The Benefits of Utilizing Non-Fungible Tokens in the Quick Service Restaurant Industry
(Technical Paper)

The Environmental Implications of Blockchain Technology
(STS Paper)

A Thesis Prospectus Submitted to the
Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Darwin Khay
Fall, 2022

On my honor as a University Student, I have neither given nor received unauthorized aid on this
assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature _____*Darwin Khay*_____ Date 11/16/2022
Darwin Khay

Approved _____ Date _____
Brianna Morrison, Department of Computer Science

Approved _____ Date 11/16/2022
STS Advisor: Richard D. Jacques, Ph.D., Department of Engineering & Society

Introduction

Non-fungible tokens (NFTs) have been a new emerging technology in recent years. With the transition to a more decentralized internet, NFTs allow for the digital representation of information stored on a blockchain. When an NFT is minted on a blockchain (that is, registering it), it creates a proof of ownership for the NFT and therefore has a unique identity; there cannot be any other NFT that is the same as the original (Hayes & Himmelrich, 2022).

NFTs have been growing in popularity because of the possibility of being able to gain large sums of profit with digital art. For instance, in March 2021, there was an artist who went by the name of "Beeple" and sold a montage of 5,000 of his digital art that he created over a 13-year time period for more than $69 million (Hayes & Himmelrich, 2022). This brought considerable attention to NFTs and cryptocurrency, causing a growth in the interest of NFTs, and this led to an increase in the number of NFTs created over the recent years. The use of NFTs is not limited to digital art as there are more use cases for NFTs, especially for businesses.

For businesses, customer engagement is an important growth factor. Without customers, businesses would not have anyone to sell their products or services to. Therefore, it is important that businesses adapt to changes within their consumer base to maintain growth. With NFTs, businesses can boost customer engagement. For businesses like quick service restaurants, this can be achieved by utilizing NFTs that allow consumers to contribute to the menus. NFTs are significant for businesses not only as a tool to boost customer engagement but are also significant for consumers too. That is, there are consequences associated with NFTs, the blockchain technology that they used and the impact that they have on the environment that all stakeholders should be aware. I will further discuss the environmental implications that

blockchain technology has and how this issue can be mitigated through existing and potential procedures.

Technical Discussion

The NFTs discussed in this paper are those that belong on a blockchain. A blockchain is a decentralized infrastructure and distributed computing model that uses encrypted chained blocks of data to verify and store data and specific algorithms to generate and update data (Li et al., 2021). NFTs that belong on a blockchain are uniquely identifiable digital representations of physical or digital items; usually, they are indivisible into smaller units (Idelberger & Mezei, 2022). Examples of digital information stored into NFTs include tweets, newspaper covers, and even law review articles (Idelberger & Mezei, 2022).

The value of NFTs does not have to derive solely from providing a method of providing a record of ownership – there are a number of possibilities for NFTs to diversify in purpose and even provide utility to their holders (Kaczynski & Duke Kominers, 2021). For instance, NFTs can function as membership cards or tickets which allow access to events, discounts, special merchandise or even function as a digital key to online spaces exclusively to holders of the NFT (Kaczynski & Duke Kominers, 2021). NFTs have more use and value than simply being digital assets with monetary value and record of ownership. Holders of an NFT are capable of being investors, members of a club, a brand shareholder, and a participant in a loyalty program simultaneously (Kaczynski & Duke Kominers, 2021). With all the numerous ways to utilize NFTs, they support the development of new business models, especially those involving engaging the community of their consumers – this is crucial for businesses.

Building a healthy customer relationship is like developing an emotional human connection with the customers, and it is key to boosting customer engagement. It is imperative that customers

feel like they are being heard and acknowledged. To the customer it would feel like the company personally knows their needs, wants, and even interests. In the quick service restaurant industry, it would be more likely for a customer to buy a meal from a restaurant that has more health-conscious menu options, or perhaps the restaurant is offering a promotional meal with their favorite music group. Customers may end up buying more meals from a restaurant who caters to them more. With a better connection between the customer and company, the customer would be more likely to buy the company's products due to a better understanding of the customer's interest. This in turn would improve customer retention rate and loyalty, thus increasing the longevity of the company.

For quick service restaurants, one of the least popular consumer demographics are those under the age of 25 ("Customer Demographics," 2014). The current demographic that is the most interested in NFTs are those aged 18-34 (U.S. NFT User Characteristics 2021, n.d.). This is an opportunity for QSRs to utilize NFTs to appeal to this demographic and in turn boost customer engagement, loyalty, and retention.

One way that QSRs can use NFTs is to allow consumers to contribute to the menus of a restaurant. To achieve this, my internship team's goal was to build an NFT marketplace application. When consumers buy a meal from a restaurant, on their receipt would be a code where they can use to claim an NFT. The consumer would enter the code on a separate promotional website, and it would be sent to the NFT marketplace application where it retrieves the NFT associated with the code that was stored in a database. Each NFT has a different rarity, and therefore a different number of votes associated with it. The votes will allow a consumer to vote for the next mystery menu item. With this, it allows QSRs to increase customer engagement, loyalty, and retention by crowdsourcing user input with NFTs.

My internship team built the NFT marketplace application using the following coding languages, frameworks, and platforms: TypeScript, React, JavaScript and Amazon Web Services. A separate promotional website was built using the standard website coding languages: HTML, CSS, and JavaScript. Evaluating the application involved running it on a local host server. This internship project started and ended from the middle of July to the beginning of August.

STS Discussion

NFTs have been growing in popularity recently and have been used for a variety of purposes such as digital art or even integration into new business models to boost customer engagement. However, there are environmental consequences to NFTs and blockchain technology overall that have been surfacing over the recent years. The most popular blockchain networks currently use a "Proof of Work" (PoW) mechanism, which defines the right to create a new block from a subset of queued transactions when one finds a solution to a complex cryptographic puzzle (Sedlmeir et al., 2020b). To maintain the functionality and security of a "Proof of Work" (PoW) blockchain network, the time to find a new block is kept constant, which leads to high power consumption because of the complex hash computations (Sedlmeir et al., 2020a).

As of July 2021, one popular cryptocurrency and blockchain network combined, Bitcoin and Ethereum respectively, consumed 190.13 TWh of energy, which is more than Thailand with only 185.85 TWh consumed (Kohli et al., 2022). The energy that they consumed goes to show the amount of energy wasted, especially since it is more than the energy usage from one country. This is detrimental to the environment, since having high energy consumption leads to high

carbon footprint (Kohli et al., 2022). To combat this issue, mitigations to the high energy consumption of blockchain technology needs to be put in place.

Regarding NFTs, one way to reduce the energy consumption produced by creating and operating on NFTs is to perform transactions that have a longer confirmation time which uses less energy (Marro & Donno, 2022). The Ethereum blockchain has planned to switch to a "Proof of Stake" (PoS) algorithm called Casper, which is expected to reduce energy usage and emissions due to making mining devices unnecessary and redundant (Truby et al., 2022). Another alternative to the current PoW blockchain network is "Proof of Authority" (PoA). With PoA the mechanism, it operates as a permission blockchain network that relies heavily on message-based consensus rather than hashing procedures (i.e., complex computations), and therefore consumes minimal energy (Bada et al., 2021). There are also efforts to convert the energy-hungry blockchain technology to use for new green energy infrastructure: if crypto-mining operations are collocated with renewable energy sources such as hydro, wind and solar, it would cut down carbon emissions while providing green power (Sisson, 2022).

Investigating how blockchain technology affects the environment in terms of energy usage and carbon emissions is imperative for stakeholders and consumers of any blockchain technology. In addition, exploring several ways to mitigate the current environmental problems inflicted by blockchain technology can inspire more regulation to be put in place.

In terms of the scope of this topic, it will only be limited to the usage of blockchain technology and its environmental impact. This topic is loosely coupled with my capstone project since my project explores more about the usage of NFTs in QSRs, but my research will explore more about the environmental impact of blockchain technology.

Research Question and Method

For my STS research, I seek to answer how blockchain technology has impacted the environment. My research will include the investigation of how blockchain technology has increased energy consumption and carbon emissions. This will be accomplished by exploring how and why specific examples of blockchain technology, like cryptocurrency and NFTs, have consumed a considerable amount of energy and released carbon emissions in recent years. Then, research on how the environmental impacts can be mitigated with potential alternatives to the current blockchain system mechanisms, how users can act, and how the high energy consumption can be used for green energy will also be investigated. Through this process, current barriers that hinder the alleviation against the environmental predicament will be revealed.

Conclusion

With the development of the NFT marketplace application and understanding the benefits NFTs have to offer for QSRs, it can be seen to have practical use. It would allow QSRs to have a means of boosting customer engagement through appealing to the interests of a particular demographic. In turn, this helps QSRs because of the increase in customer loyalty. On the other hand, understanding the impacts the usage of NFTs and the overarching blockchain technology have on the environment is crucial to all parties involved, and figuring out ways to mitigate this problem is what will allow the balance between the costs and benefits of using blockchain technology to be equal.

References

Bada, A. O., Damianou, A., Angelopoulos, C. M., & Katos, V. (2021). Towards a Green

    Blockchain: A Review of Consensus Mechanisms and their Energy Consumption. *2021*

    17th International Conference on Distributed Computing in Sensor Systems (DCOSS), 503–

    511. https://doi.org/10.1109/DCOSS52077.2021.00083

Customer Demographics. (2014). *Restaurant, Food & Beverage Market Research Handbook*,

    285–three hundred.

    https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=95942164&site=ehost-

    live

Hayes, L. H. R., & Himmelrich, N. T. (2022). The Basics of Non-Fungible Tokens and NFT

    Transactions. *Licensing Journal*, *42*(5), 1–3.

    http://proxy01.its.virginia.edu/login?url=https://search.ebscohost.com/login.aspx?direct=tru

    e&db=bth&AN=157082041&site=ehost-live&scope=site

Idelberger, F., & Mezei, P. (2022). Non-fungible tokens. *Internet Policy Review*, *11*(2).

    https://doi.org/10.14763/2022.2.1660

Kaczynski, S., & Duke Kominers, S. (2021). How NFTs Create Value. *Harvard Business Review*

    Digital Articles, 1–11.

    http://proxy01.its.virginia.edu/login?url=https://search.ebscohost.com/login.aspx?direct=tru

    e&db=bth&AN=153807518&site=ehost-live&scope=site

Kohli, V., Chakravarty, S., Chamola, V., Sangwan, K. S., & Zeadally, S. (2022). *An Analysis of*

    Energy Consumption and Carbon Footprints of Cryptocurrencies and Possible Solutions

    (arXiv:2203.03717). arXiv. http://arxiv.org/abs/2203.03717

Li, W., He, M., & Haiquan, S. (2021). An Overview of Blockchain Technology: Applications,

    Challenges and Future Trends. *2021 IEEE 11th International Conference on Electronics*

    Information and Emergency Communication (ICEIEC)2021 IEEE 11th International

    Conference on Electronics Information and Emergency Communication (ICEIEC), 31–39.

    https://doi.org/10.1109/ICEIEC51955.2021.9463842

Marro, S., & Donno, L. (2022). *Green NFTs: A Study on the Environmental Impact of Cryptoart*

    Technologies (arXiv:2202.00003). arXiv. http://arxiv.org/abs/2202.00003

Sedlmeir, J., Buhl, H. U., Fridgen, G., & Keller, R. (2020a). Recent Developments in Blockchain

    Technology and their Impact on Energy Consumption. *Informatik Spektrum*, *43*(6), 391–

    404. https://doi.org/10.1007/s00287-020-01321-z

Sedlmeir, J., Buhl, H. U., Fridgen, G., & Keller, R. (2020b). The Energy Consumption of

    Blockchain Technology: Beyond Myth. *Business & Information Systems Engineering*,

    62(6), 599–608. https://doi.org/10.1007/s12599-020-00656-x

Sisson, P. (2022). The new block club: Blockchain tech, still nascent and little understood, could

    have significant implications for city services and the environment. *Planning*, *88*(3), 34–39.

    http://proxy01.its.virginia.edu/login?url=https://search.ebscohost.com/login.aspx?direct=tru

    e&db=lgh&AN=157900416&site=ehost-live&scope=site

Truby, J., Brown, R. D., Dahdal, A., & Ibrahim, I. (2022). Blockchain, climate damage, and

    death: Policy interventions to reduce the carbon emissions, mortality, and net-zero

    implications of non-fungible tokens and Bitcoin. *Energy Research & Social Science*, *88*,

    102499. https://doi.org/10.1016/j.erss.2022.102499

U.S. NFT user characteristics 2021. (n.d.). Statista. Retrieved September 17, 2022, from

    https://www.statista.com/statistics/1265821/us-nft-user-demographics/