Blockchain Technology in the Construction Industry

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Abstract

The construction industry has not advanced as quickly as other industries in the aspects of time, cost, and quality; but Blockchain could be the solution. While there have been improvements in the construction sector such as BIM or Prefabrication, nothing compares to those in other industries. This brings the search for a new technology that would boost construction to a new level of productivity. One technology that could potentially do this is Blockchain. Blockchain, defined in a big picture, is like a shared google sheet where anybody could add information but nobody could delete it. This technology could change the way construction is done and add value to the industry with increased productivity and transparency. This paper analyzed whether Blockchain Technology would be useful to the construction industry, and to gain knowledge of Blockchain's uses in the field. The methodology used to find this information were semi-structured interviews with information presented in a summarized form. The researcher spoke to experts in the field of blockchain as well as individuals with no experience in Blockchain. Findings revealed that this technology could be beneficial for speeding up the contractual processes, payment processes, and tracking quality.

Key Words: Blockchain, Construction, Productivity, Information, Improvements, Transparency
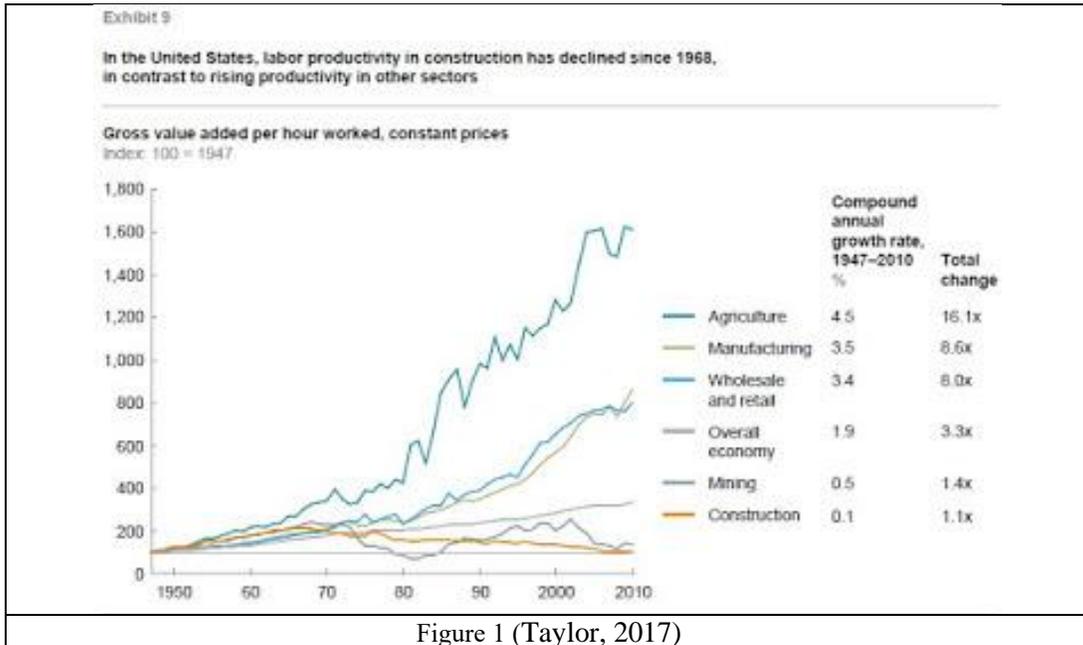
Introduction

It is well known that the construction industry has not been able to keep up with other industries in the aspect of productivity. Construction still aims to find something that can drastically change the way things are done and Blockchain could have the power to do such a thing. In the next sections, we will go over construction productivity to layout the industry's evolution, the background of Blockchain, Smart Contracts, and private Blockchains to introduce ways Blockchain could be effective for the construction industry.

Construction Productivity

Projects in the construction industry typically take way longer than they should. According to MarketWatch, "U.S. Construction-Sector productivity is lower today than it was in 1968, and investment has fallen over the past decade" (Woetzel, 2017). When compared to other industries in the last 50 years, construction has not been able to hold its own, barely improving from over 50 years ago. As seen in *Figure 1* below, construction is falling at the bottom of the list, growing only 1.1x in gross value per hour worked. Compared to other industries on the list like agriculture which grew 16.1x and manufacturing which grew 8.6x, it is clear that construction has room to improve. Agriculture, manufacturing, and retail have all capitalized on new technology, which has allowed them to speed up the processes in which they do their work. Agriculture uses the "Internet of Things to allow their farming machines to communicate with one another" (Ayoka Systems, 2020). Manufacturers use "Artificial Intelligence and robots to perform tasks and reduce cost" (NIBuisness) and retail uses Big Data to "analyze purchasing behavior and personalize a consumer shopping experience" (Marr, 2020). These are only a few examples of other industries using technological advances to their benefits, but why is it so hard for construction? The reason that it is so hard to apply these technological advances to the construction industry is because of how complex the industry is. According to the McKinsey Global Institute,

 *"The [construction] industry is extensively regulated, very dependent on public-sector demand, and highly cyclical. Informality and sometimes corruption distort the market. Construction is highly fragmented. Contracts have mismatches in risk allocations and rewards, and often inexperienced owners and buyers find it hard to navigate an opaque marketplace. The result is poor project management and execution, insufficient skills, inadequate design processes, and underinvestment in skills development, R&D, and innovation "(*Taylor, 2017).

This leads to the question of how the industry can be improved. According to the Harvard Business Review, "Blockchain Technology is among the most disruptive forces of the past decade with its power to record, enable, and secure huge numbers and varieties of transactions" (Tapscott and Vargas, 2020). While the technology is still in early stages, it is important to have a good idea of how Blockchain can enable construction companies to be more productive.

Exhibit 9

In the United States, labor productivity in construction has declined since 1968, in contrast to rising productivity in other sectors

Gross value added per hour worked, constant prices
Index: 100 = 1947

	Compound annual growth rate, 1947–2010 %	Total change
Agriculture	4.5	16.1x
Manufacturing	3.5	8.6x
Wholesale and retail	3.4	8.0x
Overall economy	1.9	3.3x
Mining	0.5	1.4x
Construction	0.1	1.1x

Figure 1 (Taylor, 2017)

Blockchain Background

Blockchain stemmed from the creation of Bitcoin in 2008 as a "blockchain that contains a public ledger of all the transactions in the bitcoin network" (Edwards, 2020). The reason that this was created was to eliminate the middleman involved with payments. This means that when you go to the store to buy something with your credit card, you are paying the mediator of the transaction (your credit card company) a small fee. You are also trusting these companies with your data and they can see everything you are spending money on. The book, *Bubble or Revolution* explains the reason behind Bitcoin's creation very well. It states that, "credit cards are digitized but not decentralized", meaning there is a middleman who charges transaction fees. It also states, "cash is decentralized but not digitized", meaning cash cannot be tracked but doesn't have the convenience of being digital (Mehta, Neel, 2019). Bitcoin was created to make a payment system that was both decentralized and digitized. This allows people to make payments without having to pay a middleman or be inconvenienced by carrying large amounts of cash.

While Bitcoin was the start of a new monetary technology, people have taken its core technology, Blockchain, and used it for different applications other than payments. Werner Krebs, CEO of Accusation gives a more recent definition of blockchain stating, "Blockchain enables an immutable, shared, decentralized ledger between untrusting parties without need for a middleman or central authority. Thus, blockchain can reduce reconciliation costs in complex commercial transactions like supply chains by establishing a single version of the truth" (Corey, 2018). People have taken Bitcoin and created Blockchain, which has many different uses. This includes building private blockchains that are built into a company's network, and Smart Contracts which enable clearer contract terms.

Smart Contracts

Smart Contracts are defined as "programs that are coded to automatically control the transfer of assets between two or more parties, once predefined conditions have been met" (White, 2018). Steven White, from *investinblockchain.com*, provides a great basic example of how this technology could be applied in the real world:

> *"Jill rents her apartment from Jack using a blockchain-based rental platform. A smart contract could be used to automatically deliver a predetermined amount of cryptocurrency tokens from Jill to Jack, after Jill has been renting his apartment for 1 month. In this instance, the parameter for the contract to be fulfilled is Jill renting for 1 month and the assets that are being transferred upon fulfillment are the cryptocurrency tokens"* (White, 2018).

While the construction industry is very complex and involves many parties, there are tasks that could be done more efficiently through automation. Applied to the construction industry, Smart Contracts could "*reduce time and cost, increase trust among parties, payment guarantee, high speed of execution, and elimination of intermediaries in transaction arrangement*" (Dashore, 2020). By using Smart contracts, the industry would greatly reduce the need for litigation required under normal contracts. Using Smart Contracts, the industry could automate payments based on agreed-upon terms and streamline the payment process.

Private Blockchains

When most people hear the world "blockchain", they think about cryptocurrencies such as Bitcoin, which is a public blockchain. What isn't widely publicized is the difference between a public and private blockchain. According to *Bubble or Revolution*, "private blockchains help organizations optimize the flow of information and goods through processes they control" and "public blockchains aim to track the ownership and movement of assets held by the general public" (Mehta, Neel, 2019). Private blockchains would be more valuable to the construction industry so it is important to focus on private rather than public.

One relevant example that provides more insight into private blockchains is the use by Xbox. In the book, *Bubble or Revolution*, Mehta et al. discuss the processes behind publishing an Xbox game. When creating a game, Xbox needs many teams of employees to keep track of royalty contracts with various contractors. They work with contractors who provide the music, visual, and special effects. Xbox decided to build a Blockchain that processed these contracts automatically. Before their internal blockchain, it could take Xbox publishers up to 45 days for all royalties to be settled (Mehta et al., 2020). Xbox decided they wanted to automate these royalty computations and consolidate data, so they decided to build a private blockchain based royalty settlement system. Through their blockchain, they were able to create a Smart Contract which stated, "Xbox will pay the contractor X% amount of revenue after the $Y amount of sales, provided the game earns at least Z stars on this review site" (Mehta et al., 2020). Xbox, with the help of Smart Contracts were able to turn all the complex contract terms into formulas that would compute the proper payments and automatically compensate contractors if they met contract terms. This process eliminated the need for paper, excel spreadsheets, and emails. Also, because a smart contract code can be read by anyone, every contractor would be sure that "they're getting exactly the money they deserve, which reduced the pain of reconciliation" (Mehta et al., 2020).

Applying a private blockchain to Xbox helped the company in many ways including reducing royalty settlement time from 45 days to only 15 minutes. The finance team also saw a 70% decrease in workload which allowed them to refocus from simple reconciliation tasks to more exiting, impactful, and value-added activities (Mehta et al., 2020). While this is only one success story, many other companies have implemented blockchain, such as IBM, Deloitte, SAP, and Walmart (Wokwicz, 2019). While they may not be construction companies, it is important to learn how other industries have used this technology to make it easier to apply to construction.

Methodology

The purpose of conducting interviews is to gain exploratory knowledge in the field of Blockchain. This researcher interviewed sources with jobs both in and out of the construction industry with varying knowledge on Blockchain. The researcher chose experts in Blockchain to see how it could apply to the industry in a practical sense. Also, the researcher conducted with people with no prior knowledge to gain new and creative ideas that may have not been established. Instead of presenting each answer word for word the researcher chose to provide the reader with a summary of each conversation. The general questions that were asked are listed below but conversations were semi-structured to allow the source to explore new ideas:

1. *What is your occupation?*
2. *Have you heard of Blockchain Technology and what do you know about its implications?*
3. *Do you believe that disagreements can be solved by a computer?*
4. *How can we implement Blockchain Technology into the construction industry, and how will this be helpful?*
5. *What would be the benefits of standardizing contracts and removing subjective wording?*
6. *Would a construction company owning their own blockchain built specifically for their company be useful? Or would a general blockchain built for all contractors be better?*
7. *What impact will Blockchain have in the industry even if people do not understand it?*
8. *What complications do you see trying to implement new technology into the industry?*
9. *What are some ideas you believe Blockchain could be used for in your industry?*

These questions aim to explore what these sources know about Blockchain, if they can use it in their industry, and how that may be translated to the construction industry.

Results

Familiarity with Blockchain

Before conducting interviews, it was clear that not many people know what this technology is and where it came from. When asked, many of the interviewees seemed to think that Blockchain was Bitcoin, which shows a lack of understanding of what Blockchain technology is. However, some interviewees had more knowledge about Blockchain. Harry Phan, a Project Engineer at BNB Builders, stated that "Blockchain has evolved from being just transactions on a network. Over the years spanning past Bitcoin, we have seen Blockchain Technology evolve into different sectors. This includes Ethereum, which allowed Smart Contracts to be supported and applications that can be built to support different

functions". Bitcoin was the seed that began Blockchain technology and the growth is already starting to show itself. It is unclear what the final stages of Blockchain will be, but from what we see now, it has the potential to be an impactful part of our lives. After conducting a little bit of research, people will begin to realize that there much more Blockchain can be used for past making payments.

Approaching Blockchain with Caution

Hannah Hank, a Supply Chain Manager at Frito Lay stated, "Blockchain technology could be a big factor for many companies in the near future. Its ability to track and record is important for many businesses' success including Frito Lay. On the contrary, there are a lot of companies that will be fine continuing the processes that they already conduct". After speaking to Hannah, Frito Lay has a sustainable model that works and it might cost them more to implement a new technology into the business. Every company has their own needs and while Blockchain could be beneficial to some, like the Xbox example presented earlier, many will be okay continuing their current processes.

While there may be many benefits, there are some concerns when it comes to implementing this technology. Alec Moens, a field engineer at RockSol states, "Applying new technology to a business is already hard in the first place. People become so used to what they are doing that making them learn something else becomes a huge process. This process grows exponentially when people don't understand how the technology even works." Applying a new technology to any business is hard, even more so when that industry hasn't improved in over 50 years. Even today in construction companies, many people still prefer to process information the old fashion way, because that is how it has been done for a long time. With that being said, it is important to push these new technologies because if not, general contractors will find themselves limited by yesterday's technology. In this next section, we will explore how Blockchain can be used in the construction industry from the perspective of those in the construction industry.

What can Blockchain be used for in Construction?

All interviewees were asked how this technology could be implemented or used in their respective industries to help shape ideas for the construction industry. Andres Nasr-church, a project engineer for Rudolph & Sletten presented the idea of a shared register of all subcontractors. All general contractors would have access to an Blockchain-based application and each subcontractor would receive a rating based on their deliverables. This would mitigate the risk of a star-based system because anyone could rate a subcontractor multiple times, convoluting the results. Having this application could lower the risk of choosing a subcontractor who doesn't meet the general contractor's requirements, slowing down the project and losing money. This system would be a great introduction for the construction industry to Blockchain Technology because it would be simple and effective for all users. If there were a trustworthy system that could rate subcontractors based on work, general contractors could be sure that they would be getting a reliable subcontractor for the job.

Another idea presented by Harry Phan used Smart Contracts. Mr. Phan stated, "While Smart Contracts are quite new and probably not ready for us to implement, the future might be bright for this technology". Some things that general contractors could use Smart Contracts for could be self-enforcing conditions that need to be met. This could include the self-monitoring of milestones, and automatic payments to subcontractors that complete these milestones. To see how this would be done, I interviewed Jeremy Whorton, who is a Computer Scientist for Nike. He revealed that this could be easily coded using if/ then statements. For example, if an ironworker finished his work, then he will

request that it be inspected. If the work turns out to be okay, then the ironworker gets paid. This would eliminate missed payments, because the money is automatically dispersed when the work is contractually finished. It would also build a more transparent relationship because money will be paid exactly when it needs to be paid. This would also eliminate the need for the long paper trail, as every requirement would be coded into the contract. There would be no need to argue whose work is whose because everything will be specified. While this technology would be very useful, this is a step that I believe will not be seen for a while. It would take a considerable amount of money to hire someone to code the whole process for a company, let alone a company that would be willing to do it in the first place. Before this happens, the technology would need to be shown to be useful in more simple contexts so that construction companies will be interested in investing in it.

Austin Frey, a field engineer at Brian Cox Mechanical, suggested that they would be able to use Blockchain to trace their goods through the procurement process. He stated, "a lot of times a project gets held up due to missing or late material/equipment. It can even get held up if the material isn't correct and gets held up in an inspection". Building applications that allow them to follow every aspect of their material procurement process would allow them to save time and money, as they would not have to deal with the stress of calling and trusting the provider. The application would track the material, allowing construction companies to know exactly where the material is in the supply chain. If there were a delay, the construction company would know the second that the provider did, which allows the contractor more time to develop a new plan to keep the project on course. While this might be hard to enforce, if a transaction is agreed upon, the contractor could write code into the Smart Contract that penalizes the provider for not updating the application. The Smart Contract would automatically penalize the provider, incentivizing them to participate.

While there may be some reluctancy to implementing blockchain multiple sources had innovative ideas to how blockchain could reduce cost and increase productivity in the construction industry. Smart contracts and Blockchain-based applications for tracking and delivering material may be worth the investment for a more productive and profitable future.

Conclusion

It is important to explore the possibilities of new technologies because if Blockchain proves to be revolutionary, being one of the first to understand and implement it could result in first mover advantages. People like Hannah and Alec feel their company would be reluctant to invest in blockchain technology because of high training costs and the struggle of adaptation for the employees. Also, they think that many companies are complacent in their current processes. With that being said, others such as Andres, Austin, and Harry felt that Blockchain could be very useful in their industries. Andres had the idea for a private blockchain-based application that would track deliverables and recommend the best subcontractors. Harry presented the idea of Smart Contracts and automatic payments which would speed up the payment process. Lastly, Austin presented the idea of a blockchain-based application that could track goods and benefit the procurement process.

After interviewing relevant sources and conducting research, I believe that Blockchain is useful in many aspects including speeding up the contractual processes, payment processes, and tracking quality. While it could be very useful for the industry, I don't think that we will see full implementation soon. This technology is at its early stages and many people still do not know what it even is. The industry will

adapt to change very slowly, but when it does and realizes how beneficial it could be, then we will start to see some productivity improvements. As stated at the beginning of the paper, construction is a very complex industry. We need to figure out how we are going to keep up with the growing demand of construction while delivering quality projects around the world.

Further research on the subject could include implementing an experimental blockchain-based application to a construction company. This would allow the industry to gain quantitative data to support Blockchain's productivity. This could be done through an interdisciplinary senior project with a Computer Science major and Construction Management major. The Computer Science major would write the code for the Blockchain, and the Construction Management major would provide the parameters that needed to be followed. While this application doesn't have to be revolutionary, it is important to conduct further research to expand knowledge in the field.

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