



## DIGITAL TRANSFORMATION WITH BLOCKCHAIN TECHNOLOGY – ACCOUNTING AND AUDITING



**CMA (Dr.) Paritosh Basu**  
Senior Professor  
NMIMS School of Business Management  
Mumbai  
[paritosh.basu@sbm.nmims.edu](mailto:paritosh.basu@sbm.nmims.edu)

### Introduction

**A**ccounting in common parlance is the process for identifying, measuring, recognising, recording, and reporting economic events to facilitate informed judgements and decisions by internal and external stakeholders. Four frameworks, viz., Conceptual, Institutional, Regulatory and Legal, are followed for establishing authenticity, fairness, relevance, reliability, and integrity of financial information. The said second framework is structured by various accounting standards as crafted by apex accounting institutions befitting the dynamics of emerging business ecosystem and country specific needs, and finally recognised in the related laws of respective countries.

Like any legislated law or regulation, historically the first two frameworks of accounting also owe lineage to practices followed by people. Researchers have established that Franciscan Luca Pacioli, considered as the 'Father of Accounting', did not

ideate, or invent double entry accounting system. In his book (1494) titled '*Summa de Arithmetica, Geometria, Proportioni et Proportionalita*'<sup>1</sup> he simply described the methods practised by Venetian merchants for keeping transactional records during the Italian Renaissance period. The first accounting book was one of the five sections in Fra Pacioli's mathematics book and the only textbook available till the 16th century for accounting.

Many present-day institutional frameworks, as opined by researchers, also stand on the foundation laid by Fra Pacioli. Albeit ERP oriented accounting systems like SAP, Oracle Financial, etc. have reduced rudimentary tasks for book writing, human interventions continue to be a must for reviewing, monitoring, and reporting. SOPs for minimising certain operational and financial risks can be embedded while configuring ERPs, yet one can still not conclude with conviction that accounting has gone through digital transformation worth reckonable. The tasks for ensuring internal controls for financial reporting (ICFR), as assigned by sections 134, 143 and 177 of the Indian Companies Act, 2013, in similar lines of Section 404 of the Sarbanes Oxley Act, 2002, USA, are still to a large extent dependent on human interventions.

### Literature Review

The author has studied since 2016 many research papers of academic scholars; publications of global professional organisations like IBM, Gartner, Deloitte, PwC, EY; and university level academic institutions like MIT, Harvard, Oxford, etc. Their findings and conclusions have been quoted in many of his earlier articles under this column. References (URLs) of those articles have been provided below under the segment 'Blockchain Technology Revisited'. Due to limitation of space those are not being repeated here.

It will be pertinent here to note conclusions of Aleksy Kwiklinski in his seminal paper<sup>2</sup> that, "*The Blockchain technology*

*aims to put an end to traditional methods of billing, documenting, processing, registering, inventory systems, and paying for business. The introduction of the blockchain technology (or its more advanced technological counterparts) will allow synchronizing accounting records between contractors, which will allow for ongoing automated audits. The emphasis will be shifting to questions that will require the auditor's own judgment: complex non-standard operations, effective internal control mechanisms, analytics and forecasting, IT audit, assessment".*

According to a report by Deloitte, Germany<sup>3</sup> "Digitalisation of the accounting system is still in its infancy. .... Some of the reasons may be found in the exceptionally high regulatory requirements in respect to validity and integrity. The entire accounting system is built, such that forgery is impossible or at least very costly. Among other things there are systematic duplication of efforts, extensive documentations, and periodical controls. Most of them are manual, labour intensive tasks and far from being automated."

None can deny that "To err is human." Again, history of human civilisation is not without black spots of financial frauds and forgeries. Therefore, whenever any system and process are crafted with deliberately designed scope for human intervention, none can ensure that there would not be any instance of human error, fraud, and forgery post its implementation. Therefore, according to the present author any attempt for digitalisation of accounting and reporting should ensure that bare minimum, if not nil, scope is left for such risky instances creeping in to distort and vitiate the entire systems and processes. Summation of relevant conclusions drawn from literature surveyed prompts to infer that Blockchain technology is the ideal solution for this out all those presently available.

## Objective

Keeping in view the above discourse one of the major objectives for digital transformation of accounting must be to ensure that none of the four frameworks of accounting and reporting are compromised, yet at the same time the errors and distortions due to human interventions are obviated. Additionally, relevance, reliability, and integrity of transactional records and reporting therefrom must further be enhanced simultaneously with improvements in speed and documented authenticity of financial

information generated from transactional and accounting records.

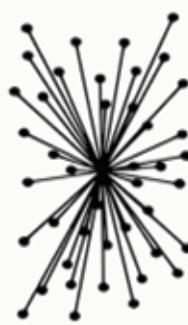
Therefore, the first and foremost objective of this article is to explain how blockchain technology, with distributed data storage management systems (DDSM), can be of help achieving all these. Efforts would also be made to bring out how blockchain technology can assure user organizations, their auditors, and stakeholders all the above features of financial accounting with near zero error possibility. This article would also explain how blockchain platforms can automate and digitalise the processes of recording each transaction, with or without involvement of financial value(s), and minimise various risks of fraud and forgery as well as reporting risks by complying with all the said four frameworks of accounting.

This article would also bring out how a blockchain a platform can ensure only one version of truth and minimise any subsequent distortion or deletion by reducing human interventions. The method for digitalising of the entire process of handling transactions, duly driven and directed by digitally embedded smart contracts, and the process for integrating blockchain platforms with the accounting platform like SAP, will also be narrated.

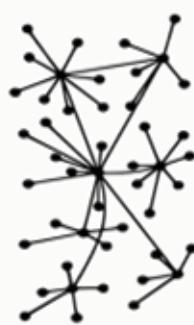
## Blockchain Technology Revisited

### Decentralised Technology

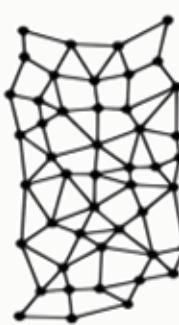
The author has in his several earlier articles narrated various features of blockchain technology<sup>4</sup>, use of smart contracts for transactions executed through blockchain platforms<sup>5</sup>, advancements in applications of blockchain technology<sup>6</sup>. Three articles have also been written by him on comprehensive applications of this technology for agriculture<sup>7</sup>, healthcare services<sup>8</sup> and crowd funding<sup>9</sup>. In the last three articles he has ideated how other digital technologies, like AI, Robotics & RPA, IoTs, AR & VR, Drones etc., can also be integrated with blockchain as the main platform for adding versatile capabilities and end to end delivery of services. Interested readers may go through those to know more. For the limited purpose of this article the fundamentals of Blockchain Technology (BT) which is also synonymously known as Distributed Ledger Technology (DLT) will be revisited, from the predominant purpose of accounting and auditing in the following lines.



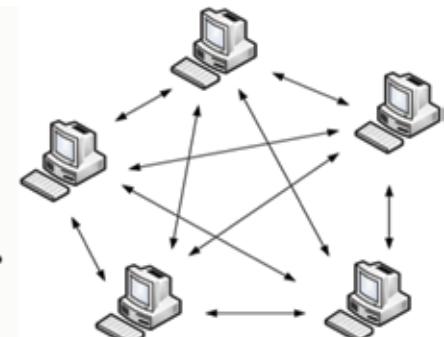
1. Centralised



2. Decentralised



3A. Distributed



3.B Interconnected Nodes in DLT

Source: 1, 2 and 3A: <https://www.semanticscholar.org/paper/Organizational-Networks-as-Catalysts-for-Strategic-Doyle-Hikisch/c254328d7977cac03ddd8b00111c342fc18d3f51>

3B:<https://www.semanticscholar.org/paper/A-Peer-to-Peer-Network-Framework-Utilising-the-Blunn/4d72b0dcfcb87231dc1f7d2bfb3834bcc1af48bc>

Information and communication technologies (ICT) can broadly be divided into three groups, viz. Intelligent, Digital and Mesh. The aspect of networking between computers comes under the third group. Computerisation during 1960s hardly had any networking facility. There used to be a centralised technology in which all records and data used to be stored at one central server, albeit inputs were possible to be inserted from computers of at different locations into the centralised record keeping facility. As is evident from the first graphic, none of the individual computers could connect with each other.

In the second stage of development came the facility of hub and spoke model with more than one sub-central storage system which in turn used to relate to the central storage system. In this decentralised system individual computing devices continued to remain outside the network, i.e., one computing device could not connect with the other. Hence for both the systems there used to be a need for a central administrator. Blockchain technology or DLT established the Mesh form of ICT in its truest sense. The computing device of each participant, technically known as a Node, is individually interconnected to each of the other Nodes participating in transactions being processed through a Blockchain Platform (BP). And hence, it is called a Mesh Architecture of Systems and Apps (MASA).

There is no need for any centralised storage of transactional records for a BP because each node has facilities to store all data and references thereof of all connected parties. Moreover, there is no role of any administrative activities at a central level except for maintenance of devices hosting the data associated with the BP at the local node level. This task would include the operating system, codebase, scripts and associated embedded smart contracts. Transaction-specific documents in digital form, which are required to be maintained as evidence(s), can be stored in a central cloud-based document management system (DMS). Such a storage system can be designed to be administered by the BP itself using encryption tools. The participants, involved in the transaction, and other connected parties, would be able to retrieve, view and download the same on a ‘need-to-know and do’ basis as defined in the smart contract and further

explained below.

According to a publication of Gartner Research<sup>10</sup>, an eminent technology research, advisory organisation “*Evolving business needs require application architecture that enables agility, flexibility, integration and innovation. MASA — a mesh architecture of apps, APIs and services — provides application technical professionals delivering applications with the optimal architecture to meet those needs. .... Most importantly, they should build new skills in areas of modern software frameworks, hybrid platforms and continuous delivery and integration.*” Digitalisation of accounting and reporting using blockchain platforms can meet these recommendations of Gartner as is evident from the above discourse and the quoted articles of the author.

### **Self-audited Wallet for Each Node and Smart Contract**

Each participating individual and/or entity can access the BP from their respective devices using an assigned Private Key and will be known to all other participants by a differently assigned Public Key. Hence there is no need for disclosure of any name, phone number, mail ID, etc. Such identity-oriented information, however, must have to be submitted at the time of gaining permission to participate in the BP from the BP Administrator. Such a process is called know your participant (KYP). The designed solution architecture of a platform crafted with the application of Blockchain technology in a mesh-network environment facilitates the following for each participating Node.

⦿ **Nodal Wallet:** This is a software that is installed in the participating Node for the purpose of engaging with the blockchain platform and contains the cryptographed details of all non-financial and financial transactions, right from expression of intent to execution and settlement by participating parties.

⦿ **Smart Contracts:** All transactions are contractually agreed and executed by all relevant participating Nodes in compliance with the terms and conditions (T&Cs) of one or more Smart Contracts (SCs) which drive and govern the transactions. SCs are embedded digital frameworks, in duly coded form, and digitally signed for recognition as a legally binding contract by

and between two or more parties. All transactions can be digitally executed subject to meeting T&Cs as drafted in the respective SCs. Such T&Cs are also considered while writing scripts and coding the BP to ensure that no transaction can pass through if any T&C is violated. SCs are drafted in total compliance with the concerned provisions of the related Laws, Regulations and Accounting Standards of all countries if the transacting parties are from more than one sovereign nations. Before adopting for any BP, eminent functional experts, lawyers, and accountants scrutinize and approve the SC. Thus, SCs serve as the backbone of the BP binding all parties. The author’s interactions with eminent professionals reveal that digital and consulting giants like IBM, Microsoft, JP Morgan, Morgan Stanley, etc. are working for creating libraries for SCs which can be adopted by BP developers with suitable modification as needed.

⦿ **Reference of Evidence and Documents:** Maintenance of reference keys for all documentary evidence, linked to any transaction, which the participating Node operator can retrieve from the storage of the BP’s DMS and act on by view and/or further propagating as per the accepted workflow. For this her/his private key and the public key(s) of the other transacting party(ies) are to be used. The DMS is administered and controlled strictly following the features of blockchain technology, including encryption.

It must be noted here that each block of transactions and related records of any blockchain technology-based platform, which are cryptographically secured using complex algorithms, are immutable. Those cannot be altered and deleted by any party. Any correction, if needed, are to be inserted by a reversed set of transactions.

⦿ **Integration of Wallet with ERP for Accounting:** The Wallet at each Node can be integrated with the ERP System(s) of the Node’s legal entity using a suitable tool called Application Programme

Interface or API. The objective is to seamlessly extract all transaction-wise quantitative and financial data from the Wallet, transform and load into the accounting and other quantitative records without any human intervention. For the second set of jobs appropriate ETL tools can be used. Reverse flow and implanting of transactional data from the ERP system to the BP can also be digitally programmed via the wallet software at the Node.

All these would in turn help in creation of accounting records like financial ledgers, etc. to be followed by preparation of financial statements and reporting. Accounting records can also be reconciled by any party vis-à-vis that of the opposite party(ies) of the same transaction(s) as any of the parties would also be able generate details of both sides of the transactions using the related public key of the other party.

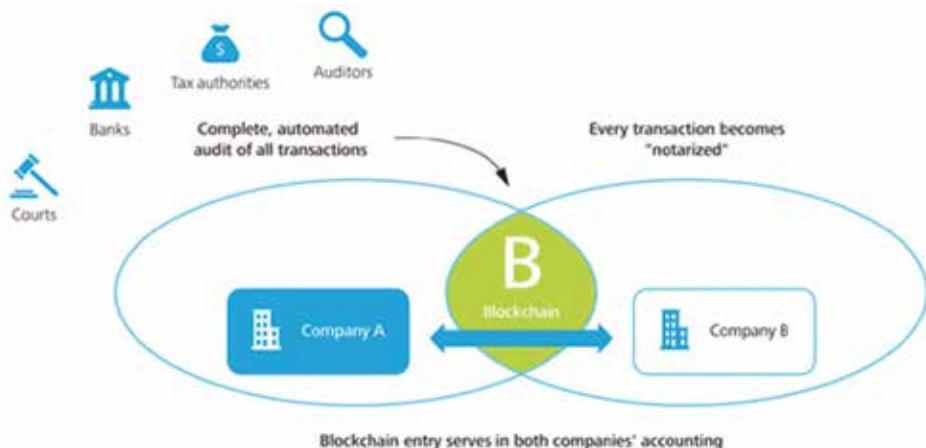
The reader might have by now realised that such a process would also satisfy the double entry system of maintaining books of

accounts. Moreover, all principles of accounting in compliance with given GAAP and Accounting Standards of the related country can also be ensured because the coded script of the BP has already taken care of the same for generating transactional information. The entity would also be able to integrate their ICT systems for generating management information for both internal and external stakeholders. Operational data, reports documents and other evidence can also be extracted for conducting analyses using Big Data Analytics and AI. This has more been explained in the following section while describing the case of a BP for delivery of health care services.

⑤ **Self-audit and IFC FR:** The above binding features of a BP strictly ensure complete compliance with T&Cs of the related Smart Contract, which have already been drafted in compliance with all the relevant provisions of all applicable Laws, Regulations and Accounting Standards. Such a feature of BPs prompts Deloitte<sup>11</sup> to conclude that

*"Stakeholders place their trust in the auditors retained by management to vouch for them. An obvious problem of agency is created by this arrangement: Do auditors work for the managers who hire and pay them or for the public that relies on their integrity in order to make decisions? .... Blockchain technology enables complete, conclusive verification without a trusted party." Here the referred trusted party seems to be the external statutory auditor, which by itself is a source of risk under agency theory,*

Thus, dependence on an external auditor for testing and establishing reliability and integrity in financial information related to operating transactions if an entity uses a BP. Such inherently embedded controlling and monitoring features of a BP also can help the functional leaders and Board of Directors of an entity to certify that there are adequate internal operational and financial controls for financial reporting (IFC FR).



Source: [https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Innovation/Blockchain\\_A%20game-changer%20in%20accounting.pdf](https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Innovation/Blockchain_A%20game-changer%20in%20accounting.pdf)

The above graphics used by Deloitte in their literature, titled “Blockchain Technology - A game-changer in accounting?”<sup>10</sup> indicates that a Blockchain technology-based platform not only help completely automated method for executing and recording transactions with consent of all, but it also helps self-auditing of those. All these features are in turn essential requirements for any efficient and effective accounting and

reporting system with much needed integrity. The author has made efforts in the above paragraphs to corroborate this conclusion of Deloitte. Thus, blockchain technology help practicing all the three features of good governance:

- ④ Openness, transparency, and integrity,
- ④ Effective collaboration, and

④ Performance orientation.

## Ideated BP for Healthcare Service Delivery (BPHSD)

In this section the above points relevant to the configuration of a BPHSD, as ideated by the author in one of his earlier articles<sup>8</sup>, have further been elucidated. The configuration would also facilitate extraction of accounting and operational data, including evidentiary documents.

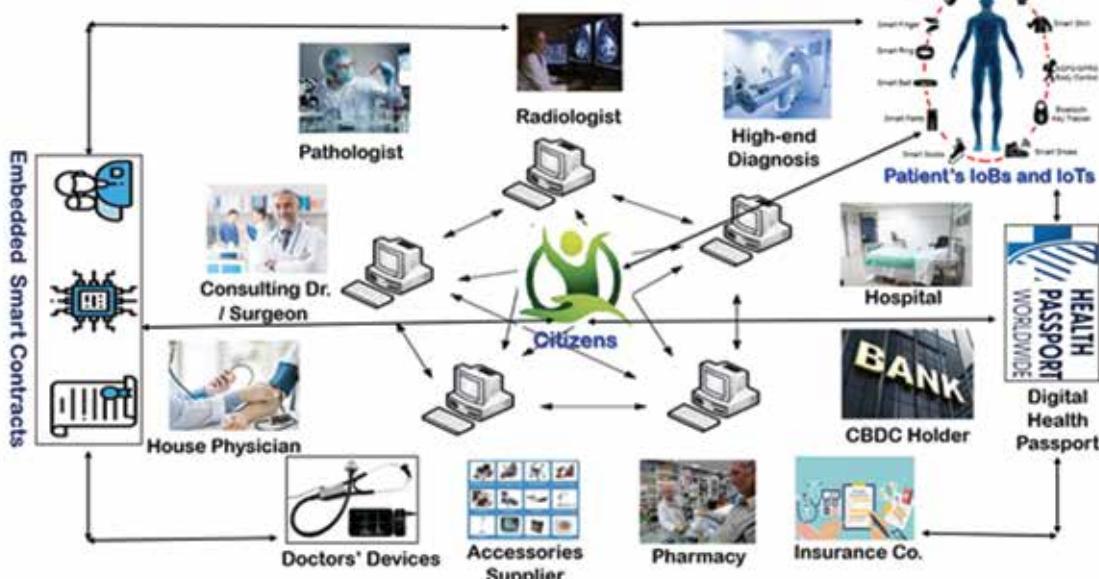
At the central point of the following schematic graphic of a BPHSD citizens have been shown as the principal recipients of services. The icon at the top right corner represents the cluster of medical internet-of-things (MIoTs) and internet of bodies (IoBs) which are linked to the platform via the Node of the patient. The interconnected computing devices around the centre represent the Nodes of various service providers as have been named in the graphic. Medical devices

used by any of the service providers, e.g., ECG and blood pressure measuring machines of doctors, report writing computers of pathologists, CT scanners and sonographers of radiologists are connected to the BPHSD and also its document management system through their respective Nodes.

Thus, in this scheme various digital tools would also function as enabling medical devices in an orchestrated manner. The entire platform is being

encompassed, presided, driven, and controlled by the Smart Contracts to be signed-off by patients and the concerned service providers before commencement of service deliveries, including insurance companies and banks. The end function of the BPHSD would be issuance of Health Passport to the citizen, subject to complying with all T&Cs, after digitally accorded concurrence of the designated agency. Such an authority would also be a participant in this ideated BPHSD.

Schematic Design of Blockchain Platform for Health Care Services



Note:

The above schematic design has been ideated by the author and graphics are from Google Images.

All data and medical records of patients can be extracted based on permissions granted by the governing SC(s) for any defined geographic region and/or specific type of disease(s). Those can then be analysed for conducting various medical research. Both federal and state government agencies, as nodal participants, would also be able to use information, processed out such data, for preparing/amending national health care policies, setting up infrastructural facilities, allocating funds, etc. wherever there are gaps. All records of health conditions and medical treatments/procedures done for a patient and related financial transaction can chronologically be stored on a permanent basis and retrieved for future reference. These can also be accessed by the contracted Insurance Company for reimbursement or direct payments to service providers as

well as the designated agency for issuing health passport.

## **Transactions of a Service Provider using BPHSD**

Let the Node of a adiography service provider be taken as an example. The sequence of transactions events and instances of transactions that would take place in the BPHSD would be as follows:

- ⦿ The patient, who is assumed to be suffering from an ailment curing of which needs a surgery, has consulted the house physician, who has advised him to consult a surgeon beforehand.
  - ⦿ The surgeon, as a prior event, has advised to get some radiographic tests done for confirmation of the prognosis through a transaction in the BPHSD and the patient

has issued a request for quotation (RFQ).

- The participating entities, who provide radiological diagnostic services (RDSP) would respond to that RFQ to provide services with quotes for charges, through the next blocks of transactions.
  - The patient would accept one of those quotes. Post that the platform would trigger the SC to be digitally executed by and between the two parties and define public keys of those other participants who would be entitled to access the RDSP's test reports on a need-to-know basis.
  - Once the reports are uploaded into the DMS of the BPHSD and acknowledged by the patient and/or the Surgeon, the RDSP would raise invoice following the scripted process. This invoice can

also be seen by the bank of the patient or the insurance company who would make payment to the RDSP post consent of the patient is accorded. The payment can be initiated from within the system if both the banks of the payer and the RDSP have account for a common cryptocurrency, e.g., the central bank digital currency (CBDC) of the country.

- ⦿ The consulting clinicians of the RDSP, physicians, surgeons would be able to extract the report(s) for confirming their diagnosis, explaining to the patient, and deciding line of treatments/surgery, and monitoring subsequent developments. The surgeon would also be able retrieve digital films, generated during radiography, through the Node of the participating hospital on the frontend display screen for viewing while performing surgery. There will be no need for off-line duplication, physical copies, and human interventions in the entire process

So far as the RDSP is concerned operational and financial transactions have ended there. It can extract all data, reports of radiologists and films of any given period from the DMS of the BPHSD for generating internal MIS and big data analytics for research and reporting purposes. All these transactional references and records, as well as the documents and reports stored in the DMS would form a part of the accounting and operational records for the RDSP as a commercial entity and meet legal and regulatory compliance requirements. Finally, all financial transactions like service invoices raised, payments and / or intimation of payments received also can be loaded into the ERP system for accounting, viz., SAP or Oracle Financial for generating accounting entries and posting into financial ledgers. For this a suitable API and a ETL are to be installed for integration of accounting system with the Node of the RDSP and data transfer.

## Role of Management Accountant

Axiom says and the common experience of any reader in personal and working life is that “What is trusted may not be what is true, and what is true may not be what is trusted”. Any blockchain technology-based platform, designed and created for any purpose, including commercial

transactions, provides a high degree of trust and bridges the gap between truth and trust. It establishes only one version of truth through compliance of the T&Cs of Smart Contracts. All these are absolute musts for accounting function, accountants, and auditors.

Such a powerful digital technology, i.e., Blockchain can be reasons of worries and anxieties for any accountant, particularly because any BP would minimise, if not obviate, routine jobs for handling, documenting, and recording business transactions. But one cannot afford to forget that BPs would demand several new capabilities from accountants, as BPs becomes more entrenched systems for mainstream finance functions. Despite automation of jobs at all steps of conducting business transactions it would demand from accountants:

- ⦿ More business insights for effective value aggregation.
- ⦿ Application oriented knowledge of the provisions from relevant laws, regulations, and accounting standards, that would govern the transactions, for approval of each T&C of the SCs which are digitally embedded into the scripts and codes for operating BPs. Else have to initiate actions for amendment using the functional steps as permitted by the platform.
- ⦿ Skills and knowledge to perform more cerebral tasks by using tools from the stable of AI and Data Analytics, and drawing inferences from information processed from large volume of data and unstructured records like invoices, logistical documents, etc. This would enable accountants to contribute toward formulation of business strategies, forecast operating volumes and create tactical plans for implementing in order to achieve strategic objectives.
- ⦿ Skills and business wisdom for according consents to different business transactions before those are allowed to be pushed through and added as blocks of transactions.
- ⦿ Capabilities to embed proactive measures to be provisioned while writing scripts and codes for the BP for proactive mitigation of foreseeable risks and ensuring smooth functioning of the BP. The predominant objectives should be

maximisation of value creation and minimisation of value destruction.

- ⦿ Professional expertise more than ever before to analyze operational and financial results rather than focusing on the mundane tasks of reconciling and verifying transactions.

It is, therefore, evident that financial and cost accountants will have to transform themselves more to become management accountants and hone skills for strategic aspects of business management.

## Auditing of Transactions of a BP

At the outset one can raise a valid question that if a blockchain technology can validate all that are needed to be verified and validated by an auditor, then what is left to be done by an internal auditor for controlling and monitoring an organisation's performances, and a statutory auditor before issuing independent opinion to shareholders. It would be pertinent to quote here a report of Wall Street Journal published in July 2018<sup>12</sup>.

*“PricewaterhouseCoopers LLP’s answer: Validate the validators. The Big Four accounting firm unveiled a new offering Friday that will provide an outside look at clients’ use of the blockchain -making sure companies are implementing and using it properly and allowing people within a company to continuously monitor its blockchain transactions. The move will facilitate and encourage companies’ use of the new technology, PwC says. Attesting that all is going as planned will help ease any internal concerns about blockchain and get people to feel more comfortable with its use, it adds”.*

One can further add the following narratives in support of the above approach for PwC toward auditing transactions in an environment of one version of truth created by Blockchain technology:

- ⦿ Systems and processes followed by different BPs cannot be validated by any standardised audit tool because the related control environment can and shall vary according to the nature and need for transactions processed using the underlying uniquely drafted smart contracts.
- ⦿ The design architecture of each Blockchain environment is unique and there would hardly be any standardization, particularly keeping

in view that no code of standards has so far evolved at global and any national level on such matters.

- ⦿ All organisations may not have trained manpower with due knowledge, skillsets, and experience, for designing of control environments. This may leave scope for congenital errors while creating the architecture, configuring codes, and writing scripts for the BP and creating the Wallet for Nodal users.
- ⦿ Hither to followed audit tools and methods, in compliance traditionally defined auditing standards, are dependent of available historic data ledger and audit trails created through human interventions.
- ⦿ Any Blockchain platform create real time environments and do not per design provide historic ledgers for auditing and incorporating audit observation related corrections.

Deloitte in their publication of 2017<sup>12</sup> have recorded the view that “*Blockchain technology will transform business models from a human-based trust model to an algorithm-based trust model, which might expose firms to risks that they have not encountered before. In order to respond to such risks, firms should consider establishing a robust risk management strategy, governance, and controls framework.*” They have cautioned that Blockchain may not be at the top of CEO’s and CFO’s agenda. Audit teams may not have the expertise in ensuring how to gain comfort with a system that puts trust in advanced cryptographic algorithms.

PwC has suggested for an online tool that would take into consideration the following:

- ⦿ Assess the risks and controls taking into consideration the customised framework of the client’s BP,
- ⦿ Develop a software befitting that customised framework for online auditing,
- ⦿ Install a read only node as a participant in the peer-to-peer network of the BP,
- ⦿ Access the BP through the node for testing and validating transactions stored in the client’s Node,
- ⦿ Keep monitoring transactions and issue reports from time to time, and
- ⦿ Modify approach and the customised auditing software with passage of time and development of technology

Keeping all these in view the present author has written an article under this digital transformation series titled, ‘Digital Transformation - Emerging Dimensions of Risks and Audit 4.0’<sup>13</sup>. He would urge upon readers to peruse through that article. The underlying theme of that article has suggested to adopt a proactive approach and involvement of auditors right from the stage of conceiving and developing the Blockchain platform.

## Conclusion

Digital enthusiasts associated with Blockchain technology predict that seven to ten years from now none would talk about what is Blockchain technology like not even a common man talks today about what is internet. In 2030s a common man will speak about what is the new application from the stable of Blockchain. From the perspective of accounting and reporting blockchain is also due to evolve further and bring in revolutionary developments. One can make out from the above narratives the capabilities of Blockchain technology at its present state. Alvin Toffler, one of the world’s most outstanding futurists and known for works on modern technologies, including the digital revolution, said that “*The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn.*”

The author is of the view that the above comment was never applicable and will continue to be not applicable to accounting and auditing professionals. However, accountants would have to evolve further, transform, and reorient themselves more for the role of a management accountants and value aggregators. The professionals of auditing fraternity will have to also evolve and make themselves savvy and confident for applying digital tools. Their roles will also evolve with the advent of Blockchain technology. The commercial world expects them to apply tools and techniques that would enable them to conduct concurrent audit using digital tools instead of applying post facto and lagging techniques. Their reports must add values by proactive alerts for risks that can cause value destruction, digital crimes, breach of data, defacing of digital displays and spawning of malwares. MA

*Note:*

*The author acknowledges excision inputs of Dr. Somnath Roy, Associate Professor*

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