

Article

A Global Review of Sustainable Construction Project Financing: Policies, Practices, and Research Efforts

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Abstract: Despite the increasing investment in sustainable development over the past decade, a systematic review of sustainable construction project financing is lacking. The objectives of this paper are to conduct a systematic review to examine the policies, practices, and research efforts in the area of sustainable construction project financing, and to explore the potential opportunities for the future research. To achieve these goals, this paper first reviewed the sustainable construction project financing practices implemented by four representative developed economies including the United Kingdom, the United States, Singapore, and Australia. Then, this paper reviewed the efforts and initiatives launched by three international organizations including the United Nations, the Organization for Economic Co-operation and Development, and International Finance Corporation. After that, this paper reviewed the research efforts of sustainable construction project financing published in peer-review journals and books. This paper identified four major research themes within this area, which are the review of financial stakeholders and market of sustainable construction, benefits and barriers to sustainable construction project financing, financial vehicles for sustainable construction projects, innovative models and mechanisms for sustainable construction project financing. Additionally, this paper revealed five directions for the future research of sustainable construction project financing, which are the identification of financial issues in sustainable construction projects, the investigation of financial vehicles for sustainable construction projects in terms of their strengths, limitations, and performances, the examination of critical drivers for implementing sustainable construction project financing, the development of a knowledge-based decision support system for implementing sustainable construction financing, and the development of best practices for implementing sustainable construction project financing. This paper contributes to the body of knowledge by reviewing existing policies, practices, and research efforts in the area of sustainable construction project financing. Meanwhile, the findings from this paper benefit the industry as well, because they are able to provide the practitioners with a holistic view of sustainable construction project financing, thereby enhancing their knowledge and skills in this regard.

Keywords: financing; sustainable construction project; review

1. Introduction

Nowadays it has been widely recognized that humanity is facing various grand challenges such as climate change, resource depletion, and environmental degradation [1–4]. Unfortunately, the building and construction industry is responsible for the rise of these challenges to a large extent, particularly because of its numerous consumption of energy, water, and raw materials [5–8]. According to the United Nations Environment Program [9], the building and construction industry has become a big energy consumer that uses 40 percent of global raw materials and 40–50 percent of global energy.

Meanwhile, it has been proved to be a principal waste contributor accountable for the 40 percent of solid waste and greenhouse gas emissions worldwide [10,11]. To address this critical issue, the construction authorities and industries worldwide have been continuously advocating and promoting sustainable construction over the past two decades, which is an innovative practice of creating resource-efficient and environmentally friendly structures [5,12,13].

Continued transformation toward a truly sustainable built environment requires an all-hands-on-deck approach [14–16]. Beyond innovative building design and materials [17–19], elevated resource efficiency standards [20,21], and comprehensive construction methods [22,23], sustainable construction project financing plays a critical role in fostering the development of sustainable built environment [24,25]. Sustainable construction project financing is a broad term that refers to raising capital investments for construction projects, or companies that are dedicated to support the development of a low-carbon and more sustainable built environment [26]. It is a strategic approach to incorporate various financial institutions (e.g., banks, insurance companies, property companies, investment trusts, institutional investors, and government) to direct their financial resources to the development of sustainable built environment [27]. Sustainable construction project financing is gaining attention currently. Particularly, momentum around sustainable construction project financing has increased significantly due to the 2016 Group Twenty (G20) Hangzhou Summit, in which the G20 Action Plan on the 2030 Agenda for Sustainable Development was released and the investment in sustainable construction was strengthened [28].

Currently, the literature on sustainable construction is ample [5,12,29,30]. However, the majority of them mainly concentrate on the environmental benefits of sustainable construction projects and the innovative design and construction technologies applied in sustainable construction projects [31–33], while a systematic review of sustainable construction project financing remains lacking. Therefore, this paper aims to review the ongoing policies, practices, and research efforts in the area of sustainable construction project financing, and to identify the potential opportunities for future research actions. This paper contributes to the body of the knowledge of by reviewing the state of the art of sustainable construction project financing and revealing the potential areas for future research. Meanwhile, this paper is helpful to industry practitioners as it has summarized and presented the lessons learned from the current sustainable construction project financing practices, thereby enhancing their knowledge and skills in this regard.

2. Methods

This paper conducts a systematic literature review of sustainable construction project financing, which not only looks at the research findings obtained by the academia but also assesses the policies and practices implemented by the authorities and industry. The literature reviewed by this paper contains three sections, the policies and practices of sustainable construction project financing implemented by representative developed economies, the efforts and initiatives launched by selected international organizations, research outcomes presented in peer-review journals and books.

Comparing to developing and undeveloped economies, developed economies are more active for sustainable construction. This is because developed economies normally have better economic conditions to address sustainable built environment development [5]. Therefore, this paper selected four representative developed economies to review their policies and practices adopted for sustainable construction. These four developed economies were the United States (US), the United Kingdom (UK), Singapore, and Australia, all of which are active players in promoting sustainable construction globally [12]. In addition to developed economies, some international organizations are keen on promoting sustainable construction as well [29]. They have launched various guidelines and initiatives to finance the development of sustainable built environment over past two decades [5]. Therefore, this paper also selected three notable and typical international organizations, namely the United Nations, the Organization for Economic Co-operation and Development (OECD), and International Finance Corporation to review their efforts and initiatives launched for sustainable construction.

To learn the research progress on sustainable construction project financing, this paper reviewed the research findings published in peer-review journals and books in the last decade (i.e., 2008–2017). Web of Science is a powerful, highly recognized academic search engines used by researchers worldwide to track the latest research progress in various areas [34–38]. Thus, this paper selected to use Web of Science to track down those published journal articles relating to sustainable construction project financing. Four concise codes, including “TITLE: (green) AND TITLE: (finance),” “TITLE: (green) AND TITLE: (financial),” “TITLE: (sustainable) AND TITLE: (finance),” and “TITLE: (sustainable) AND TITLE: (financial),” were searched in Web of Science within the collections of Science Citation Index Expanded, Social Sciences Citation Index, and Emerging Sources Citation Index. Initially, a total of 148 papers were identified from the search. Then a careful visual examination was made to check the relevance of the identified papers. The visual examination results showed that the majority of the identified papers were irrelevant to the area of sustainable construction, and that only 11 identified papers examined sustainable construction project financing specifically. Thus, these 11 papers were selected for further review. Table 1 presents the details of these papers. In addition to peer-review journals, an increasing number of books that discuss sustainable construction have been published over the past decade [39]. This makes books also an important source of literature for this paper. Hence, this paper also conducted an exhaustive search in Google Books trying to identify the books relating to sustainable construction project financing. Finally, seven books that investigated sustainable construction project financing were identified. The details of these seven books were summarized in Table 2.

The following sections review the sustainable construction project financing practices implemented by selected developed economies, the sustainable construction project financing initiatives launched by selected international organizations, the research outcomes of sustainable construction project financing published in peer-review journals and books.

Table 1. Journal Articles Identified from the Literature Search.

No.	Reference	Journal	Topic
1.	Zhan and de Jong [40]	Sustainability	Financial vehicles for sustainable construction projects
2.	Yamaguchi and Managi [41]	Journal of Environment and Development	Financial vehicles for sustainable construction projects
3.	Siamanta [42]	Journal of Political Ecology	Review of sustainable construction project financing market
4.	Streimikiene [43]	Renewable & Sustainable Energy Reviews	Review of sustainable construction project financing market
5.	Soundarrajan and Vivek [27]	Agricultural Economics	Financial vehicles for sustainable construction projects
6.	Fu, et al. [44]	Sustainability	Review of sustainable construction project financing market
7.	Busch, et al. [45]	Business & Society	Review of sustainable construction project financing market
8.	Lee, et al. [46]	The Scientific World Journal	A financing model to overcome financial barriers for sustainable construction projects
9.	Bose, et al. [47]	Energy Policy	A proposed solution for financing sustainable construction projects
10.	Patlitzianas and Christos [48]	Renewable & Sustainable Energy Reviews	A financing mechanism for sustainable development
11.	Lutzkendorf, et al. [49]	Building Research and Information	Review of financial stakeholders for sustainable construction projects

Table 2. Books Identified from the Literature Search.

No.	Book Title	Author	Publisher
1.	New Financial Strategies for Sustainable Buildings: Practical Guidance for Built Environment Professionals	Finnegan [39]	Taylor & Francis
2.	Delivering Sustainable Buildings: An Industry Insider's View	Malina [50]	John Wiley & Sons
3.	Sustainable Finance and Banking: The Financial Sector and the Future of the Planet	Jeucken [51]	Routledge
4.	The Law of Green Buildings: Regulatory and Legal Issues in Design, Construction, Operations, and Financing	Howe, et al. [52]	American Bar Association
5.	The Green Building Revolution	Yudelson and Fedrizzi [53]	Island Press
6.	Global Trends in Real Estate Finance	Newell and Sieracki [54]	John Wiley & Sons
7.	Green Building and Sustainable Development: The Practical Legal Guide	Furr, et al. [55]	American Bar Association

3. Sustainable Construction Project Financing Practices around the World

3.1. Sustainable Construction Project Financing Practices in Developed Economies

3.1.1. The United Kingdom

To promote investment in sustainable built environment development, various policies and practices relating to sustainable construction project financing have been developed in the UK [56]. These policies and practices have different forms such as direct subsidy, creating institutions and mechanism to catalyze the investments into green projects. In 2012, the United Kingdom set up the world's first Green Investment Bank, whose primary responsibility is to support and overcome barriers to investment in green projects [57]. Particularly, financing sustainable construction projects and building retrofit projects are Green Investment Bank's priority areas [58]. Also, to accelerate investment in green retrofits to existing buildings, the UK launched Feed-in Tariff in April 2010, under which private businesses sectors and households would be paid for installing green features that can generate electricity from renewable sources such as wind, solar, and small-scale combined heat and power [59]. In addition to Feed-in Tariff, the UK also launched another similar scheme named Renewable Heat Incentive in November, 2011 to encourage the installation of measures which can generate renewable heat (e.g., solar thermal panels, renewably powered district heating, heat pumps, biomass boilers and deep geothermal systems) [60]. Another scheme of sustainable construction project financing implemented in the UK is The Green Deal, which was launched in 2012 [50]. The scheme was designed based on a 'pay as you save' model: householders received up-front finance in the form of loan and used it to install energy saving measures in their buildings first, and then they repaid the loan using the savings achieved from their utility bills [61]. However, in July 2015, this scheme was scrapped by the Conservative Government saying that it had failed to deliver its objectives [62].

3.1.2. The United States

Over recent decades, the U.S. government has provided a bunch of financing options at different levels including federal, state, and municipal levels to support the development of sustainable built environment [63]. For instance, at federal level, the U.S. government initiated Energy Efficiency and Conservation Block Grant program, Weatherization Assistance Program to support the units of local government, Indian tribes, and low-income families to carry out green retrofits to their buildings [64,65]. Also, the United States Department of Housing and Urban Development launched several financing programs such as Energy Performance Contracting and Capital Fund Financing Program to assist the development of housing projects that meet energy star construction and appliance purchase

standards [63]. Likewise, at state level, a large number of grant, loan, leasing, and rebate programs had been kicked off to finance sustainable development [52]. As for municipal level, various green bonds, such as Qualified Green Building and Sustainable Design Project bonds, Qualified Energy Conservation Bonds, and Clean Renewable Energy Bonds, were launched as the main vehicles to finance sustainable development [52]. Additionally, the U.S. federal government enacted a large number of tax incentives to encourage the development and retrofit of U.S. housing to promote its energy efficiency. These incentives include Tax Credit for Home Builders, Tax Credits for Manufacturers of Energy Efficient Appliances, Tax Credits for Non-Solar Home Improvements, and Tax Credits for Home Solar Improvements [63]. Moreover, the U.S. Department of Energy funded a platform named Database of State Incentives for Renewables and Efficiency, which contains 1324 cost reduction programs available through U.S. The primary mission of this platform is to provide more affordable options for green retrofitting projects in U.S. to increase their sustainable improvements [66].

3.1.3. Singapore

Singapore is a global leader in the area of developing sustainable built environment. Over the past decade, the number of green buildings in Singapore has increased dramatically, from less than 20 in 2005 to over 2100 in 2014 [67]. It has to be mentioned that financing programs from the Singapore government contributed significantly in achieving this significant progress [68]. Currently, there are at least ten government financing programs for sustainable construction being implemented in Singapore. The missions of these programs vary significantly, from providing credit facilities for building owners to carry out energy efficiency retrofits (e.g., Building Retrofit Energy Efficiency Financing), co-funding building owners in undertaking energy efficiency retrofits (e.g., Green Mark Incentive Scheme for Existing Buildings), through to supporting private sector to developing green buildings (e.g., Green Mark Gross Floor Area Incentive Area) [69]. These programs reflect real commitment by local policymakers to the development of built environment in Singapore.

3.1.4. Australia

In 2008, the Australian Federal Government established a Green Building Fund amounting to AUD 90 million (approximately USD 71.24 million) to directly fund green retrofit to existing buildings. This fund represents the first, large scale effort on the part of the Federal Government to fund the development of sustainable built environment [70]. Meanwhile, financing actions also exist at the state level. In 2015, South Australia introduced a green building upgrade and retrofit financing scheme named Environmental Upgrade Finance [11]. This scheme enable property owners, occupants, service providers, and property managers to access a particular type of loan, which can be used to retrofit their buildings and finally repaid to financiers via a government charge levied on the property. This scheme can effectively address the barrier of 'split-incentive' for the green retrofit to leased properties, which means the tenants enjoy the benefits of retrofitting but owners bear the cost. This scheme makes good economic sense for property owners, occupants, and the business sectors that can provide clean technologies and solutions [11,71].

3.2. *Efforts and Initiatives from International Organizations*

3.2.1. United Nations

In 1972 in the United Nations Conference on the Human Environment, Stockholm, Sweden, United Nations established the United Nations Environment Program (UNEP) as its environmental conscience [72]. Since its inception, UNEP has been striving to seek solutions that can balance the economic growth and environmental protection. In 1991, United Nations launched United Nations Environment Program-Finance Initiative (UNEP-FI), a partnership between UNEP and over 200 leading global banks (e.g., Deutsche Bank and HSBC Holdings), investment funds, and insurance companies (e.g., General Accident and National Provident) [73]. The primary objective of UNEP-FI

is to engage these leading financial institutions in a constructive dialogue on the nexus between environmental protection, sustainable development, and economic development [74]. Furthermore, another objective of UNEP-FI was to catalyze private sector investment in the area of sustainability, particularly those would be used for sustainable construction. Apart from that, UNEP-FI also launched considerable publications that discuss the framework and decision-making for sustainable construction investments [75].

3.2.2. The Organization for Economic Co-operation and Development (OECD)

In 2016, the OECD established a Centre on Green Finance and Investment, whose primary mission is to help catalyze the transition toward a sustainable, low-emissions and climate-resilient economy through the development of effective institutions, policies, and instruments [76]. This Centre leverages the OECD's economics and policy expertise and serves as a global platform to engage with key financial institutions to achieve sustainable development. Additionally, the Centre was trying to make itself a knowledge exchange center for the different players of sustainable construction such as government, private sector, regulatory institutions, academic and civil society [76]. Moreover, the OECD has recently released a series of reports reviewing a variety of market mechanisms and policies regarding sustainable construction project financing [77] and clean energy investment policy [78]. Furthermore, the OECD launched several reports that summarized the rationales, mandates and financing activities of green investment banks publicly capitalized [79], the barriers to attracting international investment in sustainable development [80], as well as the various channels that can mobilize institutional investment in sustainable development [81], respectively. All these reports have provided practical information and evidence-based analysis to industry practitioners and policy makers, improving their understanding of financing for sustainable construction.

3.2.3. International Finance Corporation

As a member of the World Bank Group, International Finance Corporation (IFC) is the largest global development institution that focuses exclusively on the development in developing countries [82]. One of IFC's primary objectives is to help the private sector achieve sustainable development through innovative investments and financing. Since 2005, the IFC has invested about \$15.3 billion in long-term financing for energy efficiency, renewable power, and green buildings [82]. Additionally, IFC is also one of the earliest issuers of green bonds. It started launching green bond program to private sectors as early as in 2010 [83]. As of 2014, the IFC has supported 93 green bond eligible projects worldwide amounting close to USD 3 billion [84]. Moreover, IFC plays a leading role in developing principles, procedures, and guidelines for the global green bond market, providing the issuers and investors practical guidance in launching a credible green bond for sustainable construction projects [83]. Apart from that, the IFC also released green bond impact report annually, which has been widely referenced by numerous financial sectors and institutions around the world.

4. Research Findings within Sustainable Construction Project Financing

Based on a systematic review of the identified journal articles and books, it was found that current research of sustainable construction project financing concentrated on four areas, including the review of financial stakeholders and market of sustainable construction, benefits and barriers of sustainable construction project financing, the identification of financial vehicles for sustainable construction, and innovative models and mechanisms for sustainable construction project financing. In the following sections, each area was briefly introduced and described. Insights and reasons into current practices were also provided.

4.1. Review of Financial Stakeholders and Market of Sustainable Construction

Lutzkendorf, Fan and Lorenz [49] listed seven major financial stakeholders engaging in sustainable construction projects, including (1) financial sector like banks and insurance companies; (2) project

developers; (3) property companies and housing companies; (4) initiators, providers and managers of property funds and Real Estate Investment Trusts; (5) Institutional investors such as investment companies, investment funds, and pension funds; (6) individual/private investors; and (7) government. However, Lutzkendorf, Fan and Lorenz [49] pointed that, although most financial stakeholders (particularly banks, insurance companies and investors) have already been engaged with the development of sustainable built environment, their understandings of such particular type of projects remain limited. Similar conclusions were also obtained by Busch, Bauer and Orlitzky [45] who pointed out that current financial stakeholders have not been ready to embrace sustainable construction finance. To address this critical issue, both Lutzkendorf, Fan and Lorenz [49] and Busch, Bauer and Orlitzky [45] suggested carrying out education and training for the employees of these financial stakeholders to increase their knowledge and competencies in sustainable construction finance.

In addition to financial stakeholders, sustainable construction project financing market was also investigated. After analyzing the data collected from 33 developing countries during 1997 and 2012, Fu, Chen and Choi [44] discovered the significant promotion effect of the private investments on the development of financial markets. They also confirmed the significant mediator effect of financial market size for the positive relationship between the private investments and the liquidity of the financial market. By contrast, Siamanta [42] found some side effect of sustainable construction finance which was due to overinvesting. Siamanta [42] examined the growth of photovoltaic projects in Greece, and found that this country has overemphasized green development, resulting in a few green economy entrepreneurs monopolizing the whole country's market. This has led to the accumulation of capital to a few large renewable energy resources companies, imposing significant negative impacts on the livelihoods of small business consumers.

4.2. Sustainable Construction Project Financing: Benefits and Barriers

Several benefits of implementing sustainable construction project financing were identified from literature. First, implementing sustainable construction project financing helps promote the diffusion of green construction technologies in the construction industry. Meanwhile, it can add value to those business, organizations and corporations who engage in sustainable construction finance by creating them a positive social image and bring them a green edge further [27]. Moreover, implementing sustainable construction project financing can enable financial institutions to face less risks compared to financing traditional construction projects. This is because the building owners and contractors who embrace green technologies are likely to be more risk ready and always practice more carefully in building construction, operation, and maintenance [85].

In addition to benefits, this review spotted several barriers that hinder the involvement of financial institutions in sustainable construction. These barriers are split incentives, lack of consistent, accurate data analysis and interpretation, lack of knowledge about sustainable construction, high upfront costs, and regulatory gaps. The barrier of split incentives is actually not unique to financial institutions but a generic barrier to any organizations involved in sustainable construction. It is a principal-agent problem basically [85]. In particular, this barrier is more prominent in rental buildings as it makes building owners bear the cost of improving energy efficiency while the tenants enjoy the savings in utilities. Because of this barrier, a large number of owners of rental buildings are reluctant to invest in green retrofitting their buildings [11]. The lack of comprehensive, consistent, accurate analysis of data is another major obstacle to sustainable construction financing. This is because mostly financial institutions would not approve investment to sustainable construction projects until attractive financial returns and benefits from the future projects can be proved conclusively [86]. However, this is not feasible yet as there are many criteria, approaches, and standards being used for certifying sustainable built structures currently, making data cannot be analyzed and explained in a unified standard [85]. Lack of knowledge about sustainable construction is also a major barrier for the implementation of sustainable construction project financing. While interest in and understanding of sustainable buildings have increased dramatically in the recent years, the knowledge and skills of the professionals

in financial sectors on sustainable buildings may not catch up. A large number of financial professionals do not have a proper understanding of sustainable buildings, making them unable to deal with the financing affairs of sustainable construction projects effectively [85]. High upfront costs have also been considered as a significant barrier. According to California Sustainability Alliance [87] and Lee, Lee, Kim and Kim [46], high upfront costs is a particular barrier to investors engaging in green leasing. Another barrier to the expansion of sustainable construction project financing lies in regulatory gaps, which refers to the absence of applicable laws, regulations, and the monitoring and enforcement systems that can govern the implementation of sustainable construction finance [27].

4.3. Identification of Financial Vehicles for Sustainable Construction

Five prevailing financial vehicles that have been widely used for sustainable construction were identified, which are bank loans, green bonds, international assistance programs, government grants and tax incentives, and private capitals.

4.3.1. Bank Loans

Bank loans are one of the most common financial vehicles for sustainable construction due to its high flexibility in terms (e.g., long-term and short-term) and types (e.g., secured, unsecured, demand, subsidized, and concessional loans) [40]. Over past two decades, numerous banks around the world have been continuously arranging loans to finance the development of sustainable built environment. For instance, Citigroup launched a green lending initiative amounting to USD 50 billion in May 2007 [63]. Bank of America unveiled a USD 20 billion, ten-year green mortgage program in March 2007 [63]. Up to 2009, Wells Fargo has loaned more than USD 1.7 billion to approximately 35 Leadership in Energy and Environmental Design (LEED) projects [55]. However, according to the review, despite their active involvements, banks' attitudes toward loans for sustainable development seem divided in terms of their sizes. Furr, American Bar Association, Section of Real Property and Law [55] noticed that, compared to larger banks, the smaller regional banks are more supportive of financing sustainable development. They offer various preference programs for sustainable development, such as preferred project review, reduced interest rates, exemption for initial premium of mortgage for green commercial building development, and increased loan-to-value ratios. By contrast, larger banks are relatively more conservative. They normally treat sustainable development projects as conventional development projects. They do take green specific considerations into account when doing project reviews. But as a whole, they still grant loans based on the fundamentals underlying the projects. In addition to the merits of bank loans, some of its disadvantages were also reported by literature. These disadvantages contained high financing costs, limited credit amounts, and complicated procedures to obtain approval from banks [40].

4.3.2. Green Bonds

According to The World Bank [88], essentially a bond is a form of debt security issued to raise capital for certain development purpose and can be bought and sold between corporate entities. As for green bond, literally it is a debt security that is issued to raise capital for environmental projects which has definitely covered the sustainable construction projects. According to review, in the past decade, green bonds are receiving increased attention from financial institutions and institutional investors and have become popular in financing sustainable construction projects. Especially, multilateral banks are the most active financial institutions in issuing green bonds to support sustainable construction [88]. For instance, the African Development Bank issued a USD 500 million green bond in October 2013 to support the development of sustainable built environment in Africa [88]. In 2007, the European Investment Bank issued a EUR 600 million green bond that mainly focused on renewable energy and energy efficiency retrofit to buildings [89]. Since 2008, The World Bank has issued over USD 10 billion equivalent in green bonds through more than 130 transactions in 18 currencies to support at least 70 sustainable development projects around the developing world [88,90]. The green bonds issued

by those multilateral banks have catalyzed financial market on sustainable construction projects tremendously and helped attract substantial investment in such type of projects. Furthermore, review also shows that recently private sectors have become interested in issuing green bonds to finance sustainable construction projects. A typical case is Regency Centers Corporation, a real estate investment trust who issued USD 250 million of green bonds in May 2014 to finance the construction of shopping malls that would meet the standards of the U.S. Green Building Council [91].

4.3.3. International Assistance Programs

Recently, several international financing institutions such as the Global Environment Facility (GEF) Trust Fund, Special Climate Change Fund, Least Developed Countries Fund, Nagoya Protocol Implementation Fund, and Adaption Fund have provided a series of international assistance programs to support the sustainable development around the world, particularly in those developing countries [92]. One of priorities of these international assistance programs is to finance sustainable built environment development [93]. For instance, The Global Environment Facility Trust Fund offered a USD 6.16 million grant to sponsor the development of Sino-Singapore Tianjin Eco-City. The grant was allocated to four areas, including integrated water technical assistance, energy utilization, transport management, and construction of green buildings [94]. Additionally, when reviewing these international assistance programs, a commonality could be sensed, namely, the amounts of these programs are basically limited to certain extent. Nevertheless, still these international assistance programs are helpful and even play vital roles in financing sustainable development. This is because actually international assistance programs are actually the walking advertisements for those sustainable construction projects and can help attract more capitals and investments. The reason behind this is simple. Once a project is sponsored by an international assistance program, its feasibility and viability have been proved as the assessment process of these international assistance programs are very strict and rigorous in most cases.

4.3.4. Government Grants and Tax Incentives

In order to promote sustainable construction, governments around the world also provide increasing support in terms of grant preferences. For example, the United States Department of Housing and Urban Development launched a large number of financing programs such as Energy Efficiency and Conservation Block Program, State Energy Program, and Public Housing Capital-Energy Conservation Retrofit Investment Program to assist housing projects and help them meet energy star construction and appliance purchase standards [52,63]. Singapore initiated a series of incentive plans (e.g., Green Mark Incentive Scheme for New Buildings in 2006 and Green Mark Incentive Scheme for Existing Buildings in 2009) to encourage local developers, building owners and project consultants to develop and construct green buildings [67,68]. Some countries' governments are relatively more straightforward. They appropriate cash subsidy to sustainable construction projects directly. For example, from 2013 to 2015, the city government of Tianjin, China appropriated CNY 299.72 million (approximately USD 44.18 million) to Sino-Singapore Tianjin Eco-City to support the development of this sustainable construction megaproject [40]. In addition to government grants, tax incentives enacted by governments around the world are another financial vehicle to encourage the development of sustainable construction [63]. In USA, numerous tax incentives have been launched, such as Energy Investment Tax Credit, Tax Credit for Energy Efficiency Improvements to Existing Homes, Residential Energy-Efficient Property Credits, Energy-Efficient Commercial Buildings Deduction, and Energy-Efficient New Homes Tax Credit [52]. During the development of Sino-Singapore Tianjin Eco-City, it has been reported that Tianjin government also refunded part of taxes derived from the project in order to encourage its development [40].

4.3.5. Private Capitals

Sustainable construction requires long-term investment and sustained financing [95,96]. Traditionally, public budgets are an important financial source for sustainable construction. But given the strains on public budgets, private capitals are needed for sustainable construction as well [97]. Over the past ten years, an increasing amount of private capitals from private companies have flown into sustainable construction sector [53,55,98]. In the beginning, private companies, particularly those real estate private companies, they invest in sustainable built environment mainly to create a positive image in term of corporate social responsibility. However, gradually they realize such particular investment can bring them reasonable economic returns. Therefore, they increase these investments [53]. Recently, a large number of Real Estate Investment Trusts around the world have invested in sustainable buildings. For example, both Corporate Office Properties Trust and Liberty Property Trust developed LEED Silver buildings for corporate tenants [99,100]. This is because they find sustainable buildings are wiser investments as they are leased up faster, cheaper to operate, and can attract tenants of better quality [53]. Another case is Corporate Office Properties Trust. One of its sustainable construction projects is 318 Sentinel Drive, in the National Business Park in Annapolis Junction, Maryland, which received the 2005 National Associations of Industrial and Office Properties Green Development Award. The project, a four-story, 125,000-square-foot office building, was fully leased even before the completion of construction [100]. In addition to investing to earn benefits, numerous private capitals have also been donated to renovate old buildings with green features. For example, a major donation was received by Ecotrust organization in Portland, Oregon from a single donor which was used to renovate a 100-year-old warehouse into a 70,000-square-foot modern building. This project won the second LEED gold-certified project in the United States when it opened in 2001 [53].

4.4. Innovative Models and Mechanisms for Sustainable Construction Finance

Another stretch of sustainable construction project financing research explores the innovative financing models and mechanisms. Realizing the development of sustainable built environment may face barriers in attracting sufficient funds, Lee, Lee, Kim and Kim [46] suggested a financing model that includes a governmental guarantee. Similarly, Yamaguchi and Managi [41] introduced a Green Net National Product-Linked Bond to finance sustainable construction. This developed bond can lead nation's wealth to sustainable development, raise future tax revenue if combined with tax reform, realize intergenerational sharing of well-being with current investors, and be a good opportunity to diversify assets to lower investment risk and volatility. Patlitzianas and Christos [48] introduced a modern financial mechanism named "JESSICA" to finance sustainable urban development projects. Under this mechanism, various forms of funds such as equity, loans and guarantees were provided to fund the development of sustainable urban projects, and the returns, for instance loan repayments will be used to reinvest new urban development projects and thereby bolstering sustainability. In order to improve the financing performance of sustainable construction projects, it is important and necessary to examine the relationship between the nature and the sources of financial flows. Hence, Bose, Ramji, Singh and Dholakia [47] developed an approach named "financial gradients" to analyze financial flows in sustainable construction projects. This approach can help identify and secure a single, long-term, stable inflow of finance to sustain the process of sustainable construction projects.

5. Future Research Directions

Based on the systematic review as above, five future research directions in sustainable construction finance can be sensed, including the identification of financial issues in sustainable construction projects, the investigation of performances for diverse financial vehicles for sustainable construction projects in terms of strengths, limitations, and performances, the examination of critical drivers for implementing sustainable construction financing, the development of a knowledge-based decision

support system for implementing sustainable construction financing, and the development of best practices for implementing sustainable construction project financing.

5.1. Identification of Financial Issues in Sustainable Construction Projects

One important point that has been omitted by current literature is to identify the financial issues in current sustainable construction projects. Currently, financial issues in traditional construction projects have been adequately addressed [101–104]. Various financial issues in traditional construction project, such as inflation and fluctuation, shortages of investment capital, poor credit ability, interest rate, liquidity, currency exchange restriction, have been comprehensively investigated [105–108]. However, similar research efforts have not been made in sustainable construction projects. Therefore, it is necessary and important to bridge this knowledge gap by identifying and summarizing the prevailing financial issues in current sustainable construction projects. By identifying these financial issues, it can provide the authorities and industry with a full view of the obstacles hindering sustainable construction project financing and then develop effective improvement strategies accordingly.

5.2. Investigation of Financial Vehicles for Sustainable Construction Projects in Terms of Strengths, Limitations and Performances

Although various financial vehicles such as bank loans, green bonds, international assistance programs, government grants and tax incentives, and private capitals have been identified in the current literature [40,52,55,63,94], they are yet to be investigated systematically. Thus, the next step of sustainable construction project financing research can also go to the investigation of financial vehicles for sustainable construction projects. Such kind of investigation may look at two aspects. First, there is necessity to investigate the strengths and limitations of various financial vehicles. This kind of research efforts cannot only help building owners and developers choose the most appropriate financial vehicle or the best combination of different vehicles to fund sustainable construction projects, but also provide the financial institutions with a good opportunity to upgrade their vehicles accordingly and thereby making them more financially feasible. Second, it is imperative to develop some systematic approaches to measure the financial performance of different financial vehicles, which can help building owners, developers and financial institutions to lock down the best financial vehicles. Furthermore, it would also be interesting to compare the performances of financial vehicles in traditional and sustainable construction projects, which will help the relevant stakeholders to decide whether to develop a sustainable building or a traditional building.

5.3. Examination of Critical Drivers for Implementing Sustainable Construction Financing

Current literature has looked into the benefits of and barriers to implementing sustainable construction project financing [11,27,85,86], however, it has not touched the drivers for implementing sustainable construction project financing. Thus, one of the most important directions for the future research can be examining the drivers for implementing sustainable construction project financing. Compared to examining benefits of and barriers, examining drivers is relatively more crucial as it is looking for some critical enablers that can help promote sustainable construction project financing in the current construction community. It would be particularly interesting to conduct some empirical studies to quantify and visualize the contributions of the different drivers for sustainable construction financing, the results of which will help enhance the academia and industry practitioners' understandings of sustainable construction financing greatly.

5.4. Development of a Knowledge-Based Decision Support System for Implementing Sustainable Construction Financing

Further to the examination of the critical drivers, a knowledge-based decision support system for implementing sustainable construction financing can be developed, which could be used by the investors, building owners, and developers to assess and select the best financial vehicles for a

given sustainable construction project. The system would be established based on a comprehensive knowledge base and a decision support algorithm. The knowledge base would consist of different financial vehicles as well as the various drivers that could affect the use of these financial vehicles. The decision support algorithm would calculate the feasibility scores of different financial vehicles for the given project based on the users' assessments of the drivers and then provide the corresponding recommendations.

5.5. Development of Best Practices for Implementing Sustainable Construction Financing

Existing literature reveals that current financial stakeholders are yet to be ready to embrace the tide of sustainable construction project financing due to their knowledge limitation in sustainable construction [45,49]. Thus, it is imperative to direct some particular research efforts in this regard to equip financial stakeholders with proper knowledge to make them capable of addressing sustainable construction finance. Actually, it would be even more meaningful if some research efforts can be made to develop a set of best practices for implementing sustainable construction project financing. Such a set of best practices can help financial stakeholders get a deeper understanding of sustainable construction finance, improve the skills of its workforce, and make them respond more quickly to the new challenges and problems. When developing the best practices, it is important to differentiate between different financial stakeholders as they play different roles in sustainable construction project financing and thus their best practices should be tailored and customized.

6. Conclusions

Investment in sustainable construction will definitely take place on a far greater scale over the coming decades due to the promotion of sustainable development. However, a systematic review of sustainable construction project financing remains lacking. Therefore, this paper undertakes a systematic review of practices, policies, initiatives, and research efforts in the area of sustainable construction project financing and explores the potential opportunities for future research actions. First, this paper reviewed the sustainable construction project financing practices implemented in representative developed economies such as the UK, USA, Singapore, and Australia. Then, this paper reviewed the efforts and initiatives of sustainable construction launched by a selected international organizations such as the UN, OECD, and IFC. After that, this paper reviewed the research efforts of sustainable construction project financing published in peer-review journals and books. Based on the review, four major research themes within the area of sustainable construction project financing were identified, which are the review of financial stakeholders and market of sustainable construction, benefits and barriers to sustainable construction project financing, identification of financial vehicles for sustainable construction, and innovative models and mechanisms for sustainable construction project financing. This paper also identified five future directions for sustainable construction project financing research, which are the identification of financial issues in sustainable construction projects, the investigation of financial vehicles for sustainable construction projects in terms of their strengths, limitations and performances, the examination of critical drivers for implementing sustainable construction project financing, the development of a knowledge-based decision support system for implementing sustainable construction financing, and the development of best practices for implementing sustainable construction project financing.

Although the objective of this paper has been achieved, there are some limitations. First, because of the limited time and space, this paper cannot cover all the sustainable construction finance practices and initiatives of every developed economy and international organization. Second, due to the limit of the search code, some studies and books that investigated sustainable construction project financing partly in their contents might be omitted.

In spite of the limitations, the findings from this paper are still valuable. This paper has presented the prevailing policies, practices, and research efforts of sustainable construction project financing implemented worldwide. This can provide practitioners with a holistic view of sustainable construction

project financing, thereby enhancing their capability in this regard. At the same time, this paper identified significant future research opportunities of sustainable construction project financing, which are helpful and informative to the academia as well.

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