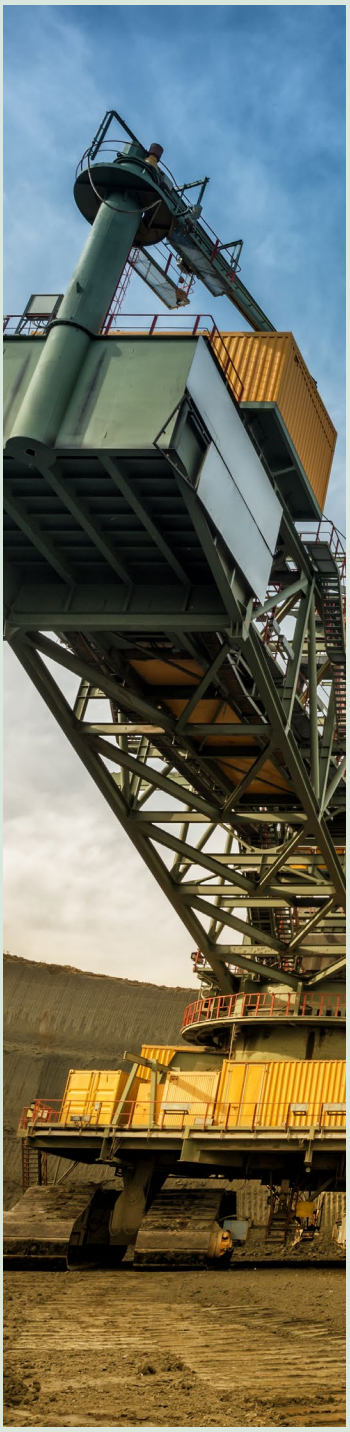
WHITE PAPER



BLOCKCHAIN

Understanding the Practical Applications for Mining

Mining Journal INTELLIGENCE

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Technology has transformed the mining space and it has been a rough ride for a sector that has a well-earned reputation as a laggard among industries. Mining may have pedigree, with its roots in the Bronze Age, but with direction and momentum established over some 5,000 years it also has the turning circle of the QEII. But this is changing. Though the sector is still far from agile, it is embracing innovation, largely in the form of new technologies. Process automation and Big Data, which many predicted would be gradually introduced, have arrived with a bang and are now verging on common practice for new mines. Other technologies are emerging with perhaps equally disruptive qualities.

One of these is Blockchain.

With this in mind, *Mining Journal* recruited a leading global technology consultant, Infosys, to partner in a blockchain round table in Toronto in early March. Contributing to the session were a mixture of senior executives from juniors to genuine majors, with varied levels of blockchain understanding and experience.

The idea was to establish the level of understanding around blockchain and determine the use cases showing the greatest potential for disruption.

The session was run over two hours and participation was based on Chatham House Rules, which meant the identities of those contributing must remain anonymous. However, we are able to publish the experiences shared and the broad round-table findings.

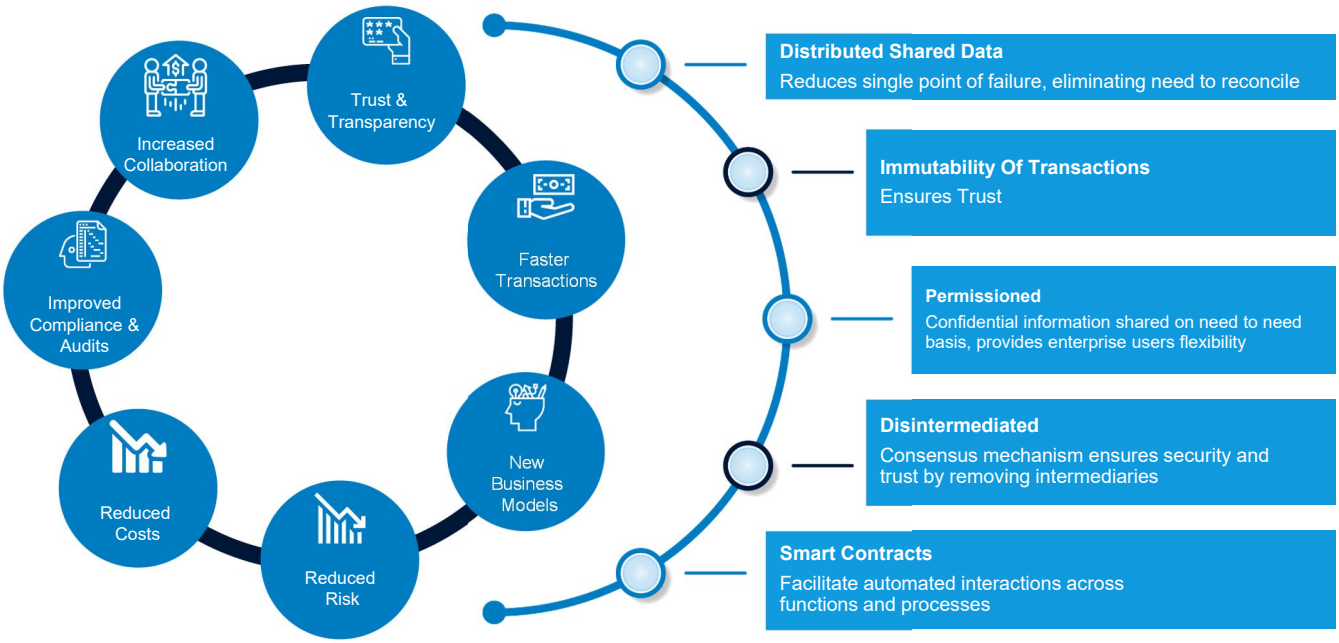
Like the round table itself, those reading this report will have a range of experience with blockchain and, so, it is worth taking a few moments to establish the basic principles of blockchain technology.

The most celebrated example of blockchain technology is Bitcoin. Its founder, Satoshi Nakamoto, described the technology as a "chain of digital signatures" but, to the layman, blockchain is essentially a type of database.

There are two key differences between blockchain and a more traditional database, which make blockchain unique:

1. Transactions entered into the database are copied and distributed to all participating stakeholders on a network that have to approve the transaction, rather than held by a centralized hub that acts as the regulator. This happens in real time and so increases transparency, efficiency and security among network participants.
2. Entries to the database are secured by encryption and agreed through consensus mechanisms so the network flags up false entries, which 'break the chain'. The longer the chain of entries (chain), the more complex the encryption sequence becomes and the harder it is to corrupt, or hack. This cements the integrity of the data.

It could therefore be described as a far more secure and trustworthy database, which is shared across network participants.



There are two types of Blockchain.

The most widely known is public blockchain, which is the basis for Bitcoin and other crypto currencies – the first and most widely known implementations. This allows anyone with the appropriate software to read or write data into the database, or ledger.

Public blockchain has its own system of data consensus or validation that, unhelpfully for those in the mining sector trying to understand the technology, has been termed 'mining' – despite having nothing to do with the actual mining industry. Thankfully, the opportunities most applicable for this discussion do not use this type of blockchain.

The second type is private, permissioned blockchain and followed once business acknowledged the potential of the technology.

A private blockchain establishes a discrete network of known participants, usually across a number of organizations related through business. Data uploaded into the ledger is validated by a set of rules, usually established by a contract and/or confidentiality agreement. This is most applicable to mining.

The uptake of private blockchain in industry has been primarily as a lubricant to make current practices more efficient, where multiple parties can transact faster because of real-time data and transparency. The opportunities, however, appear far more expansive.

"We believe that mining industry will see accelerated adoption of blockchain in 2019 as the technology matures from implementations in other industries. As a capital intense industry with an elaborate partner/supplier network, blockchain can delivery business value in the near/long term with contracts management, provenance, supply chain traceability and many more use cases for mining. Understanding the source of business value, its distribution amongst participants, and long term incentives are fundamental to any project's success." – **Srikanth (Sri) Challa, Senior Director, Infosys Blockchain**

Where is Mining in its Blockchain Technology Journey?

Blockchain technology was introduced about a decade ago as the basis for crypto currency. Most industries looking at private blockchain applications, meanwhile, are still in the proof-of-concept phase, though there have been successful implementations. These are being led by banking, where financial institutions have come together to form consortiums and are seeing success by integrating blockchain with their existing production systems.

The mining industry has the opportunity to be a fast adopter, and it would appear the appetite is there.

Mining Journal surveyed its readership to understand how relevant blockchain was to mining, according to industry professionals. The volume of responses received in less than a week – 703 – showed that, if nothing else, great interest in the technology.

Of those 703, only a quarter said blockchain wasn't relevant to mining, while 40% said it was either 'quite relevant' or was 'very relevant and the opportunity was exciting'. Tellingly, however, a third said they didn't understand what blockchain was.

Several round table participants were able to share practical case studies:

Case Study 1

A major miner trying out the technology across multiples areas.

One core implementation has been to work with banks and vendors to limit the amount of cash reserves required on hand at any one point to facilitate payments, and therefore increase the company's working capital. In theory, a transparent ledger would allow the bank and vendors to anticipate the need for funds and make transition of funds from the company to the vendor more efficient.

The other key application was a customer network so transactions become simpler and to give them more visibility over the quality and source of the ore.

Case Study 2

Another major miner trying out the technology across multiples areas.

The greatest near-term opportunity was seen as working with government on land title and tenure pieces, and environmental projects like a shared ledger for water management. This would increase transparency as well as improving administrative efficiencies.

The other opportunity was supply-chain visibility for suppliers of parts and maintenance, as an efficiency mechanism to reduce costs. This is similar to the first case study where bringing parties together on a network would increase visibility, efficiency and accountability. This was expected to have a direct impact on the bottom line.

Both case studies 1 and 2 were in the proof of concept stage and were among a number of new technologies the majors were assessing.

Case Study 3

Junior commodities trader, formerly a mineral development group.

The company encountered a number of challenges attempting to implement blockchain technology in geographies known for conflict minerals, namely replacing incumbent paper-based databases with cloud-based systems.

The company is currently working with artisanal mine sites on establishing a chain of custody. This starts with ring-fencing the site with strict access controls so there's identity provisioning. The chain of custody incorporates GPS data as products are moved from regional depots to an export center, before exiting the country.

Combined with what we understand from media reports, it therefore seems the number of successful implementations in the mining space are few compared to banking, for example, but the interest and exploratory work is at a level to change this in the near-term.

Near-Term Applications

The round table made it clear there were areas of the mining industry that represented low-hanging fruit in terms of obvious areas where blockchain should, theoretically, make a big difference and the execution should be, relatively, straight forward.

These core areas centered on improving efficiencies of basic business functions and transactions to cut costs. Most of these focused on bringing elements of the supply chain together on a network and were, in principle, derivatives of parts traceability and maintenance requirements, and contract management.

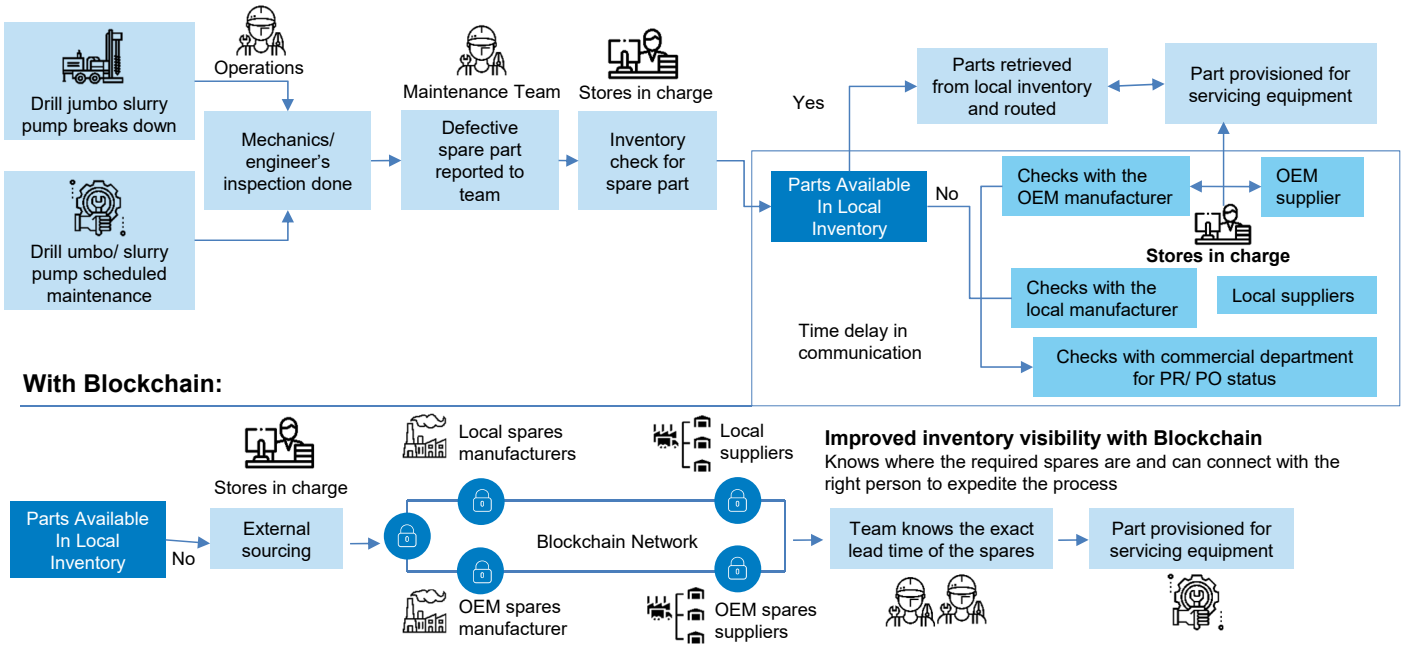
Spare Parts Traceability and Maintenance

This is applicable from both an auditing standpoint and in limiting downtime.

How regularly servicing was completed and by who; which parts have been replaced and how regularly; and which faults are registering most often are important when something goes wrong, particularly if it is a serious accident (particularly fatalities). Having an immutable database that shows the full, time-stamped life of a piece of equipment, signed off by network participants makes the auditing process and liability straight forward and irrefutable.

At a day-to-day level, having local spares manufacturers, local suppliers, OEM spares manufacturers and OEM suppliers on one network database that an operator can plug into means the need to replace parts for scheduled maintenance is visible to all stakeholders and the people needed to do the work are in place to execute. The downtime on a parts failure is also reduced.

Example: Inventory visibility for mine and mill maintenance

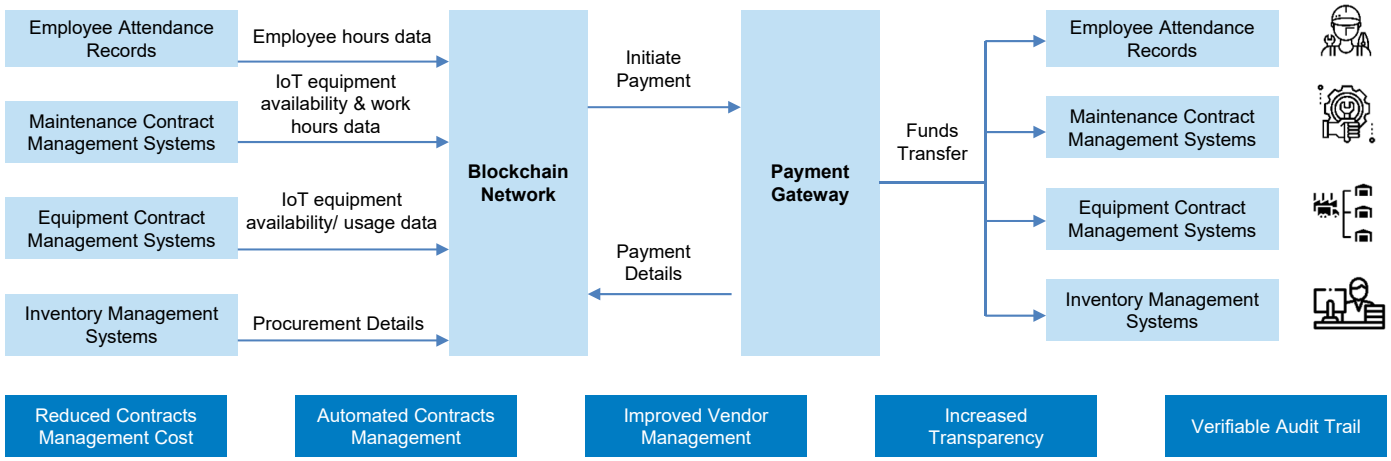


Contract Management

This includes a variety of contracts but is most advantageous where more people are involved; there are time-sensitive elements; and delivery is dictated by performance, so an irrefutable ledger can smooth the process and resolve or mitigate objections. Examples include maintenance contracts, equipment contracts and labor contracts.

The challenges in executing on contracts are generally around human intervention, which can result in poor execution or miscalculations and increase man power and legal costs. Blockchain technology automates the contractual executions to keep the process on track and objections to a minimum, and improves trust between stakeholders.

Contracts management using smart contracts



Provenance

Provenance was a challenge almost immediately targeted when blockchain technology emerged but, while the ambition remains, the application has proven difficult so far.

The main driver of provenance-based applications is currently US legislation, namely the Frank Dodd Act, specifically section 1502 that requires issuers to provide a public audit of their supply chain on an annual basis if they're using certain minerals such as tantalum, tin, tungsten and cobalt.

This pressure is being followed closely by the European Commission, which is in the midst of implementing similar requirements for conflict-related minerals, though the feeling at the round table was this would spread across the mineral spectrum and so would soon be more stringent than US law.

The other driver is the financial benefit of being able to show proof of mineral integrity, which in the agricultural sector secures a premium for the seller. Those close these issues at the round table felt we were some way off this reality in mining.

The current database for minerals in many of the places in question is a paper-based logbook system, which has been tough to dislodge. Downstream participants such as smelters have also resisted moving to a distributed ledger based on the suspected overheads of setting it up, while they remain skeptical of the benefit.

One current model being piloted is the isolation or artisanal workings and the tagging of samples for GPS tracking, as touched on earlier. Integration with bar-code scanning and GPS needs to get better for full implementation but it's an attainable goal.

Beyond the industrial applications of this for corporates in proving provenance, this has health and safety applications in artisanal mining; cost saving applications in terms of tracking ore around and operation; and revenue raising potential for governments concerned about corruption.

In a similar way – but far more orderly in execution – blockchain could be used to track high-value samples from exploration activity, or monitor samples to potentially ensure market-sensitive results are not manipulated.

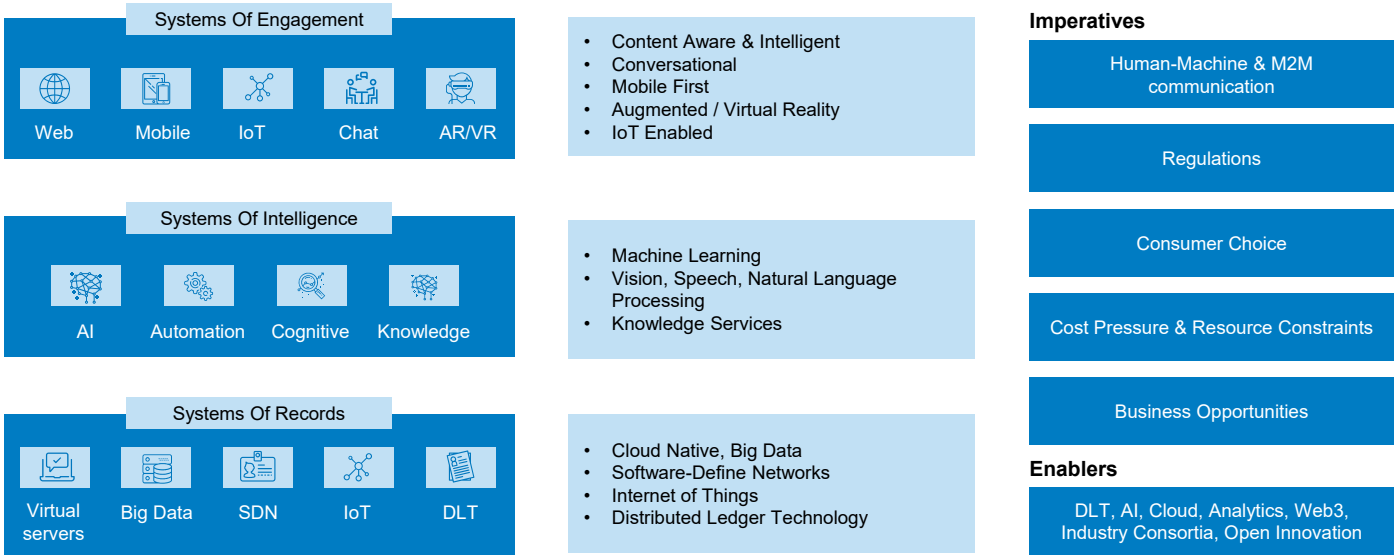
Longer-Term Applications

There is plenty of appetite for more futuristic and far-ranging uses. Regulators, for example, could benefit based on the simple fact blockchain is an aid for auditing. Whenever you have a compliance challenge, putting data on an immutable distributed ledger is a huge opportunity. This, in turn, may build the trust needed to allow a relaxation of the administrative burden currently weighing down small companies battling with increasingly stringent compliance requirements.

The security of blockchain feels like it should have cybersecurity applications, though, for now, the feeling at the round table was current cybersecurity measures were doing the job well when applied correctly.

Setting up a blockchain as a secure platform for M&A due diligence procedures, however, felt like it may have more potential. In such a case, sensitive information would be made available to only parties on the network with the right access codes, with groups from the same organization and other organizations having access to different data, all of which is on the blockchain, as applicable. This would ease an administratively heavy process, while keeping sensitive data safe.

A common element for the round table corporate participants was an ambition to integrate blockchain with other technologies, which was in line with the advice from the Infosys experts present.



Blockchain, as a digital technology, should be part of a three tiered technology strategy that included systems of engagement (web, mobile, internet of things, chat and augments/ virtual reality); systems of intelligence (artificial intelligence and automation) in conjunction with human cognitive functions and knowledge; and systems of record (virtual servers/cloud, big data, software-defined networks, and, again, IoT). This 'systems of record' tier is where blockchain sits – a database fed by intelligence aggregated at various points of engagement.

Something like an IoT device or mobile phone captures the data; and a system of intelligence like AI enters it into the blockchain to become that immutable source of truth that cannot be tampered with. The system of intelligence would have two roles: validating the data captured; and querying the immutable data already in the system of record to provide intelligent insights.

What Infosys had found in the mining sector was clients wanted to be vertically integrated. And, while, generally, the level of operational technology (OT) was good and the level of information technology (IT) was also good, the integration of OT with IT was lagging.

Blockchain will play a key role in the future of mining and we see its adoption in provenance, spare parts maintenance and contracts management as quick wins for mining companies to test and adopt Blockchain technology." **– Ram Ramachandran, Senior Director – Resources, Americas**

The Challenges are Real

For all the opportunities, challenges remain ahead of even basic implementation and much will be learned from the first wave of successful executions.

For a start, though the industry has a broadly changed attitude to new technologies, many mining folks remain oblivious to much of the technical language being used to describe blockchain theory and practice. Some participants on the round table were, at times, noticeably struggling to keep up, while it is worth harking back to the 33% of *Mining Journal* readers who simply don't really know what blockchain is.

It's also worth considering the 26% that said blockchain was not relevant. That underlying skepticism combines with the usual fears of the unknown to make these first cases difficult to execute. Private blockchain networks, at their core, require buy in from participants – the greater the buy-in the greater the benefits; similarly, low-level buy-in can make the technology pointless.

One of the majors at the round table was working through what it hopes will become a standardized onboarding process for its vendors and suppliers that it hopes to bring into various networks. That will comprise of education around the technology and support with infrastructure.

Another major reported difficulties reaching consensus between participants on the rules that would govern the blockchain. The theory worked beautifully but at any point when humans were required to move the process forward, things became messy.

This wasn't, however, viewed as a fatal flaw, but rather a challenge to be overcome as the industry worked through its fledgling period with the technology.

Investment bank Goldman Sachs has previously warned of a reticence among business to take on the technology until proven. The firm also suggested concerns of liability and other legal hurdles may outweigh the clear benefits possible in regulatory applications.

This is in addition to thinking among some who see private blockchain as a temporary flirtation that will be discarded once the challenges around scalability and concerns around privacy associated with public blockchain are successfully navigated, so all blockchain applications would unlock the full capacity and security of a mass network.

Next Steps

One point the Infosys experts were keen to leave with roundtable participants was that **blockchain was not a silver bullet.** Yes, the technology presented an opportunity to overhaul several everyday processes to make them faster, better, cheaper and more secure, while building trust between parties and removing redundant intermediaries, but there was a danger in seeking out applications to fit the solution.

Rather, applications should be 'problem driven' with an open mind to considering blockchain in a mix of potential solutions.

At the same time, and as much as the industry should not inflate the potential for blockchain, those 26% of *Mining Journal* readers closing their eyes to the relevance of the technology should be asking themselves if there are changes coming that will make their businesses inefficient or even irrelevant if they haven't considered how blockchain could work for them.

There are two ways of assessing this potential: a top-line and a bottom-line approach.

The top-line approach asks if the technology can offer something that will create new revenue streams. A good example is utility companies, which are likely the only organizations that know if you live at a given address and are paying your bills. The core function of a utility company is to provide power, water, etcetera, but by leveraging blockchain, a utility can provide an identity verification service.

A bottom-line approach identifies structural (as opposed to competitive) inefficiencies that can be avoided. The example is the health profession in the US where all insurers are required to update contact databases for providers, which for a large firm requires some 80,000 phone calls a month. All firms must do this so there is no competitive advantage, while setting up a blockchain to securely share information updated in real time could save millions across the industry.

The mining industry is awake to this potential and there are large and small firms alike blazing a trail in step with other industries to identify and execute on relevant applications. Those that remain fixed in the past need to be aware that, as with other sectors, companies not willing to explore these opportunities risk losing competitiveness.

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