invited to participate in interviews were for the most part individuals with some degree of expertise and involvement with the blockchain environment since its inception. A few interviewees had been engaged with blockchain for more than 7 years, when the technology really started to gain traction, through working with Bitcoin or in a technology research capacity.

Table 24: Length of time interviewees have been working with blockchain, including in their current sector and prior experience.

Number of years	Number of interviewees working with blockchain
0-2 years	3
2-4 years	7
4-7 years	7
7+ years	3

Annex 5 Interview Questions

The project teams in India and Australia devised a series of seven baseline research questions for the interviewing blockchain ecosystem stakeholders about their awareness of and attitude towards technical standards, there questions were as follows:

1. Outside of the financial sector, what are the most exciting emerging use cases for blockchain (that offer economic, security, and social benefits)?
2. What are the three most influential factors influencing the development of these blockchain use cases?
3. Are you aware of the development of technical standards around blockchain domestically and internationally? What role do such standards play in shaping the evolution of blockchain?
4. What are the most significant technical standards for blockchain? [List in order of importance]
5. What technical standards bodies engage in blockchain standards setting? *[List in order of importance]* / How important is it for any regulatory standards that operate to be accessible, equitable and inclusive? [PROMPT - why?]
6. Do you engage in these discussions? Why/Why not?
7. Who are the significant stakeholders domestically in the blockchain ecosystem?

Concordance of formal and informal interview questions

The Australia team conducted interviews with a schedule of discursive/informal questions mapped to the baseline questions (Table 25).

Table 25: Shows the baseline questions number (Q1 is base line Questions 1.), interview question number (#) and the interview question text.

Baseline question	#	Interview question text
Q1	1	Most people have heard about blockchain being used in the financial sector. What other industries are you aware of where blockchain is starting to be used?
Q2	2	Why do you think that's happened? "What do you think led to these use cases' emergence/existence?"
Q1	3	Can you describe any specific benefits that the use of blockchain brings –
Q1	4	To the other industries you've mentioned?
Q3	5	Are you aware of regulatory technical standards in using blockchain?
Q1	6	Would you like to say some more about that?
Q3	7	How much do you know about technical standards for blockchain generally? Do you think that you know a lot, little or not much about blockchain standards? Can you explain?
Q3	8	And what about in your sector?
Q4	9	How do you feel about those regulatory standards?
Q4	10	Are there particular standards you think need to be applied?
Q4	11	Are there any you think are particularly important or necessary?
Q5	12	How important is it for any regulatory standards that operate to be accessible, equitable and inclusive? (PROMPT - why?)
Q5/7	13	Can you name, or describe, any organisations or bodies that are involved in setting standards for blockchain?
Q6	14	Are you involved in any way, with any of the organisations that you have just mentioned or any others you haven't mentioned responsible for blockchain standards?
Q6	15	Are you contributing in any other ways to discussion or activities around blockchain use or standards?

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