Department of Information Technology and Electronics
Government of West Bengal

Webel
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Automating trust in citizen services

Leveraging blockchain technology

pwc

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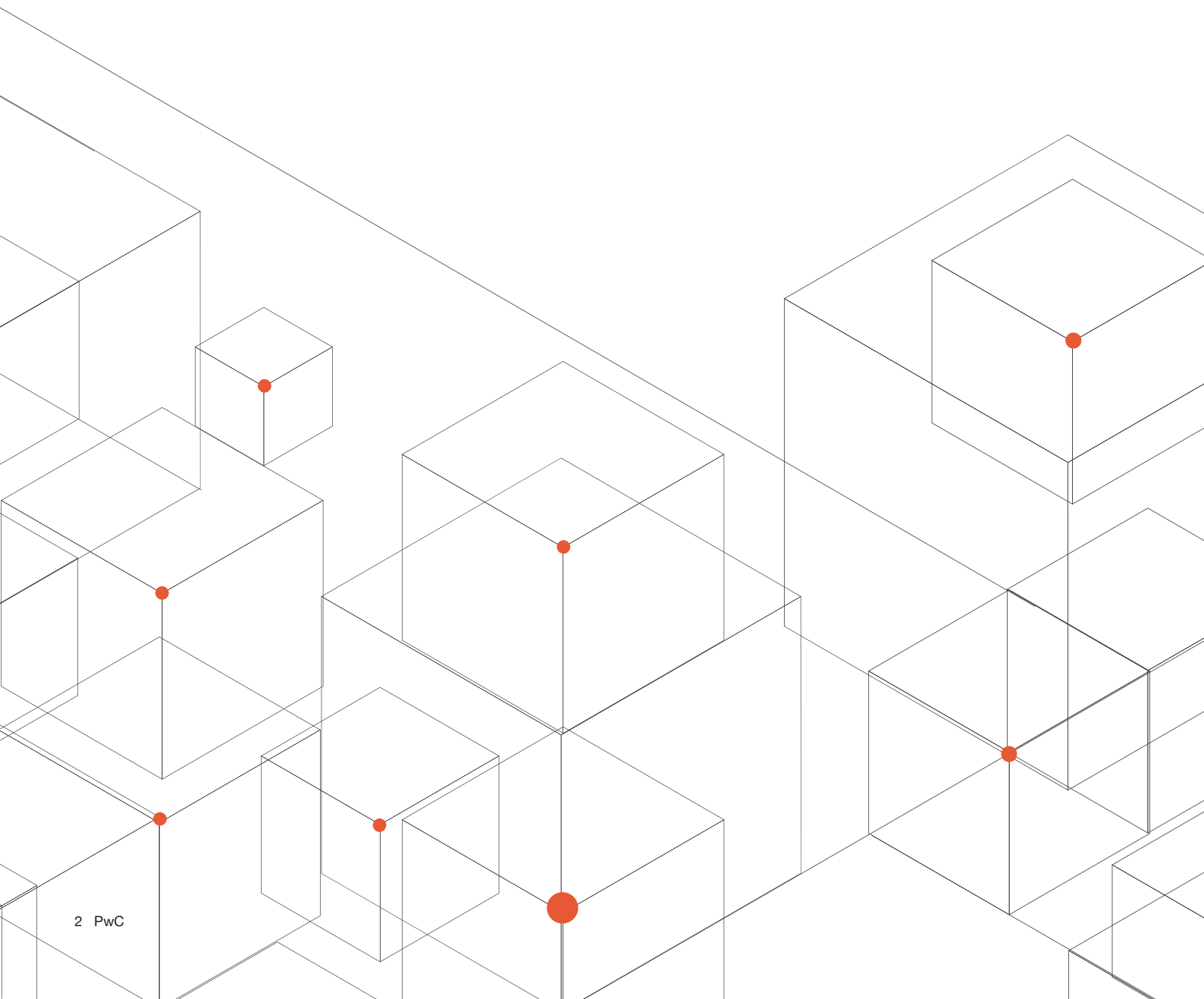

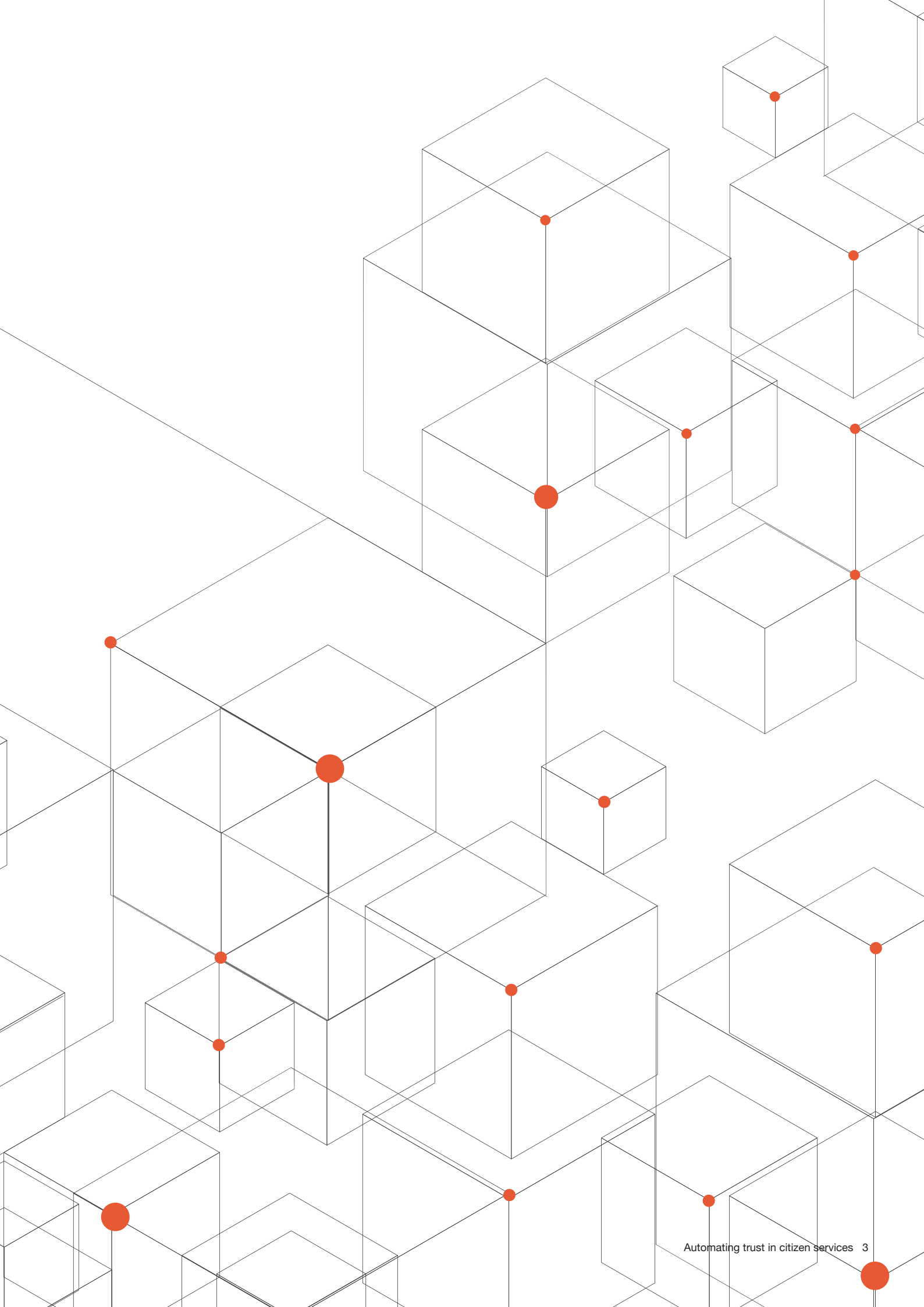

Foreword

We live in exciting times. The digital age has descended upon us in its various avatars and it's quite certain that these technologies have an immense potential to transform the global economy. It is heartening to see that not just businesses but governments as well have evinced active interest to leverage the power of these emerging technologies, especially in Blockchain to usher in the digital economy.

Focus is to use this technology to serve the common people with applications in health, education, agriculture, infrastructure, etc. Also we have to harness these technologies for climbing the value chain in digital governance for the service of the common people.

We also must recognise that the new technologies have the potential to come in conflict with the fundamental premises on which human society and human civilization is built. This is particularly so in the case of ASI (Artificial Super Intelligence). A robot may understand human thoughts and emotions affecting human behaviour in the future. The typical danger that may emerge is when the robot knows by discovering patterns of thoughts through ASI that the human may be ready to pull the plug. What happens then…? Here it is instructive to read the counterpoints from such AI leaders today like Elon Musk and temper our excitement with maturity, prudence, and a bigger vision on technologies.

The key point is that the technology is produced to serve mankind and then it is a means for a larger end and not the end itself.

I can only hope that the Blockchain Congress will produce ideas and processes which will serve the interests of the common people to allow them to ascend to higher trajectories.

Keeping the above concern in view, concrete focused steps are therefore imperative in the next 3-4 years to ensure that India does not miss the bus but develops deep expertise to dominate and drive the Blockchain technology space towards benefit of the common people in particular.

Global Blockchain Congress: Consensus 2018 - the first International Blockchain Conference ever to be held in Eastern India, is one such step by the Government of West Bengal to provide an avenue for Global and Indian blockchain experts to share their research and mind-space on the technology and its benefits for the Indian economy at large. I congratulate DIT&E and WBEIDC for conceptualising and organising this event, and I am hopeful that the event would lead to germination of entrepreneurs, cross-country alliances and partnerships in the future.

Dr. Amit Mitra
Hon'ble Minister for Departments of Finance, Information Technology & Electronics, Industry Commerce and Enterprise, Micro, Small and Medium Enterprise and Textile, Government of West Bengal

Today, the world is witnessing considerable upheaval in the technology space. To avail the first-mover advantage, firms usually prefer to ride the wave of digital disruption rather than follow it.

Blockchain, one of the emerging technologies, holds immense potential to disrupt the way business is done today. Blockchain's capabilities aren't limited to the business world and it can also be used to augment and amplify the existing citizen services delivered by the government. As the sixth largest economy in India, West Bengal has started exploring opportunities and identifying suitable cases for blockchain adoption.

The mission of our state's IT policy is to 'make West Bengal the hub of emerging technologies and thereby capture opportunities in new age technologies'. Since March 2018, the Department of Information Technology & Electronics (DIT&E) has already conducted seven monthly knowledge workshops on the latest technology topics like cyber security, artificial intelligence, blockchain, the Internet of things, FinTech, embedded technology and quantum computing. These events saw a cumulative audience of more than 3,000, comprising esteemed faculty from academia, representatives from the government and industry, start-ups and students. To ensure a healthy ecosystem for academia, start-ups and technology companies, DIT&E has also proposed to set up a Centre of Excellence for these emerging technologies in partnership with leading educational institutes like ISI Kolkata, IIT Kharagpur and Maulana Abul Kalam Azad University of Technology (MAKAUT). Recently, the department launched a blockchain-based crowdfunding application for public good.

Even though blockchain is an emerging technology, the labour market is already witnessing decent demand for blockchain developers. As the technology is yet maturing, it provides a level playing field to students, technology enthusiasts and even experienced IT professionals to learn about blockchain, create blockchain products and to venture out as entrepreneurs. I hope that the Global Blockchain Congress will serve as a steady platform for participants, start-ups and businesses to learn from blockchain experts and collaborate on the journey to making West Bengal a promising blockchain destination.

Debasish Sen
Additional Chief Secretary
Department of Information Technology & Electronics
Government of West Bengal

Message from PwC

Technology is redefining the way governments engage with their citizens. According to PwC's 21st CEO Survey 2018,[1] the world will increasingly require new metrics for measuring prosperity. The traditional way of measuring prosperity through GDP growth or similar financial parameters should evolve into a process involving multifaceted metrics, such as quality of life. Emerging technologies are going to play a significant role in establishing such measurable systems, building trust in the systems, and solving some of the important problems of society.

While government-to-citizen (G2C) services are getting rewired with the help of information technology, lack of trust and regulatory uncertainty are two unsolved problems. Newer technologies like blockchain, coupled with AI and other new technologies, can help in solving some of these problems by automating trust in citizen service delivery.

Webel and PwC conducted an online and offline survey to understand the views of senior executives in West Bengal on the possibility of automating trust in the delivery of citizen services. The respondents also shared their opinions on the role of blockchain technology and its relevance with respect to automating trust. About 23 senior executives from the government and private businesses responded to our survey. In this report, we have shared their perspectives and our point of view on how citizen services can be delivered through trustworthy automated platforms.

In addition, we gathered the views of some prominent officials about the role of blockchain technology; their views are also presented in this report.

We thank all respondents and senior executives for their time and for sharing their valuable inputs.

Amulya Patnaik
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Partner
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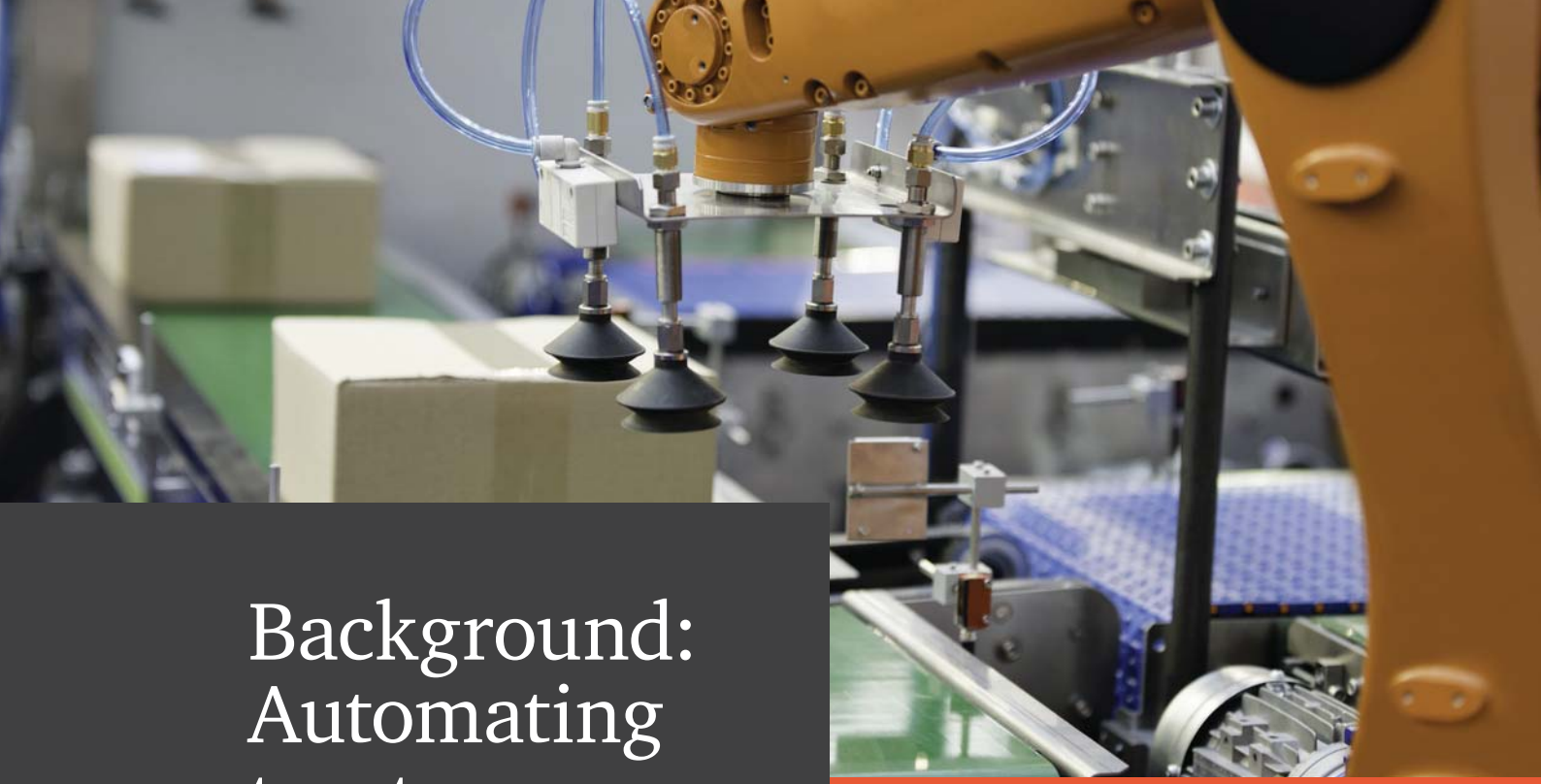
PwC India

1. https://www.pwc.com/gx/en/ceo-agenda/ceosurvey/2018/gx.html



Background: Automating trust

The technology landscape around us is changing rapidly. Many technologies that were emerging a few years ago are being widely used today and are maturing quickly. Needless to say, technology has a huge impact on economies and in the day-to-day life of people. It is shaping citizens' behaviour, employment, growth and many other macroeconomic parameters.

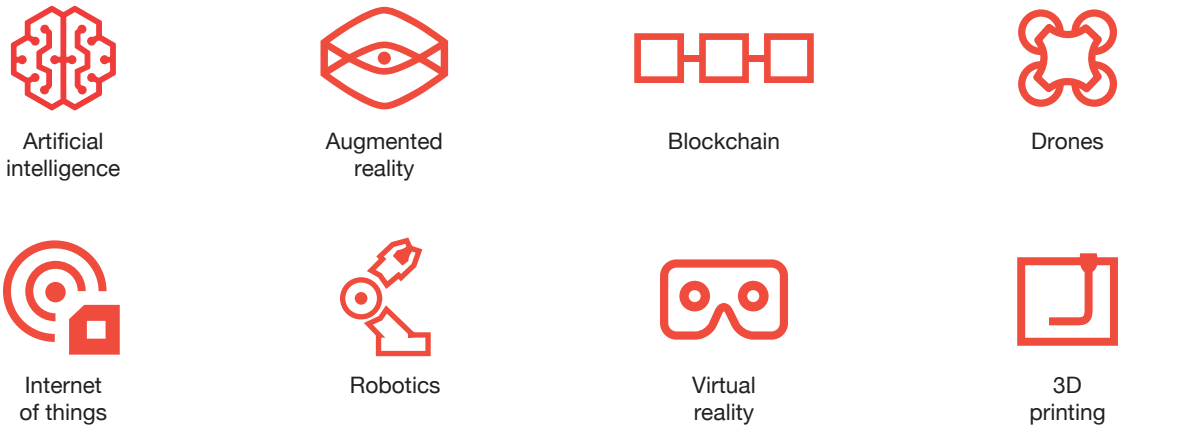
On the other hand, there are other worldwide trends that pose challenges to economies, such as rapid urbanisation, demographic changes, shift in economic power, climate change and resource scarcity. The emerging technologies, if used in the right way, can solve many of these challenges. They can provide a better quality of life to people and also aid economic development. In addition, their adoption can bring competitive advantages to corporates. For this reason, today, companies, governments and academia across the globe are keen to invest in the adoption of technology.

Technological breakthroughs shaping economies

Technological breakthroughs are happening in all spheres – from material science to computation. And many of these technologies have an impact across sectors. After considering more than 150 such new technologies, PwC has identified eight that are likely to shape the world of the future. They are called the Essential Eight – artificial intelligence (AI), augmented reality, blockchain, drones, Internet of things (IoT), robotics, virtual reality and 3D printing.

These technologies are solving many important challenges of the global economy today. For instance, China recently unveiled a social credit system to assess individuals and government agencies on areas ranging from tax payment to judicial credibility. The system makes use of big data and analytics to build a risk assessment model.[2] Similarly, to deal with rapid urbanisation, many countries, including India, are developing smart cities using cloud technology, mobile devices, data analytics and social networks.

Moreover, the individual technologies are being combined to yield powerful applications that are greater than the sum of their parts. One example is the use of IoT sensors to automatically collect data about raw materials moving through a supply chain, and then recording that data in a blockchain to create a singular and unchangeable record that everyone in the supply network can see. Or, using video captured by a drone flown over that same raw material and using AI to not only recognise the material but also determine how much had been used since the last time the images were analysed. While technologies can break new ground, it is also imperative to understand the fundamental principles underlying each one.



The Essential Eight
(Source: PwC)

2. https://www.researchgate.net/publication/324988134

Blockchain – the fundamental problem it can solve

Blockchain, one of the Essential Eight technologies, promises to solve many important problems of society and the economy. It was first applied in the financial services industry. Today, blockchain technology is considered disruptive and impactful across industries. In PwC's Global Blockchain Survey 2018, which involved the participation of 600 executives from 15 territories, 84% said that their organisations had at least some involvement with blockchain technology.[3]

84%

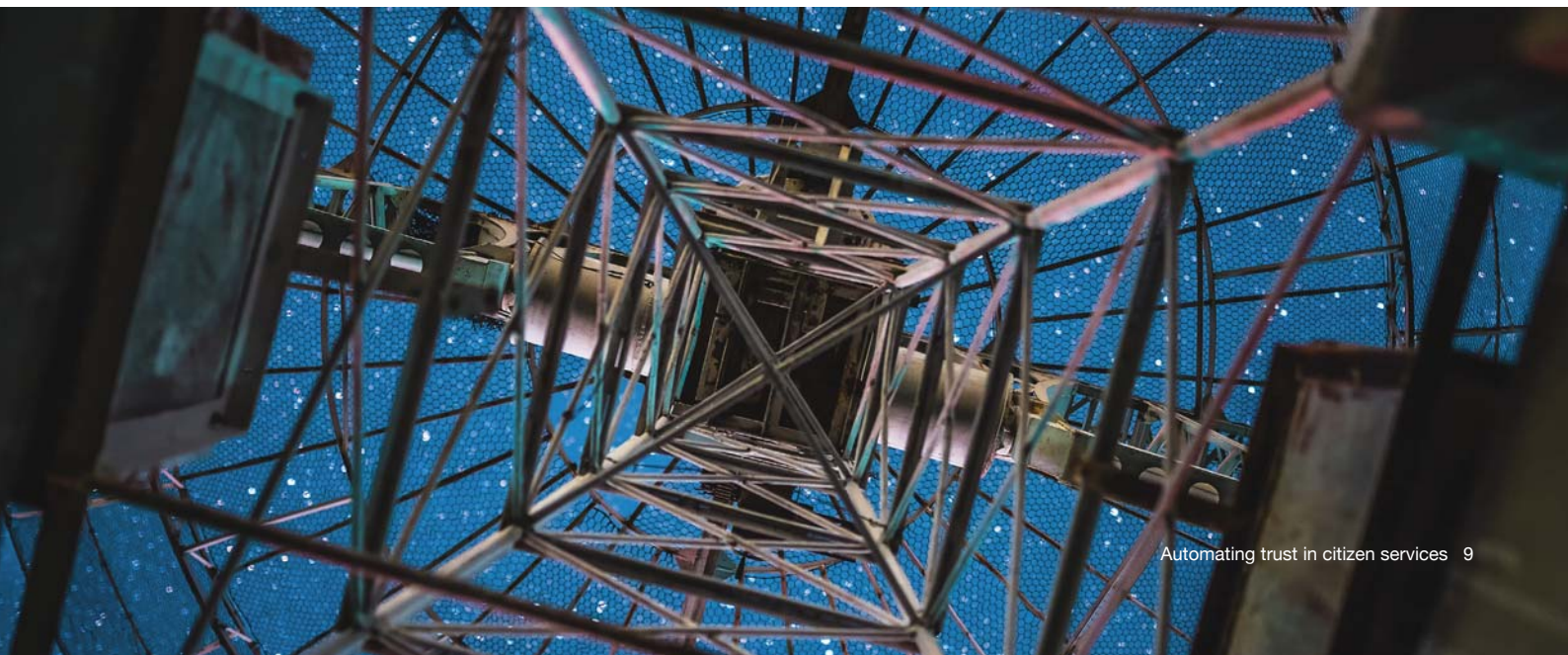
My organisation has at least some involvement with blockchain technology

Source: PwC's Global Blockchain Survey 2018

Just like any other technology, blockchain aims to solve one problem. Fundamentally, it bridges the gap in trust and automates trust-based transactions. Historically, intermediaries helped in bridging the trust gap within an economic system. Blockchain technology helps in establishing a similar kind of trust through a non-repudiable system. Once all participating entities and individuals are on board with such a system, they can conduct transactions amongst themselves with trust and speed, thus improving the overall efficiency within the system. Additionally, blockchain makes data more secure and tamper-proof than any traditional record-keeping system, thereby helping to protect valuable data from adversaries such as hackers and fraudsters.

> Blockchain is starting to disrupt industries and citizen services are no exception. Blockchain can build the required trust among citizens in government services and increase the speed with which these services are delivered. For governments, it can act as a powerful tool to manage registries, licenses/permits, identity and supply chains.
>
> **Sreeram Ananthasayanam**
> Partner, Government and Public Sector
> PwC India

3. https://www.pwc.com/gx/en/issues/blockchain/blockchain-in-business.html



Establishing trust – the technology perspective

Stakeholders in a transaction using blockchain technology can rest assured that a transaction and data associated with it are secure. One of the reasons for this trust is that blockchain does not depend on any centrally controlled database to store information. In a centrally controlled database, one of the parties called the central administrator essentially has greater authority to control data, while other parties have to trust the administrator. Moreover, this centralised database becomes a single point of failure. At its heart, blockchain is a shared and distributed ledger, and members of the network have their own copy of the ledger. Every change in the ledger gets reflected in each of these copies through a peer-to-peer network. This makes the system less vulnerable.

Moreover, there is no centralised authority for verification of transactions. Rather, a transaction is committed by consensus, and any dubious transaction is likely to get rejected by the system participants.

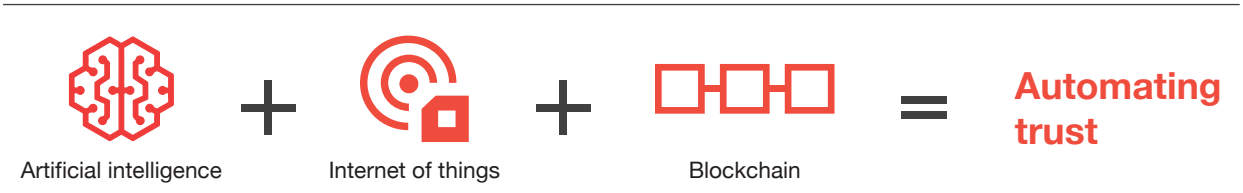
Finally, the records cannot be tampered with once they are entered into the blockchain. Each block is knit with its previous block in such a way that any effort to break that sequence is improbable. This is also true of the content of a block. This feature is supported by technologies such as hashing and signing of data using public-private key pairs.

> Blockchain bridges the trust deficit that has become even more evident in the digital age. In the e-governance space, the technology has the potential to augment the existing G2C services to deliver effective and customised services to citizens.
>
> **Amulya Patnaik**
> Partner, Government and Public Sector
> PwC India

How blockchain technology can automate trust

The use of blockchain can not only establish trust but also automate trust by combining IoT and AI. Automating trust is one of the five emerging themes that have been identified by PwC.[4]

In such a system, trust is automatically built in. The system gives the desired outcome repetitively without any need for manual intervention. IoT helps to gather data from various sources through sensors.



Source: PwC

4. https://www.pwc.com/gx/en/issues/technology/essential-eight-technologies.html

The sensors may send data from drones, machines and other sources. The data is then put into a blockchain system so that the record becomes immutable. In this way, data can enter into a blockchain system automatically from every stage of a record-keeping activity, such as a food distribution chain or property ownership management, without any manual intervention. AI helps the system take various actions or spawn actions based on gathered data.

Since the data enters directly from sensors, it is more reliable than manually entered data. In a typical food distribution chain, where multiple parties who are unaware of each other's data are involved, this model can assure the parties of the authenticity of the data entered.

This model is emerging in supply chain and food chains across the globe, both in the government and private sector.

> The emerging technologies are maturing fast, and they need to be deployed simultaneously to solve some of the larger problems of society. Automation of trust while delivering citizen services is one such solution which will be driven by blockchain and a few other new technologies.
>
> **Arijit Chakraborti**
> Partner, Technology Consulting, PwC India

Blockchain types for citizen services

Blockchain can be of various types depending on access rights provided to the participants – public, private and federated. Different types of blockchains are suitable to meet different needs.

If multiple companies are collaborating, they can establish a consortium blockchain system, where viewing, writing and consensus authorisation stays with selected nodes. Such a system enables executives to monitor the activities through a distributed ledger.

The government can take the lead in forming such consortiums and thus regulate industries such as food supply and microfinance. In this model, the government does not have to collect any data from citizens. The main objective achieved here is that public interest is protected through proper implementation of regulations.

The government can also set up a blockchain-based system where citizens will be able to contribute their data and have access to it. Registration processes, such as registration of birth, death, marriage and land, can be set up in this way. The right to write, validate and consensus can be designed based on the requirements.

Typically, in such a model, a selected group of people, mostly officers of a government organisation, will contribute and authorise data. Citizens will also be able to contribute data to a limited extent, such as initiating a request for registration. Subsequently, an authorised group of people will create, verify and attest new blocks. A consensus will be reached through specific agreed methods (e.g. votes of a majority of authorised nodes).

Moreover, authorised entities will be able to search data within the system to verify certain information. For example, an authorised lender would be able to search for the status of a piece of land before granting a loan to build a house on that land.

The model design can vary based on the requirements.

Global trends of blockchain usage in citizen services

Why is blockchain so relevant for delivering citizen services?

Worldwide, governmental institutions face an issue with building and sustaining trust with citizens, owing to a perceived lack of transparency in public service delivery. Lack of trust is mostly attributed to the large number of intermediaries across major activities of governance, with varying levels of human intervention. Human intervention and centralised processes result in disparate systems with power being concentrated in the hands of a few individuals, leading to lack of trust in the processes and systems.

These issues have for long sparked the need for technology that can track transactions at a granular level in real time such that transactions once recorded in a system cannot be altered by unauthorised entities. Blockchain addresses this need perfectly.

Blockchain is steadily emerging as the ideal fit for governmental institutions in solving long-standing problems across public sector service undertakings.

How blockchain is used in various countries for citizen services

Blockchain has increasingly received attention as a means to ensure regulatory monitoring, compliance and reporting for greater transparency in existing regulatory procedures. The use cases already being implemented by governments worldwide belong to various service areas such as public healthcare, digitised ID, welfare distribution, bills and payments, legislation records, legal enforcements, taxation, and peer-to-peer electricity trading.

A few global examples:

Estonia: Blockchain in healthcare, digital ID and governance

Estonia is leading the way in the blockchain revolution. The Estonian government has been testing the technology since 2008. Since 2012, blockchain has been in operational use in Estonia's registries, such as national health, judicial, legislative, security and commercial code systems, with plans to extend its use to other spheres such as personal medicine, cyber security and data embassies.[5]

Estonia has also developed a blockchain solution for government services.

Dubai: Automating governance operations through blockchain

The Dubai government is launching a blockchain platform as part of the Smart Dubai initiative, with a goal of making all government services paperless and executing them through blockchain. By 2020, Dubai wants all visa applications, bill payments and license renewals to be transacted digitally using blockchain. By adopting blockchain technology, Dubai stands to unlock AED 5.5 billion in savings annually in document processing alone — or the equivalent of the value of the Burj Khalifa.[6]

Honduras: Land title registry

Honduras pioneered land registration through blockchain. Due to the high reliability of the 'blockchain backbone', the 'proof of existence' and 'proof of process' features will constitute scientific evidence which can debunk and legally trump any false or manipulated land titles in court.[7] Many governments across the globe, including Georgia, Honduras and Sweden, are working towards implementing blockchain in land title registry operations.

15%
Companies indicate that their blockchain applications are live

42%
Companies indicate that their blockchain applications are being developed or piloted

20%
Companies are researching block-chain technology

Source: PwC's Global Blockchain Survey 2018

Major challenges in blockchain adoption for citizen services globally

Blockchain adoption for citizen services has not been a smooth journey, with many government organisations encountering issues.

In Honduras, improper traceability of records in land registry posed a major issue. Land records were apparently open to a wide range of unauthorised users who could make changes to them. The government therefore initiated the blockchain land registry project to secure land records. However, the project was stalled for years because the officials were not convinced of its benefits.[8]

PwC's Global Blockchain Survey 2018[9] shows that blockchain projects have been stalled not just in the public sector. Business leaders have indicated that 7% of blockchain projects across sectors globally are stalled.

According to the same survey, one of the major challenges in blockchain adoption is lack of trust in technology. Blockchain, by its very definition, should engender trust. But organisations face trust issues, largely due to lack of clarity about blockchain technology and its benefits. Further, reliability, speed, security and scalability of blockchain-based systems are yet to be tested and proven.

The other challenge is bringing everyone in the network together. Blockchain for citizen services often entails participation from many organisations, including government organisations, regulators and private entities. The success of such a system depends on successful collaboration among all the stakeholders, which is often a huge challenge.

7%
Companies indicate that their blockchain projects are paused

45%
Lack of trust among users is a major challenge in adoption

44%
Ability to bring the network together is a major challenge in adoption

Source: PwC's Global Blockchain Survey 2018

5. https://e-estonia.com/
6. https://smartdubai.ae/initiatives/blockchain
7. https://s3.amazonaws.com/ipri2016/casestudy_collindres.pdf
8. https://www.reuters.com/article/us-honduras-landrights-tech-idUSKBN1AR151
9. https://www.pwc.com/gx/en/issues/blockchain/blockchain-in-business.html

Use of blockchain in West Bengal to provide citizen services

The Indian blockchain technology market is projected to grow at a CAGR of 58% during 2018–24.[10] In the last quarter of 2017, adoption of blockchain technology registered rising end-customer acceptance, especially among banking and financial services, transportation, and government verticals.[11]

The Government of West Bengal has been actively involved in the evaluation and implementation of blockchain technology. Some of these initiatives are described in the following section. Various other state governments in India, such as those of Andhra Pradesh, Maharashtra, Telangana, Gujarat and Karnataka, are also taking steps to evaluate and implement blockchain technology with varied objectives.[12]

The survey conducted by Webel and PwC in 2018 sought to understand the extent of blockchain adoption and associated challenges in West Bengal. Senior executives from both public and private sectors participated in the survey.

The survey results indicate that participants from both sectors are confident that the use of blockchain can bring significant benefits to citizens if used for the delivery of citizen services.

10. https://www.researchandmarkets.com/reports/4557091/india-blockchain-technology-market-2018-2024
11. https://www.researchandmarkets.com/research/79zscb/india_blockchain?w=5#
12. https://economictimes.indiatimes.com/tech/internet/maharashtra-plans-a-pilot-to-try-out-blockchain-technology/articleshow/62896305.cms

West Bengal government's vision and achievements

The West Bengal government has been actively pursuing initiatives towards the development of blockchain and financial technologies in general throughout the governance landscape of West Bengal. Usage of blockchain for cyber security and protection of state documents has been on the cards.

One of the milestones in blockchain adoption in West Bengal has been the development of a crowdfunding solution. DIT&E, Government of West Bengal, catalysed the development and implementation of this tool for a charitable organisation. The tool is designed to fund various social welfare and research projects.

Every transaction in the form of a donation to this portal is now traceable at a granular level and every donor is able to view the flow of funds. This blockchain-based solution, which has been developed on Ethereum (an open-source computing platform), is already running and has increased confidence and trust in the blockchain system.

Another ongoing blockchain application, a blockchain-based social network, is being developed for the New Town Kolkata Development Authority (NKDA). The platform allows for tokens to be generated based on the activity of participants, which in turn can be reimbursed for various gifts and memorabilia.

The West Bengal government has also envisioned a blockchain-based web application where land title ownership records will be successfully stored in an immutable distributed ledger. The smart contract will automate the fee calculation process as well as reduce human intervention.

Major initiatives envisioned or implemented by the West Bengal Government using blockchain technology

- **Land registration through blockchain**
- **Blockchain-based solution to increase the transparency of crowdfunding transactions**
- **Blockchain-based loyalty programme to encourage citizens to participate in a social media network**
- **Blockchain-based hotel check-in registration system**
- **Electronic human records**

An interview with Debashis Sen (Additional Chief Secretary, Department of Information Technology & Electronics, Government of West Bengal):

1. Tell us how blockchain technology is going to assist the Government of West Bengal in achieving some of its goals.

A: The West Bengal government's plan for adopting blockchain technology will help us to be prepared for the future. It will create an ecosystem around the emerging technologies in this state.

It will also help us apply this technology to various areas of e-governance practices, including land management, registration of births and deaths, taxation records of citizens, improvement of public infrastructure through crowdsourcing, and creation of a framework for transport and traffic.

2. What do you see as some of the top challenges the state needs to overcome for the successful adoption of blockchain technology?

A: Lack of skill to implement the technology and cost of transition from conventional cloud-based data management to blockchain are the top two challenges I see at this point.

3. How are you planning to improve skill development in the state in order to foster blockchain technology?

A: We are tying up with Indian Statistical Institute (ISI), Kolkata, to create a Centre of Excellence for sustained efforts in promoting a culture of blockchain in Bengal. In addition, through knowledge workshops, product displays, social media and a continuous dialogue, we are trying to create the necessary ecosystem in the state.

4. How prepared do you think citizens and government employees today are to embrace advanced technologies like blockchain?

A: Most interfaces are very interactive and easy to understand. The municipal official need not understand the intricacies of blockchain to register births, marriages and deaths through a user-friendly app-based interface. So, I do not see any obstacles in embracing the technology.

Potential benefits of blockchain for West Bengal: A few select case studies

The West Bengal government can continue its blockchain journey by leveraging the technology's potential across a number of citizen-centric services. It can use blockchain to manage the complete lifecycle of a citizen's interaction with the government. By doing so, the government can effectively manage benefits and welfare programmes as well as the public distribution system. The other important areas where blockchain can be applied are land registration, food supply chains, and microfinance, to name a few.

According to PwC's survey on blockchain in West Bengal, the top two areas where blockchain can provide the maximum benefit are transparency in public distribution and land registration.

According to you, what are the top areas of citizen services on which the West Bengal government should focus for blockchain implementation?

Top two responses:

- **Transparency in public distribution system**
- **Online leasing and licensing for land registry**

Source: Webel and PwC's survey on blockchain in West Bengal, 2018

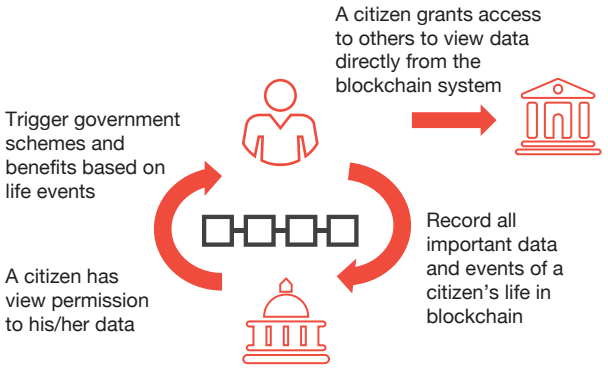
In the following section, a few select cases where blockchain can be used in West Bengal to benefit citizens are discussed.

Integrated citizen lifecycle management

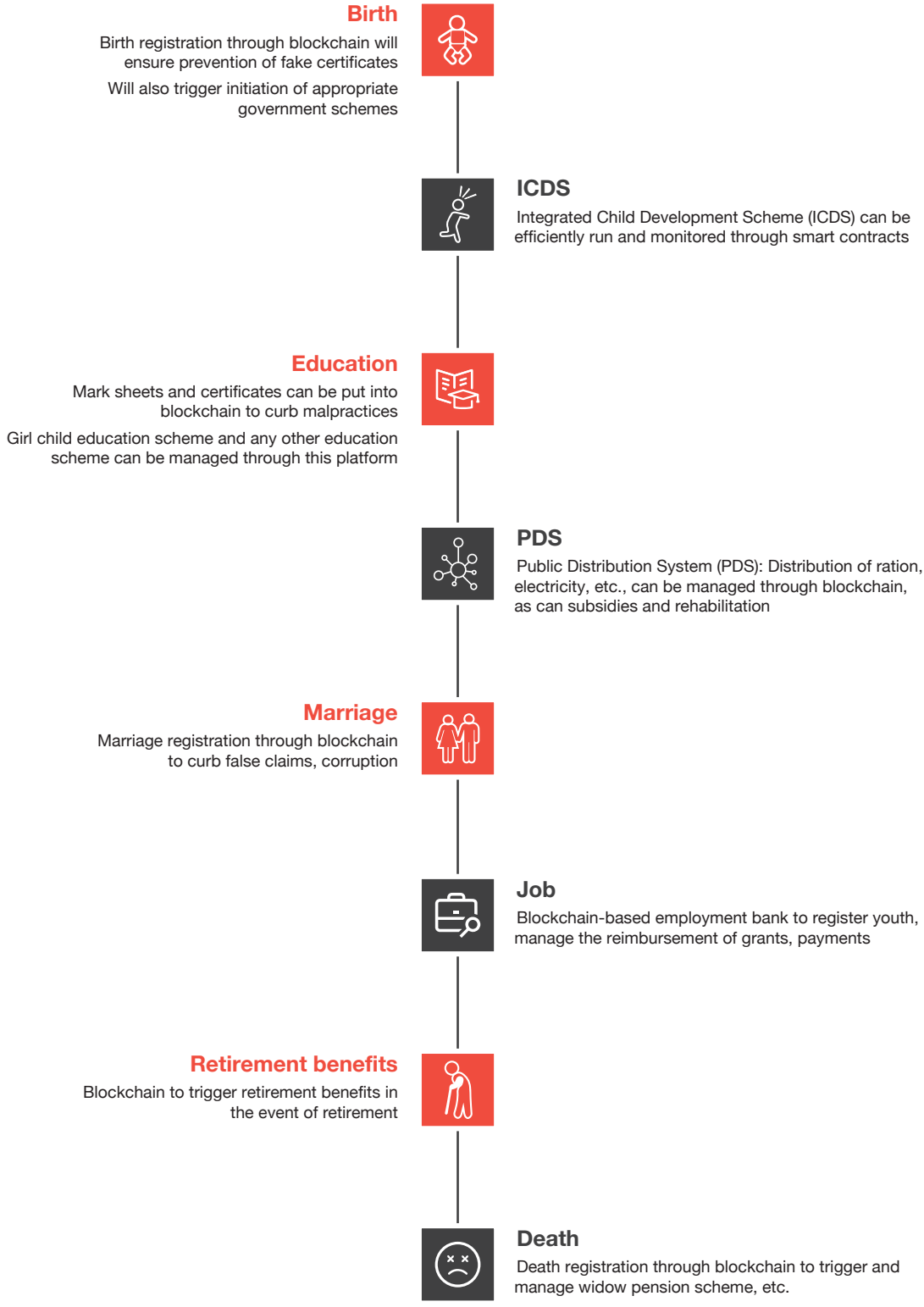
Blockchain can be used to effectively manage the entire gamut of the citizen lifecycle, whereby a blockchain-based platform can be used to record all important records of a citizen's life. This will help the government to run and manage different government schemes much more efficiently and effectively.

This platform acts as a trustworthy source for the government to distribute benefits and subsidies. Thus, it reduces intermediaries and brings more transparency. Also, any government department or private enterprise can use the system to view an individual's personal records through a request instead of performing a costly verification process or relying on the documents handed over by the person.

Integrated citizen lifecycle management – how it will work



Different stages of a citizen's life and events captured



How integrated lifecycle management can be used for citizens' benefit

Curb fraud and counterfeit	Since all data registered in blockchain is immutable, the record becomes the source of truth. Any fraud and counterfeit can easily be detected and rejected. This will bring transparency in governance.
Government benefits distribution	Government benefits can automatically be triggered by smart contracts when a certain event meets its eligibility criteria in the blockchain system. Kanyashree Prakalpa, a UN-recognised scheme of the Government of West Bengal, provides benefits to unmarried girls aged 13–18 years who meet certain criteria.[13] With records of the girl and her family in the blockchain, the system will be able to automatically validate her eligibility for Kanyashree and trigger benefits for her when she reaches the appropriate age.
Information availability	At different stages of a person's life, educational institutions, companies and various other entities need to validate a person's information such as educational qualifications and previous job details. This information can be directly retrieved from the blockchain system by those who need it, provided the individual grants access to it.
Flexibility to upload attested documentation	At distinct stages of a person's life, an issuing agency outside the blockchain platform may issue different types of certificates, such as an education degree obtained from a foreign university. The platform can work as a reliable storehouse for attested copies of such credentials. Citizens can obtain attestation from competent individuals through the blockchain platform and subsequently store it there for authenticated agencies to view and verify.

Financial assistance to small business and farmers

West Bengal is an agricultural state. The state is the highest producer of rice[14] and the second highest producer of potatoes in India.[15] Comprising only 2.7% of India's geographical area, it supports nearly 8% of its population.[16] A big base of micro, small and medium enterprises (MSMEs) is present in this state, too. Farmers and small businesses often look for small loans to operate and grow their farm or business. For such small loans, farmers and small businesses generally approach microfinance institutes (MFIs).

Since MFIs serve as a medium for financial inclusion of farmers and small businesses, it is important that governments properly regulate them to ensure that they are not driven solely by financial motives but also play a larger role in society. Blockchain can help by bringing transparency and enabling the government to regulate MFIs.

Farmers can be assigned a digital identity provided by the blockchain system. The underwriting of loans by MFIs will have to go through a validation and consensus process before getting added to the blockchain. The government, as a regulator, can take part in this consensus process. Once the data is entered into the system, it cannot be altered; thus, the same data can also be audited by regulators.

For MFIs, the KYC process adds to the cost of underwriting loans. For microcredits, such a fixed cost can translate into a higher interest rate. Having a digital identity in a blockchain can enable all MFIs to refer to the same authentic data and loan payment history. This can reduce the cost of KYC and, therefore, the interest rate.

The state government can bring MFIs operating in the state within the ambit of such a blockchain system. Any fresh lending, interest payment and KYC process can happen through this platform. The platform can then provide transparency to all regulators, starting from local authorities to the Reserve Bank of India. Moreover, the state government's schemes to support self-help groups and self-employment can also be conducted through this platform.

13. https://www.wbkanyashree.gov.in/kp_faq.php
14. http://mospi.nic.in/statistical-year-book-india/2017/177
15. http://www.wbagriculture.com/
16. https://wb.gov.in/portal/web/guest/agriculture

Land registration and records management

Land registration is considered an important parameter for the development and economic growth of a region. Proper registration of land is important for borrowing and business investments.

Land records stored in digital or physical form are susceptible to manipulation by groups with vested interests. It is estimated that over 70% of the people in the world who own land have a tenuous title against it.[17] Blockchain can ensure transparency and trust around the land registration system.

Benefits of blockchain use in land registration

Conclusive titling	Due to the 'presumptive nature of land property ownership' in many countries, it is very difficult to reliably establish a trail of ownership of immovable properties. This puts the onus on the buyer or the recipient to be diligent while establishing provenance. Blockchain implementation may enable the government to move from a presumptive titling to conclusive titling system.
Enhanced security of land records **Tamper-proof land records leading to enhanced transparency**	Effective implementation of land registration and record management on blockchain can lead to tamper-proof and immutable land records. It will help in eliminating centralised land records, thus dramatically enhancing transparency.
Enhanced transparency	A distributed, auditable, tamper-proof land records management system will lead to enhanced transparency.
Elimination of information silos	In countries like India, land records are maintained and administered by more than one department, all of which operate in silos. Effective implementation of blockchain can provide a comprehensive view of land records information to multiple parties in the blockchain network.
Enhanced process efficiency	Effective implementation of blockchain can help in automating multiple processes and eliminating non-value adding intermediaries. This will lead to increased process efficiency such as reduced time of registration. It may also lead to paperless, cashless and faceless land registration and record management.
Reduced property disputes and unsettled civil cases	A blockchain-enabled conclusive titling system can help reduce the number of land/property frauds. Each property is uniquely coded and linked to a smart key which will be held only by the owner. This will bring down disputes and the number of unsettled civil cases in the judiciary system related to property ownership.
Favourable business environment	Generally, clean and trustable land titles enable investment. A blockchain-based system can enable inherent trust in the land records maintained by the government. This will improve ease of doing business in the country.
Improved tax management by the government	Conclusive titling and blockchain-based efficiency can help in reducing the administrative burden of monitoring and collecting land-related taxes. Smart contracts can cut down the costs associated with collection of taxes. Further, the overall visibility and traceability of the tax management system will increase.

17. https://www.pwc.in/assets/pdfs/publications/2018/blockchain-the-next-innovation-to-make-our-cities-smarter.pdf

Land registration process automated and recorded by blockchain

Buyer/seller

Pay stamp duty through e-stamping and log into the registration portal to upload all relevant documents (including e-stamp duty receipt)

Relevant land registration authority

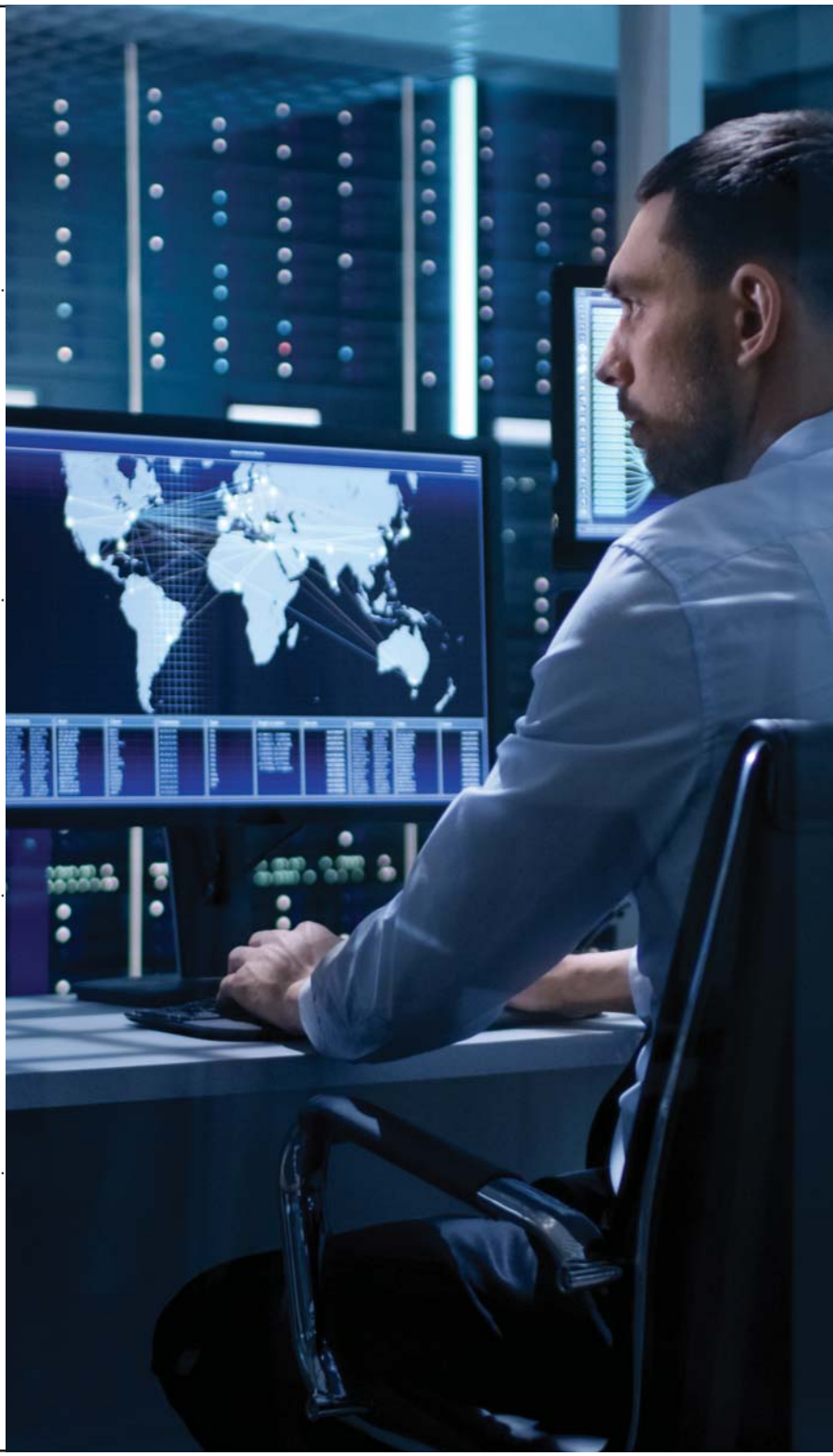
Form is forwarded to land record authority who verifies the documents uploaded

Registrar

Forwarded to registrar office after verification

Assessment and verification of information in the form. If verified, issue certificate with digital signature

Registration certificate is issued and the form is saved as a unique record in blockchain



Source: PwC report on 'Blockchain: The next innovation to make our cities smarter'

Automated trust in the safety of food

The quality and safety of food are often questionable nowadays. However, the food supply chain is a very large operation which is difficult to monitor if not automated properly.

Further, with increasing consumer demand for transparency in the food supply chain, producers and manufacturers struggle to provide accurate data from farm to table. Unfair pricing due to price extortion, delayed payments, the presence of middlemen and high transaction fees are some other challenges that exist in agriculture supply chains. Additionally, food shipping and logistics are complex and at times require intra-continent supply chains. Such supply chains involve dozens of personnel and hundreds of interactions with high probabilities for human error.[18] Blockchain technology promises to improve traceability and transparency within agriculture value chains.

At present, the food safety regulations are mostly enforced by inspections. But there are simply too many factors that can affect food safety – raw materials used by food processing companies, production processes of these companies, and condition under which food are transported or stored in warehouses. Frequent inspection of the complete supply chain is nearly impossible and extremely expensive. Moreover, manual inspection has limitations in terms of transparency in process and data.

Technologies like IoT, AI and blockchain can help solve the above challenges. The combination of these technologies can automate trust. IoT can ensure that all the parameters related to production and transportation, such as weight, time, location, temperature and humidity, will get entered into the system automatically. This will eliminate fraudulent practices during data entry. Blockchain will ensure that the data entered is being accepted through a verification and consensus mechanism and becomes immutable.

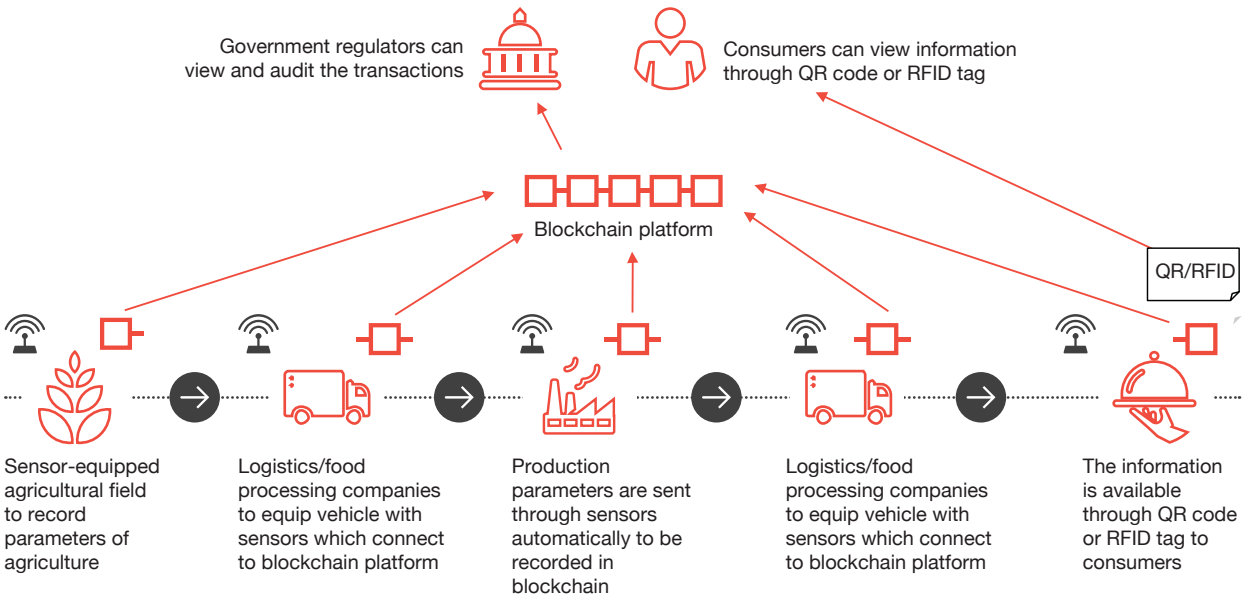
The system will make the entire supply chain data transparent to regulators, who can audit it anytime. Moreover, if any production parameter does not meet regulatory standards, the system can raise an alert based on the underlying AI-based logic of the system.

By increasing the probability of detecting any malpractice significantly, such a system will reduce its chance of occurrence and in turn ensure food safety.

Companies can also make selected information available to consumers through QR code or RFID tag as a trust- and relationship-building measure.

This model will work only when all the parties in the food supply chain are equipped with sensors connected to an IoT platform and blockchain system. The government can encourage food processing companies, logistics companies and all other parties towards this end either through legislative enforcement or by offering incentives, subsidies and training programmes to farmers and small businesses to adopt this practice, or a combination of both.

Automating trust in food supply chain to ensure food safety



18. https://www.pwc.in/assets/pdfs/publications/2018/blockchain-the-next-innovation-to-make-our-cities-smarter.pdf

Managing contests and participants' opinions

In West Bengal, a company has created a blockchain-based platform to capture people's opinions. Recently, they used this platform to select the winners of a contest held during Durga Puja. The company shared the results of the poll with the Government of West Bengal and assisted it in selecting the winners, who were felicitated at the annual carnival.[19]

Usage of blockchain in a contest management system makes the poll results immutable. Blockchain-based contest and poll management systems have wider application for gathering public opinion on a variety of topics.

Automated trust in executive decision making

Blockchain enables trusted decision making in the public sector. Integrity of data, a key driver for trusted decision making, is ensured through blockchain. Moreover, smart contracts can automate approval processes based on certain parameters and built-in intelligence, which automates manual decision making.

Decisions like granting citizenship can become more trusted if the entire history of a citizen is made available on a blockchain. Data analytics can be used on the data captured through blockchain for future policymaking.

Skill development of available talent pool

West Bengal has a large IT sector. Total exports from the state's IT sector are estimated to have crossed INR 19,000 crore (US$2.83 billion) in 2016–17.[20] The government's blockchain initiatives will help the talent pool in this sector to develop blockchain-related skills, besides building up transparent systems for better governance.

Blockchain and its associated technologies are quite new and emerging. Therefore, not all IT professionals are trained to work on them. The Government of West Bengal plans to set up a 'Blockchain Centre of Excellence' with the assistance of the Indian Statistical Institute (ISI) Kolkata. The main participants in the Centre of Excellence would be the government, technology companies and start-ups of the state.

This can be a differentiator since lack of skills is one of the commonly faced bottlenecks for blockchain implementation. A recent news report[21] stated that only 1 out of every 400 Indian developers was skilled enough to work on blockchain.

West Bengal's IT policy[22] emphasises the state's commitment towards large-scale blockchain adoption, with a broader vision of positioning the state as a hub of such emerging technologies. Since March 2018, DIT&E has already conducted seven knowledge workshops on these emerging technologies, including one on blockchain.

Quite a few technology companies have begun setting up their blockchain centres for research and development in the state, and this is expected to further aid skill development.

Easy availability of blockchain-related skills will help other industries grow in the state. Blockchain has a big impact across industries such as financial services, healthcare, retail and logistics. Companies from these industries will be able to take advantage of the readily available talent pool to embrace blockchain solutions for their business.

The financial services sector has been one of the major adopters of blockchain technology, and companies in this sector will find a local talent pool of blockchain experts valuable. This ties in well with the plan of the West Bengal government to build a major financial hub in Kolkata[23] which is expected to benefit the state by attracting more investment.

How do you think the West Bengal government can catalyse blockchain adoption?

Top three responses:

- **Sponsor training on this technology**
- **Create a Centre of Excellence**
- **Adopt this technology to deliver citizen services for building skills**

Source: Webel and PwC's survey on blockchain in West Bengal, 2018

19. https://hackernoon.com/why-do-voting-systems-need-blockchain-e85e747e906d
20. https://www.ibef.org/states/west-bengal.aspx
21. https://economictimes.indiatimes.com/tech/software/one-out-of-every-400-indian-developers-can-work-on-blockchain-research/articleshow/64099262.cms
22. https://www.webel.in/assets/newsletter/IT_Policy_2018/
23. http://digitalindia.gov.in/writereaddata/files/West%20Bengal.pdf

Employment generation

Like all new technologies, blockchain also brings its own set of promises with respect to job creation. As the governments of West Bengal and other states work towards building a platform for automated trust, there are opportunities to create new types of jobs.

For one, blockchain initiatives by the government will create jobs for blockchain professionals in IT and technology consulting organisations as technology strategists, architects and developers. Public and private companies that are implementing blockchain will need skilled professionals to run a blockchain implementation programme and to oversee operations after it is implemented.

Additionally, these professionals will find employment in technology fields such as cyber security, cloud computing and analytics as well.

Finally, the blockchain revolution is a good opportunity to spark entrepreneurship in the state. Blockchain initiatives by the government and subsequent adoption in the private sector will boost the growth of technology start-ups.

Top challenges of blockchain adoption in the region

As per senior executives from public and private sectors who participated in the survey,[9] the top three challenges of blockchain adoption are lack of adequate skills, lack of clarity regarding effective use cases and issues related to stakeholder collaboration.

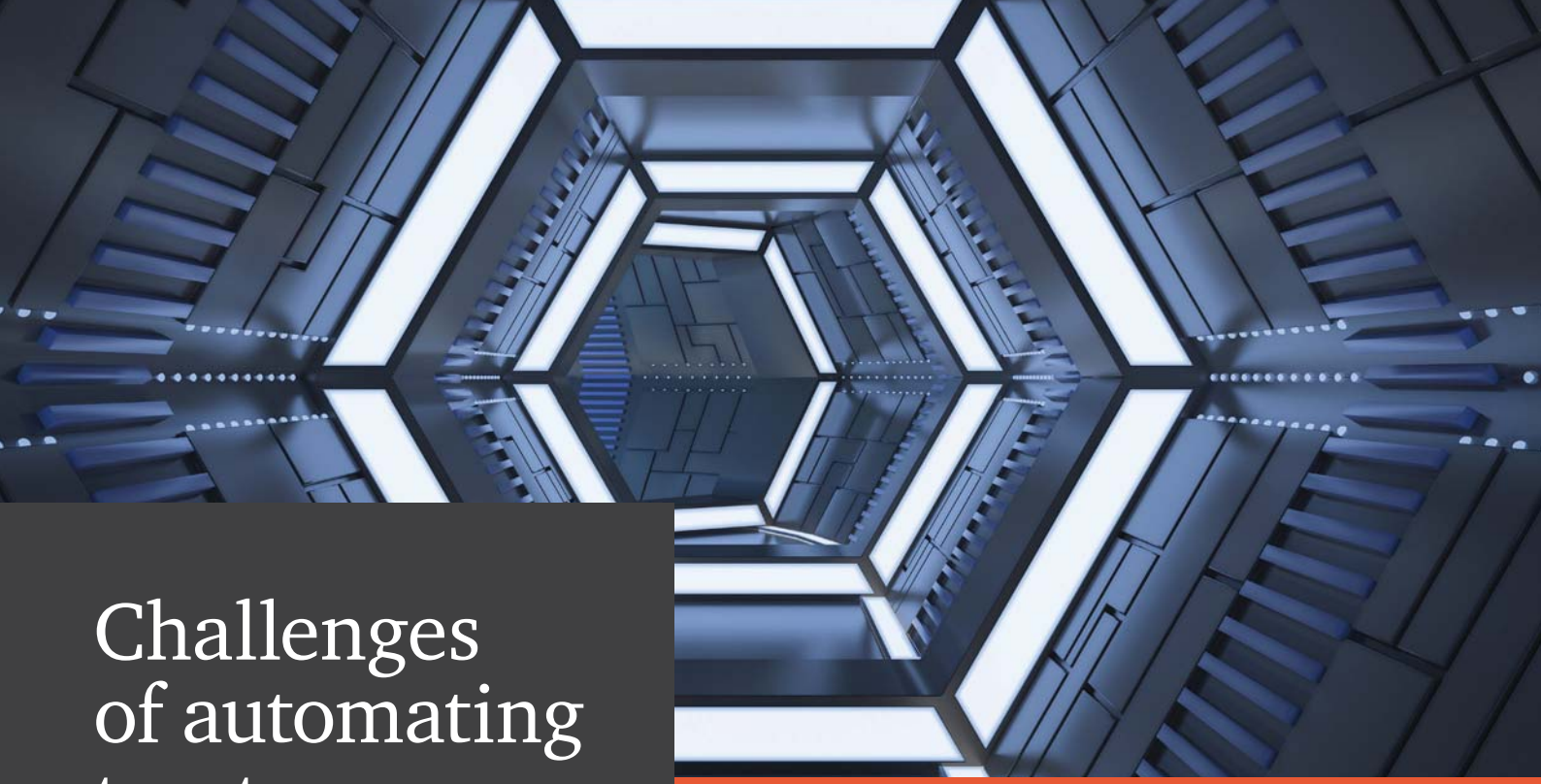
Since the technology is yet to witness large-scale adoption, the return on investment and effectiveness of the use cases are not always readily available. Similarly, finding the right skills in the job market to implement this technology is a challenge.

What do see as the top challenges in blockchain adoption?

Top three responses:

- **Lack of adequate skills to implement this technology**
- **Effective use of this technology is not yet clear to many leaders**
- **Bringing all stakeholders together for a successful implementation**

Source: Webel and PwC survey on blockchain in West Bengal, 2018



Challenges of automating trust

Blockchain is a technology that will disrupt many sectors, including the public sector. However, the technology has certain limitations, and understanding these will help in designing better blockchain solutions.

Regulatory challenges

Regulations that protect privacy can pose a challenge to the usage of blockchain technology. Recently, the General Data Protection Regulation (GDPR) has provided ordinary EU citizens the right to be forgotten. The individual can exercise this right by requesting for erasure of his/her data. It also makes it obligatory for an organisation to delete an individual's personal data when such a request is received. This goes against the fundamental architecture of blockchain which is based on immutability of data.

Therefore, while designing a blockchain solution, careful consideration must be given to sensitivity of data, regulatory requirements and roles of various participants.

In addition, in case blockchain solutions are spread across various countries and jurisdictions, it is often difficult to figure out the jurisdiction or regulations that will be applicable since the same digital ledger will be replicated across all the nodes.

Cyber security related challenges

From the cyber security perspective, there are factors to be ascertained while setting up a blockchain system. One of them is the security level of the platform. While using third-party platforms for blockchain, it is important to consider the vulnerability of the platform.

If the cryptographic keys that blockchain uses are stored on an insecure platform, a cybercriminal could get hold of them through conventional means. That person can then impersonate someone in the entire blockchain.

A permissioned blockchain, which is often a suitable model for a company, a consortium of companies or for governments carries its own challenges. The threat often depends on who the authorities that grant permission to other people are and how the system ensures that the validators are who they claim to be. The ability to secure the ecosystem surrounding the core blockchain system is of utmost importance.

Challenges pertaining to fraudulent data entry

Once data is entered into a blockchain, it becomes immutable and cannot be tampered with. But the technology itself cannot verify the correctness of the data being entered, as this takes place through a consensus mechanism. In a private or consortium blockchain, a consensus can be reached if a certain number of nodes agree to put the data in the chain. So, if the actors are not carefully designed in the blockchain, it is possible for a group of actors to create a coalition, enter fraudulent data into the blockchain and achieve consensus.

There may be cases where it is not possible for the other parties in the blockchain to validate the records coming from one party. If a company is entering the production parameters for its product into a blockchain, it is not possible for any of the other companies in the consortium to validate this information without an inspection. In these cases, automating trust is the best way to ensure that the data directly comes from sensors and IoT platforms without manual intervention.

Conclusion

Blockchain is a promising technology that can revolutionise governance in the digital age. While various research reports have suggested the huge growth potential of the Indian blockchain market, it is important to recognise that this technology is not a cure-all. Rather, it is an effective and versatile instrument in the hands of the government to ensure better, and perhaps personalised, service delivery to each citizen of the state. West Bengal's IT policy[24] is rooted in the state's vision of promoting itself as a hub of such emerging technologies, especially blockchain. As part of its strategy to achieve this vision, in March 2018, DIT&E conducted a day-long knowledge workshop on blockchain.

If the Government of West Bengal implements blockchain-enabled G2X services, it will be necessary to ramp up the talent ecosystem in the state so that a steady stream of blockchain technologists is readily available to develop such products. Towards this end, DIT&E plans to set up a 'Blockchain Centre of Excellence' with the assistance of ISI Kolkata. This Centre of Excellence will play the role of an ecosystem builder. With such ecosystems in place, it is expected that the existing IT workforce within the state would be able to reskill and align itself to the market demand. This initiative also presents an excellent opportunity to the youngsters of the state to skill up and develop newer products, thus enabling the demographic dividend of the nation to be leveraged. As the state continues to develop its blockchain capabilities, its unique location as a gateway to the North East and easy access to South East Asia would also play a major role in shaping its position as the blockchain destination of the East.

Though blockchain is an emerging technology, it definitely isn't a fad. In fact, researchers believe that blockchain is currently at the innovation stage on the 'diffusion of innovation' curve in terms of its application in multinational enterprises. However, with major firms investing in the technology, it is expected to reach an inflection point, similar to the Internet in the 1990s.[25] In sum, by virtue of its underlying design principles, blockchain is a potent tool which can be used by the government to enable faster, better and more citizen-friendly services to the masses. Without a doubt, blockchain is here to stay.

24. https://www.webel.in/assets/newsletter/IT_Policy_2018/
25. https://scholarworks.lib.csusb.edu/jitim/vol26/iss2/4/

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