BLOCKCHAIN, SMART CONTRACTS FOR SMART & SUSTAINABLE BUILDINGS

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BACKGROUND

Canada's commercial real estate sector has committed to reducing GHG emissions and energy consumption in alignment with the Canadian Net-Zero Accountability Act by 2050 (Berardi & Jafarpur, 2020). As Canada's population continues to grow, urban infrastructure strategies will be integral to the overall life quality of Canadian citizens (Oliveira et al., 2020). Residential, commercial, and institutional buildings in 2015 accounted for 22.6% of energy use-related GHG emissions in Canada (Berardi & Jafarpur, 2020). BOMA (Building Owners and Management Association) and LEED (Leadership in Energy and Environmental Design) are Canada's two leading certification systems for sustainable buildings (Rahman et al., 2017). Recently, the sentiment around smart buildings has changed drastically within the commercial real estate industry and academic literature (United for Smart Sustainable Cities, 2020). Canada's commercial real-estate sector believed that smart cities would pose significant security and privacy risks that would not be manageable or feasible (Kitchin & Dodge, 2019). Accelerated by Covid-19 and the need for resilient infrastructure, new digital solutions have demonstrated enormous potential for sustainable buildings in Canada (United for Smart Sustainable Cities, 2020). The transition to smart cities and buildings in Canada is evident in BOMA's adoption of tech strategies for their certification system (Daily et al., 2019). One of the most controversial technologies for smart, sustainable buildings is Blockchain (United for Smart Sustainable Cities, 2020). The proposed research aims to understand the use case for blockchain integration to achieve smart, sustainable buildings in Canada.

RESEARCH QUESTION

What does the literture reveal about Blockchain's potential for Smart & Sustinable Buildings?

OBJECTIVES

- Conduct a Literature Review on Blockchain and its potential for Commercial Real-Estate
- Overview of the top green building rating programs globally
- Decipher the potential of Blockchain for sustainability approaches given the high rate of Bitcoin mining operations that allow it to exist

KEY DEFINTIONS

PROOF OF WORK VS PROOF OF STAKE

The difference between Proof-of-Work (POW) and Proof-of-Stake (POS) is important to consider when analyzing the energy efficiency of a blockchain project (Nur Arifin Akbar, 2021). POW protocols requires complex computations that take place in order for a digital ledger to persist (Nur Arifin Akbar, 2021). These complex computations require enormous amounts of energy that make sustainability approaches on blockchain counterintuitive (Nur Arifin Akbar, 2021). POS offers a less energy intensive protocol to the computations that allow the blockchain digital ledger to persist (Nur Arifin Akbar, 2021).

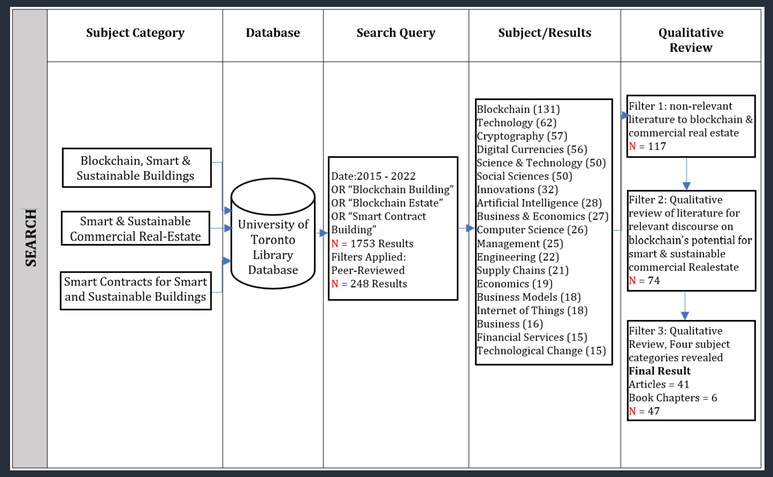
BLOCKCHAIN, DISTRUBUTED LEDGER PEER-TO-PEER NETWORK

Blockchain is a democratically sustained and distributed public ledger of transactions (Rana et al., 2019). Blockchain operates on a decentralized peer-to[1]peer network through bitcoin mining operations (Rana et al., 2019). Blockchain has five core principles that explain its technology process (United for Smart Sustainable Cities, 2020). Blockchain operates on coding irreversibility, peer-to-peer transactions, decentralization, transparency, and algorithm bitcoin mining nodes (United for Smart Sustainable Cities, 2020).

SMART CONTRACT

A smart contract is a program that is representative of a digital code. that is recorded and transacted on blockchain (Arcari, 2019). Examples of a blockchain digital ledger are Ethereum, Cardona, and Solana. Smart-Contracts are instruments that are written in code that control and record the exchange of consideration between two or mote parties (Arcari, 2019). Advocates believe that smart contracts will revolutionize the way that firms have historically transacted and will offers a plethora of use-cases to be applied to sustainability protocols (Arcari, 2019). The future of smart contracts remains undefined my because its potential uses cases are limitless and can be applied to a plethora of sectors (Arcari, 2019).

METHODOLOGY



RESULTS REVEAL - FOUR MAJOR SUBJECT AREAS

Blockchain, Smart and Sustainable Buildings Exploratory Literature Review - Subject Areas			
	Articles	Book Chapters	
Blockchain Construction Strategies for Commercial Realestate	17	1	
Blockchain Energy Management Strategies for Commercial Realestate	11	2	
Blockchain, Smart Buildings within Smart Cities	8	2	
Blockchain, Smart Contracts for Smart Buildings	6	0	N = 47

FINDINGS

Canada has agreed to carbon net-zero status for all commercial real estate by 2050 per the Paris agreement (Parida and Ananthram, 2021). One of the most significant barriers to this goal is that there are no overall statistics of how many buildings exist in Canada (Parida and Ananthram, 2021). Canada's most prominent green building certification programs to move this agenda forward are EnergyStar, BOMA, LEED, WELL, and BREEAM (Parida and Ananthram, 2021). However, these voluntary programs are presented with barriers beyond environmental assessment and energy-efficient applications (Bond, 2016). Canada's commercial real estate industry consists of large portfolios such as QuadReal and Fiera Capital, managing hundreds of buildings across Canada. These buildings are constantly sold from one portfolio to another, and during this process, new property managers are continuously assigned to new properties (Bond, 2016). During this transition, property managers have little to no record of the sustainability management practices that were in place before their arrival (Bond, 2016). A smart contract that acts as a building sustainability record beyond real estate portfolio or property management regulation offers a solution to this problem. Smart Contracts operate on a blockchain digital ledger through applications such as Ethereum, Cardona, and Solana (Jaradat, 2022). Attaching a digital record to a building utilizing blockchain will allow data input to be stored transparently. In addition, no party can alter the energy-efficient data previously stored on the digital record (Francesca, 2020). This framework would also hold property managers and building portfolios accountable for moving their buildings' sustainability agenda forward to carbon net-zero status. Lastly, a sustainability digital record would also provide a digital consensus of how many buildings exist and what stage they are in on their path to reach carbon-net zero status. The literature review revealed four different use cases for blockchain in commercial real estate. These use-cases include blockchain in construction, blockchain in energy management, smart city blockchain applications, and smart contracts for smart buildings. The key findings demonstrated that smart contract use cases for sustainability in commercial real estate are heavily under-researched. However, the literature on blockchain for commercial real estate demonstrates an overall consensus that blockchain does have the potential to be an integral part of sustainability approaches to commercial real estate goals moving forward.

ETHEREUM, CARDANO, SOLANA

Ethereum is the most popular blockchain digital ledger, it functions by establishing a peer-to-peer networks that securely executes smart contract transactions (Hunhevicz et al., 2021). This process allows for participants to interact with each other without the need of a central authority (Hunhevicz et al., 2021). Cardano has risen to popularity because of its energy efficient framework for peer-to-peer transactions on the digital ledger that provides a multi-asset ledger for verifiable smart-contacts (Hunhevicz et al., 2021). Lastly, Solana demonstrates the fast progress the crypto sector has made in developing an energy friendly digital ledger that has extremely low gas and transaction fees (Hunhevicz et al., 2021). The progress from Ethereum to Cardona and Solana demonstrate that the benefits that smart contracts have to sustainability are not counterintuitive and they are tangible.

GREEN BUILDING RATING & ASSESMENT PROGRAMS

Green Building Rating Systems (GBRs) have existed internationally for twenty-plus years (McArthur & Powell, 2020). However, the process for applying, measuring, and reporting the associated sustainability certification programs is still somewhat of a confusing subject area (Vieira De Castro et al., 2020). Although many sustainable certification programs exist globally, the nature of the sustainability guidelines and green building schemes differ vastly in wording and meaning (Vieira De Castro et al., 2020). Internationally, the commercial real estate industry is growing in its awareness of the benefits of sustainability approaches (Daily et al., 2019). Currently, owners, corporate tenants, and property investors are beginning to understand how vital environmental, social, and governance frameworks are to making holistic investment decisions (Vieira De Castro et al., 2020). Sustainability rating systems tend to have three main stages classification, characterization, and valuation (Subramanian, 2017). Below is a list of five of the most prominent and well-known certification programs globally (Vieira De Castro et al., 2020). The list aims to give the reader a basic introduction to the framework and approaches of GBRs.

ENERGY STAR

The Environmental Protection Agency established Energy Star in 1992, aligning with the Energy Policy Act of 2005 (Energy Star, 2022). Energy Star specializes in energy-efficient strategies that involve led light bulbs, better insulation, smart thermostats, and computer-powered management systems (Energy Star, 2022). Since 1992, Energy Star has been able to help industrial and commercial real estate in the United States save five trillion kilowatt-hours of electricity (Energy Star, 2022). Energy Star and its partners have saved more than four hundred and fifty billion dollars in associated energy costs throughout the United States in commercial real estate (Energy Star, 2022). Energy Star has demonstrated to the commercial real estate industry in North America that there are significant cost savings associated with sustainable energy management practices (Energy Star, 2022).

U.S. GREEN BUILDING COUNCIL LEED USGBC

The LEED rating system was established in 1998, by the United States Green Building Council (Subramanian, 2017). LEED is considered by industry stakeholders as the most widely recognized sustainable certification program in the world (Subramanian, 2017). LEED certification utilizes a point system to categorize four thresholds of achievement; certified (40-49 points), silver (50-59 points), Gold (60-79 points), and platinum (80 points and above) (Subramanian, 2017). There are a total of seven categories where projects can accumulate points to a maximum of 126 points; sustainable sites (26 points), water efficiency (10 points), energy and atmosphere (35 points), materials and resources (14 points), indoor environmental quality (15 points), innovation in design (6 points), and regional priority (4 points) (Subramanian, 2017).

BOMA Canada

The BOMA corporate entity consists of BOMA International and its affiliate BOMA Canada (Daily et al., 2019). BOMA International consists of 93 local organizations across the United States, while BOMA Canada consists of 11 local organizations that are spread out across the provinces of Canada (Stowe, 2008). BOMA was first founded in 1907 by the BOMA International federation. BOMA Canada established BOMA BEST in 2005 to address the needs for tangible standards for the energy and environmental performance of existing buildings (Daily et al., 2019). BOMA Canada has currently certified over three thousand buildings across Canada that fit into the categories of enclosed shopping centres, health care, light industrial, multi-unit residential buildings, and office asset types (Daily et al., 2019). BOMA BEST is Canada's largest certification programs for the environmental assessment of existing buildings (Daily et al., 2019). BOMA Canada also facilitates national initiatives through the exchange of ideas to support their local member associations in the promotion of advocacy, and education (Rahman et al., 2017).

BREEAM

BREEAM was launched in the United Kingdom in 1990 and has established itself as an internationally recognized measure of building standards (Subramanian, 2017). International versions of BREEAM have been created to fit the context of buildings associated with different regions globally (Subramanian, 2017). The classification criteria for new constructions using BREEAM are health and wellbeing, energy, water, materials, waste, land use and ecology, innovation, pollution, and management (Subramanian, 2017). A percentage-based system is used to asses the project development and as follows; pass (30%), good (45%), very good (55%), excellent (70%), and outstanding (85%) (Subramanian, 2017). BREEAM has also established an international network of over 2500 fully licensed and trained auditors that asses the application of BREEAM to new construction projects (Subramanian, 2017).

WELL

WELL, provides a performance-based approach to measuring the sustainability of buildings as it relates to its affect on human health (Young, 2016). WELL, utilizes best practices that focus on design and construction of buildings to better enhance the well-being of its tenants (Young, 2016). Specifically, WELL looks to understand the features of the built environment that impact human health such as air quality, water, nourishment, light, fitness, comfort, and mind (Young, 2016). WELL, uses medical and scientific research to back their approach to developing the best practices health buildings and tenants (Young, 2016). The WELL Standard is composed of more than 100 features that can be applied to commercial and institutional offices in three construction types: new and existing interiors, core and shell, and new and existing buildings (Young, 2016).