Energy & Buildings 231 (2021) 110561

Contents lists available at ScienceDirect

Energy & Buildings

journal homepage: www.elsevier.com/locate/enb

Green building policies in cities: A comparative assessment and analysis

Mary Ann Joy Quirapas Franco [a], Priya Pawar [b], Xiaoying Wu [c,*]

[a] Department of Political Science, National University of Singapore, Singapore
[b] Institute of Energy Efficient and Sustainable Design and Building, TUM Department of Civil, Geo and Environmental Engineering, Munich, Germany
[c] Department of Building Science, School of Architecture, Tsinghua University, China

ARTICLE INFO

Article history:
Received 19 July 2020
Revised 7 October 2020
Accepted 11 October 2020
Available online 16 October 2020

Keywords:
Green building policies
Green building standards and certification
Cities
Energy efficiency

ABSTRACT

The development of green buildings brings opportunities to achieve energy efficiency and low-carbon societies. However, opportunities are not without risks and unintended consequences. The article contributes to the academic literature on green building by undertaking a comparative assessment and analysis of green building development from both developed and developing countries across the globe. From the various experiences and best practices of the selected cities, the study conducts an in-depth evaluation of Metro Manila: an analysis of the opportunities and challenges of developing a green building sector. The outlook of the research spans the political, economic, technological, social, and environmental perspectives. Aside from paving the way for a low-carbon city, the development of the green building sector could provide socio-economic benefits to Manila through job opportunities, inter-sectoral collaborations, and development of energy-efficient and resilient technologies. However, these benefits can only be maximized if the present policies also address the inherent conditions of the city like traffic congestion, urban sprawl, safety, and personal security issues, and lack of reliable public transportation. Beyond a cost-benefit analysis, the study critically assesses the unintended risks and consequences of the green building sector development in Manila and recommends various policy strategies to mitigate them. The research concludes that, for Metro Manila to reap the benefits of green buildings, an inclusive and holistic policy planning, and implementation must be present to mitigate the risks and unintended consequences.

1. Introduction

The year 2015 stood witness to the surpass of two environmental milestones; carbon dioxide (CO_2) levels reaching 400 ppm and 1 °C rise in annual average temperatures. The COP21 (Conference of the Parties 21) articulated two long term goals towards global climate efforts for 2025. The two aims of COP21 were to reduce the greenhouse gases (GHG) by 2025 to 2030 and vulnerability to the effects of climate change [1,2]. The building sector plays a vital role in accomplishing the targets for both developing and developed countries [3].

According to the International Energy Agency (IEA), the building and construction sector alone accounted for 36% of global final energy consumption and around 39% of energy and process-related CO_2 emissions in 2019 [4]. Manufacturing of building-related materials and products like cement, glass, and steel contributes about 11% of the fore-mentioned emissions [4]. Massive urbanization of new economies resulted in a surge of new building developments. However, the older building stock is largely left untouched with little regards to improve existing inefficiencies. If the current business as usual scenario continues, the anthropological GHG emissions from buildings in the next 20 years will be more than double the levels as accounted for in 2015 [5]. To modulate the rise as well as meet the targets of global GHG emission reduction, government agencies must tackle the emissions from the building sector. Mitigation of emissions from the buildings sector must serve as a cornerstone of all national climate change strategy.

The Intergovernmental Panel on Climate Change (IPCC) has published significant amount of scientific content along with research findings regarding the rise in global GHG levels, its effects on the global climate, mitigation framework and recommendations for stabilizing emission levels [3].The United Nations (UN) reports that 55% of the world's population already lives in urban areas and an increase to 68% is expected by 2050 [6]. IPCC's prediction for increase in energy use for Asian countries in the coming decades will be mostly from the building sector [5]. According to the global consultancy McKinsey & Company, in China alone, the urban pop-

* Corresponding author.
E-mail address: wuxiaoyi16@mails.tsinghua.edu.cn (X. Wu).

https://doi.org/10.1016/j.enbuild.2020.110561
0378-7788/

ulation may expand from 572 million in 2005 to 926 million by 2025, requiring a construction of four to five million new buildings to support the population's demand [7]. Countries in Southeast Asia also experience rapid urban growth where 70 million people in the region are forecasted to live in cities by 2025 [8]. The immediate need for megacities like Manila,[1] Bangkok and Jakarta are to have an "*adequate and sustainable urban infrastructure to meet the increasing pace of urbanization.*" [8, p. v]

The building industry, by virtue of its size, is one of the largest users of energy, material resources and water and is a formidable environmental polluter. As such, there is growing consent amongst establishments to commit towards the implementation of environmental performance targets. When accompanied with appropriate strategies and actions, the building sector has the potential to make its activities more sustainable [9]. All these actualities have incited the creation of green building standards, certifications and rating systems that can mitigate the impact of buildings on the natural environment through sustainable design [10].

The article explores and analyses various developments of the green building activities, standards, and certifications from across the globe and their applicability to the case of Metro Manila. In Southeast Asia alone, Metro Manila is one of the fastest growing cities in terms of economic growth and population [11]. However, it is also listed as one of the world's least sustainable cities in the world [11]. The mega city has not been able to successfully utilise its economic wealth to create social and environmental improvements necessary to achieve sustainable development. Scholars argue that for Manila to achieve such a status, there must be a balance amongst the three pillars of sustainable development – economic, environmental and social [12]. The article is an attempt to provide a clarity on the current gaps on the city's existing policy framework on sustainable development. What could be the lessons learned or best practices from other cities which Manila could adopt and tweak in order to drive sustainability? Using risk and consequences framework and comparative analysis of different cities across the globe, the paper argues that the establishment of green building design and practices, its standards and certifications could be among the crucial steps for Manila's sustainable development.

While there are technical reports and market analysis about green building standards and certifications, the study presented here is one of the few attempts to systematically outline the opportunities and challenges, risks, and consequences of green building development in Manila using an academic research framework. The main methodological approach of this article is a combination of within-case and cross-case analyses. The case study approach is employed in the study because of its usefulness to investigate further the "how and why" of particular event, a public policy or a decision. A case study based research can provide explanations on the rationale of decision, the decision-making process, and how they were implemented (or could be implemented) [13]. For the current paper, the authors particularly focus on the impacts of a policy implementation, i.e. green building development.

Although the study investigates a single case (within-case), it provides an in-depth and multidimensional analysis of Manila from the political, economic, social, environmental and technological perspectives. Furthermore, the authors make use of a comparative lens in drawing different countries' experiences in their development of green building standards and certification (cross-case). Both primary and secondary data analysis through expert interviews and desk review of related studies, reports, and publications.

[1] Technically, the city of Manila is one of the 16 cities within the Metropolitan Manila however for this study Manila and Metro Manila are used interchangeably. This study covers the whole Metropolitan Manila (a.k.a. Metro Manila).

Following is a brief description of the various sections of the article. Section 2 gives an overview of the definition of a green building, its importance to address carbon emissions and most importantly the current efforts from around the world in the development of green building standards and certifications. The section presents a comprehensive summary and collation of green building standards from different cities across the globe based on the it's country's status on the spectrum of development level, i.e. developing to developed countries. Section 3 expounds on the theoretical foundation of the paper, the justifications and limitations of using the chosen methodological approach and theoretical framework. Section 4 lays out the opportunities and challenges of green building development in the case of the Metro Manila. The analysis is multi-dimensional – investigating the topic from political, economic, social, technological, and environmental aspects. The main analysis and discussion of the article can be found in Section 5. In this part, the authors have critically emphasised the intended and unintended risks and consequences of green building developments, standards and certification. The paper ends with a conclusion and the recommendations from the findings of the authors.

2. Green Buildings, standards and certification

2.1. Addressing carbon emissions through green building standards and certification

In 2018, the building sector accounted for 28% of the global energy-related CO_2 emissions [14, p. 14]. According to an International Energy Agency (IEA) report, a rise in the emissions from the buildings has been witnessed for two consecutive years (2017 and 2018). The rise has been higher than the numbers noted in 2013 and is currently logged at all-time high [15]. The reversal in the trend of emissions from buildings is a combination of various factors. In 2013, there was a decrease in the emissions associated with building sector as progress was made in reducing the power generation carbon intensity [15]. However, there was an increase in the demand for building services dependent on energy consumption such as electricity for cooling appliances and equipment, plug loads. The demand for these energy services has grown faster than the production of decarbonized power which has subsequently led to the upturn of building-related emissions [15]. The change in climatic conditions also influenced the demand of mechanical heating and cooling with the buildings. The extreme weather changes in many parts of the world with hotter and prolonged summer conditions in the past decade are responsible for the increase in the electricity consumption [15]. Finally, there has been a decrease in the speed of energy intensity reduction from 2015 (2.5%) until 2018 (0.6%) and an increase in the floor area of 2.5% from 2017 to 2018. [15].

IEA report on World Energy Model suggests, *"the world is not on track to meet the energy-related components of the Sustainable Development Goals (SDGs)*" [16, p. 1]. IEA further explains the various Sustainable Development Scenarios (SDS) which may impact a significant transformation of the global energy system. The SDS illustrates the possibility of how the world can evolve to simultaneously achieve the three main energy-related SDGs [16]. In addition, the increase in building energy sector due to the combination of all the above mentioned factors is suggestive of impeding energy policy progress and a need for the evolution of building energy codes [15]. In order to get the energy performance of building sector on track with the SDS, the IEA report suggests a global annual drop in the energy intensity per m^2 to return to at least 2.5% (which was the rate of early 2000 s) at the earliest [15].

Both in developed and developing countries, the building sector contributes to significant amount of energy consumption and car-

bon emission. The rate of change in building energy intensity in developing country needs to double. The same is true for the developed countries as they need to apply deep energy renovations to the existing building [15]. In European Union (EU), energy consumption and carbon emissions from the building sector amount to around 40% and 36% respectively [17]. In China, 20% of the country's total energy consumption comes from buildings' operations. Beijing's energy usage in the building sector alone, accounts for more than three-quarters of all the city's carbon emission [18]. Manila is among the most densely populated city in the world – 40% of its carbon emissions are accounted from the building sector, predominantly from electricity consumption [18]. The residential energy consumption is expected to increase three times from 2003 to 2020 with 5% annual increase [18, p. 4862].

With change in the climate, there has been an increase in the end-use energy consumption worldwide. The increase in built up floor area results in the increase cooling load demand. Globally, the space cooling demand increased 33% between 2010 and 2018, while the heating demand decreased 1% since 2010 [19]. From the statistics presented through the research review, it is evident that as the climate continues to change and the rapid addition to the floor area globally increases, the cooling demand increases as with it. Although the adoption of novel technologies in various building systems such as lighting and building envelop system are crucial to reduce the use of heating and cooling, a mandate on minimum level of building performance is inevitable. A positive change in the building energy consumption and emissions trend can be brought about when building design codes and certification stay a policy priority alongside integration of energy-efficient building systems technology.

The intention of green building is to achieve good indoor environment and lower energy consumption as well as carbon emission while providing maximum occupant comfort. For example, the life cycle carbon emissions of green buildings in China is found to be 10% lower for residential and 32% for commercial non-green buildings [20]. Energy conservation is also commonly required in all green building certification standards globally shown in Table 1 below. The actual performance of green buildings varies from country to country because of the different priorities in evaluation criteria [21].

2.2. Definition of green building, standards, and certification

The World Green Building Council (WGBC) defines a green building as *"as building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts on our climate and natural environment"* [22, p. 1]. The U. S. Green Building Council defines green buildings slightly different, suggesting it to be, *"a concept that starts with the understanding that the built environment can have profound effects, both positive and negative, on the natural environment, as well as people who inhabit building every day. Green building is an effort to amplify the positive and mitigate the negative of these effects throughout the entire life cycle of a building,"* [23, p. 1].

Green buildings are primarily expected to efficiently use natural resources such as energy, water, air, and light. They provide protection to the occupants, improve their health and productivity and are also expected to reduce waste, pollution and environmental degradation [24]. Beyond the provisions of the primary functions, buildings that include the integration of renewable energy, such as solar or wind energy is also classified as a green building. Finally, a building that enables adaptation to a changing environment alongside the fore mentioned characteristics is a holistic concept of a green building [22].

A building function does not define whether a building can be classified as green building or not. However, different countries and region have their own standards which may define green buildings based on climatic conditions, building typology and user ages, environmental, economic and social impacts and cultures and traditions [22]. The 2019 Global Status Report for Buildings and Construction indicates that by 2020, countries are urged to share information regarding their new or updated nationally determined contribution (NDCs) highlighting the efforts mapped out to reduce national emissions and mitigate the forthcoming impacts of climate change [19]. In light of the same, the extent and the influence of the building performance codes, and certification policies have continued to grow and gather strength. Many countries have adopted meaningful improvements which can bring about energy consumption and emissions reduction within the building sector of a country and subsequently worldwide.

There are different categories that encompass a "green building": energy efficiency or energy performance, resources (water, waste, materials), indoor environment (thermal environment, lighting environment, acoustic environment, indoor air quality), sustainable site, management (project management and building management) and innovations. Fig. 1 below shows the radar chart of the different certification systems of countries around the world. Each certification system has various categories which depend on the policy focus of the green building development of the country.

2.3. Multidimensional perspective on green building development

The general development of green building, its standards and certification at the global level are brought about and influenced by the combination of various political, social, economic, technological and environmental conditions across the world. First, the creation and adoption of green building standards is usually because of the existence of supportive and enabling political environment to address the detrimental environment impacts of climate change. The development of the sector is normally mandated by a national law on energy efficiency or conservation. For instance, the establishment of the first two international green building standards were driven by the push to decarbonise especially in the major cities of the country. Building Research Establishment Environmental Assessment Method (BREEAM) was the first building performance standard in the world to define green building in 1990, followed by Leadership in Energy and Environmental Design (LEED) in 1998. BREEAM was intended to evaluate the environmental performance of new and existing designs of buildings while LEED's definition of green building has been adopted by various countries and cities across the globe [25]. BREEAM and LEED have been followed by the emergence of different green building standards and schemes around the world.

Second, the presence of supportive national policies to develop a green building sector needs to be complemented by active and responsive local actors like non-governmental organisations, private companies and other stakeholders from the society. In Europe, Germany has a target of reducing carbon emission by 10% per city for every five years since 2010. The government mandated of Energy Conservation Ordinance (EnEV) promote energy efficiency in buildings while Kreditanstalt für Wiederaufbau (kFW) and Market Incentive Programme (MAP) provide incentives for the development. In addition, the Deutsche Gesellschaft für Nachhltiges Bauen (DGNB) also known as the German Sustainable Building Council is a non-profit organization that facilitates the green building certification according the recommended framework of EnEV. The EnEV "is a performance-based code that requires a mandatory (equivalent model building) energy frame calculation to establish the expected primary energy consumption of residential and non-residential buildings" [26]. Together with the national government, DGNB ensures that green building policies and standards are effectively implemented in the country.

Table 1
Categories of eight green building standards in the world.

Country	Name of Green Building Standards (latest version)	Credit Categories and Weighting	Certification Levels (latest version)	Remark
Singapore	Green Mark New Buildings	• Pre-requisites • Climatic Responsive Design (25%) • Building Energy Performance (18%) • Resource Stewardship (25%) • Smart and Healthy Building (18%) • Advanced Green Efforts (14%)	Platinum (≥70)Gold Plus (≥60) Gold (>50) Maximum Point: 140 points	n/a
China	Assessment Standard for Green Building (GB/T 50378)	• Compulsories (37%) • Credit Items • Safety and Durability (9%) • Healthy and Comfort (9%) • Convenience of Occupation (9%) • Resources Conservation (18%) • Environmental Liveability (9%) • Innovation (9%)	★★★ (≥85 & ≥30% of points in each category & full fill the requirements in Compulsories) ★★ (≥70 & ≥30% of points in each category & full fill the requirements in Compulsories) ★ (≥60 & ≥30% of points in each category & full fill the requirements in Compulsories) Certified (full fill the requirements in Compulsories) Maximum Point: 110 points	n/a
German	DGNB Certification System Version 2018	• Environmental Quality (22.6%) • Economic Quality (22.5%) • Sociocultural and Functional Quality (22.4%) • Technical Quality (15.2%) • Process Quality (12.3%) • Site Quality (5%)	Platinum Gold Silver Bronze	It includes bonus system for a total of 16 criteria. It could be applied to nine types of buildings including Office, Education, Residential building, Hotel, Consumer market, Business premises, Logistics, Production and Shopping centre. The weightage factors are different for each type of building.
US	LEED V4.1	• Integrative Process (1%) • Location & Transportation (25%) • Sustainable Sites (8%) • Water Efficiency (9%) • Energy & Atmosphere (26%) • Materials & Resources (10%) • Indoor Environmental Quality (13%) • Innovation (5%) • Regional Priority (3%)	Platinum (≥80)Gold (≥60) Silver (≥50) Certified (≥40)	The credit %age is calculated for an example of new project which is under BD + C scheme
UK	BREEM(New Construction 2018)	• Waste (6%) • Water (7%) • Pollution (8%) • Transport (10%) • Management (11%) • Energy (16%)	Outstanding (≥85) Excellent (≥70) Very Good (≥55) Good (≥45) Pass (≥30)	The credit %age is calculated for fully fitted out project under the scheme

Table 1 (*continued*)

Country	Name of Green Building Standards (latest version)	Credit Categories and Weighting	Certification Levels (latest version)	Remark
		• Materials (15%) • Health and Wellbeing (14%) • Land Use and Ecology (13%) • Innovation (10%)		
Japan	CASBEE(New Construction 2014)	• Environmental Quality of Building • Indoor Environment • Quality of Service • Outdoor Environment • Environmental Load Reduction of Building • Energy • Resources & Materials • Off-site Environment	Excellent (BEE $\geq$ 3.0 & Q $\geq$ 50) Very Good (BEE $\geq$ 1.5) Good (BEE $\geq$ 1) Fairy Poor (BEE $\geq$ 0.5) Poor (BEE < 0.5)	BEE (building environment efficiency) $=\frac{Q:EnvionmentalQualtiyofBuilding}{L:EnvironmentalLoadofBuilding}$
Australia	Green Star(Design & As Built Version 1.3)	• Management (13%) • Indoor Environment Quality (15%) • Energy (20%) • Transport (9%) • Water (11%) • Materials (13%) • Land Use and Ecology (5%) • Emissions (5%) • Innovation (9%)	6star ($\geq$75) 5star ($\geq$60) 4star ($\geq$45)	The credit % age is calculated for fully fitted out project under Design & As Built
Philippines	BERDE 3.1.0 [22]	• Management • Use of Land and Ecology • Energy Efficiency and Conservation • Water Efficiency and Conservation • Waste Management • Green Materials • Transportation • Indoor Environment Quality • Emissions	1star (51 to 60%) – minimum practice 2stars (61 to 70%) – good practice 3stars (71 to 80%) – ideal performance 4stars (81 to 90%) – exemplar practice 5stars (91 to 100%) – world class	The weighting of the score for the project is the average of the total awarded score for the Core Framework and the Electives, and the total available score applicable for the project. The maximum weighting for the project is 100%.

Similarly, the local government in Japan, the Tokyo Metropolitan Government (TMG) takes the lead in addressing different building-related environmental problems. The Tokyo Cap and Trade Program (Tokyo CTP) was launched in 2010 which was the world's first city-based and a trade which included the building sector [27]. Tokyo CTP is a mandatory emission reduction system which targets a reduction of 25% of carbon emission in two-five years period from 2010 to 2020 [27]. CTP covers almost all the high-rise buildings in Tokyo from the commercial and industrial sectors. Other green building-related programs in Japan is the Tokyo Green Building Program (Tokyo GBP) which aims to improve the environmental performance of new buildings [27]. Japan also has its own green building evaluation and rating system called the Comprehensive Assessment System for Built Environmental Efficiency (CASBEE) created by the Japan Sustainable Building Consortium [27]. This rating system is on voluntary-basis and non-regulatory in nature [27]. In this case, the successful implementation of national policies and standards on green building goes together with the participation of various stakeholders from the local level. This could ensure that the government's targets are fulfilled while making sure that the needs and conditions of local stakeholders are addressed.

Third, developed countries like Singapore have also been active in pursuing green building standards with the aim to reduce carbon emissions and at the same time, to positively contribute to the growth of green economy. For instance, the Green Building

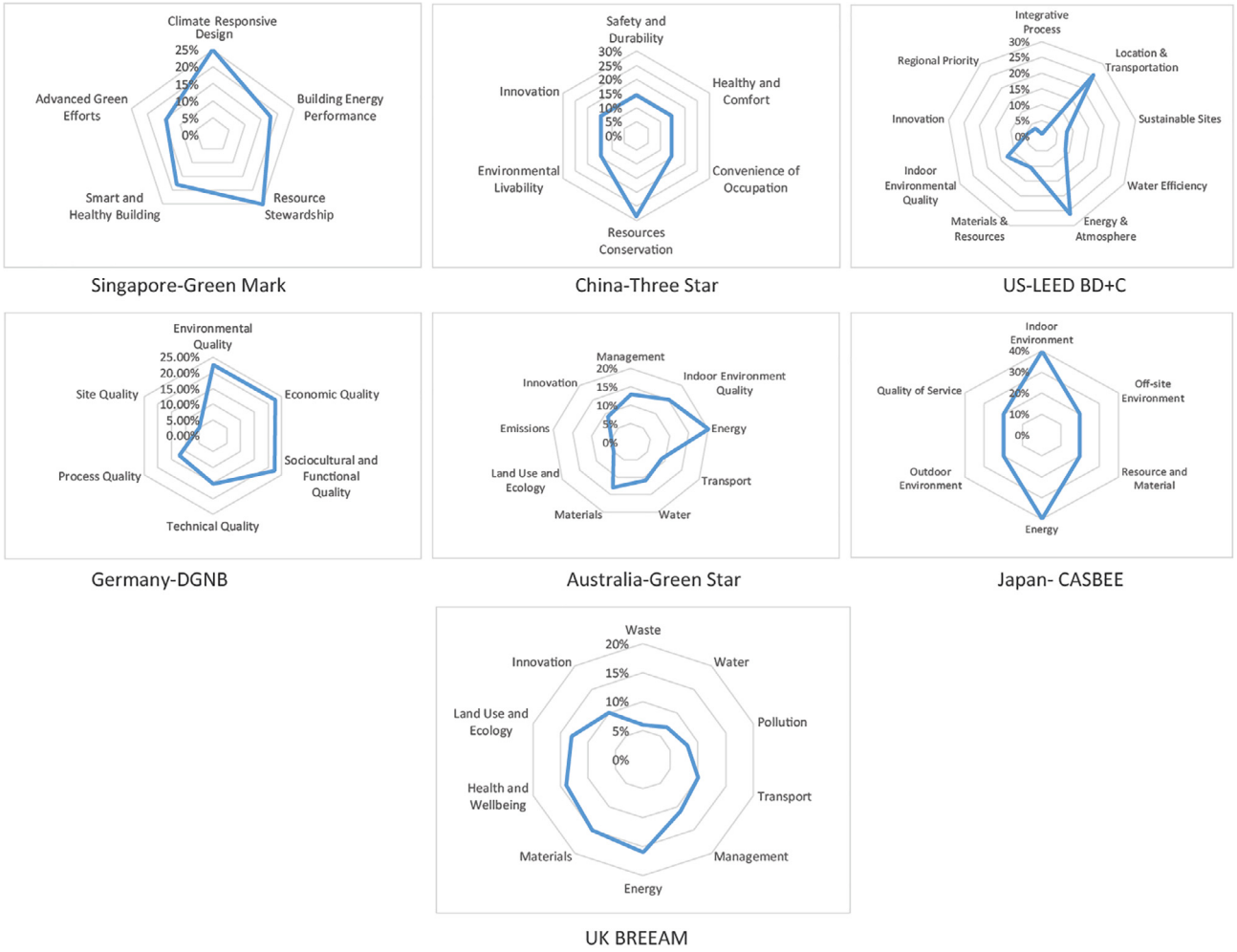

Fig. 1. Radar chart of seven rating systems in different countries around the world.

standards and certification is driven by Singapore's goal to decrease carbon emission intensity by 36%. This includes the city-state's target to make 80% of its building stocks green by 2030. In addition, a legislation was passed in 2008 to require new buildings with gross floor area of more than 2000 sqm to achieve a Green Mark certified rating through the Building Control (Environmental Sustainability) Regulations. While it obliges the building owners to conduct energy audits every three years, this also gives opportunities for a continuous development green building expertise, research and development in the field of energy efficiency and more employment opportunities to individuals interested in sustainability of building and construction sectors. As would be elaborated more in the next sections of this paper, Singapore incentivises the growth of the green building sector by providing financial support on green innovations and capacity building activities through training and development of technical skills on green building technologies.

On the other hand, developing countries also face multifaceted prospects to develop their green building sectors, standards and certification processes. These countries need to address what scholars call as "energy trilemma" where there is a need to attend to the increasing energy demand while continuously pushing for economic growth that is not harmful to the environment. For example, China is driving green building initiatives to lessen the country's carbon emission by 40 to 45% this year [28]. The government created and passed various policy mandates to implement green building standards and certification country wide. For example, the Energy Conservation Law of People's Republic of China was launched in 2007 to promote sustainable development, energy conservation and efficiency and protect the environment of the country [29]. This was followed by Act 530, the Regulations on Energy Saving for Civil Buildings which is the regulatory framework for the management of energy conservation, utilisation of energy efficiency and reduction of energy consumption of civil buildings in China [30]. These policy initiatives gave incentive schemes developed by the government to achieve at least 30% of the new buildings to be green by 2020.

Among the countries studied for this article is the Philippines which has the highest target of decarbonisation within a decade. The country has a target of 70% reduction by 2030 below business as usual scenario and together with the local government units (LGUs), they create policy mandate to promote green initiatives per municipality [31,32]. Recently, the present administration signed the Energy Efficiency and Conservation Act (Republic Act 11285) which recognises the need to,

> *"institutionalize energy efficiency and conservation as a national way of life geared towards the efficient and judicious utilization of energy by formulating, developing, and* implementing *energy efficiency and conservation plans and programs.*" [33, p. 1]

There are also concurrent policies specific on green buildings from previous administration. The Green Building Act was passed "to mitigate the effects of climate change and preserve the environment by requiring planting of trees for any construction activity

of residential, commercial industrial and public buildings" [34, p. 1]. The regulation requires all applicants of building permits (residential, commercial, industrial and any other type) to submit a Tree Planting Plan in addition to any other building requirements imposed by the local government. In 2007, DOE also released the "Guidelines on Energy Conserving Designs of Buildings" which provides the energy efficiency guidelines in the design and construction of buildings in the Philippines.

While there are supportive policy mechanisms present in the fore-mentioned developing countries to develop a green building sector and their national government recognises the economic and environmental benefits it can bring, the sustainability of the green building development also depends on other political, societal and technological conditions of the country. For example, although there are laws passed at the national level, the buy-in and participation of local stakeholders are also important to ensure an inclusive development of the green building sector (as seen in the cases of Germany and Japan). The presence of continuously improving the technical know-how and capabilities of the society is also crucial not only to create more innovative technological innovations but also to have better economic opportunities for individuals interested to join the green economy. Finally, from the analysis of Metro Manila in the next sections, the inherent structural conditions and behavioural constraints of a city and its residents can impact its readiness to implement green building technologies, standards and regulations.

In summary, since the first versions of BREEAM and LEED, green buildings have been promoted world widely. More standards are published around the globe in different cities and countries since 2000s. Presently, 570,411 buildings have been certified by BREEAM, 104,699 by LEED, 2353 projects by Green Star, 2166 by Green Mark, etc. However, developing the green building sectors comes with a consideration of its multifaceted nature, especially in the developing countries where governments are faced with energy trilemma. These issues will be explored further in risk and consequences analysis of developing green building sector in Metro Manila.

Table 2 below summarises these different categories per city as collated by the authors of this paper.

2.4. Green building, standards and certification in the Philippines

In the case of the Philippines, the Philippine Green Building Council (PHILGBC) developed the Building for Ecologically Responsive Design Excellence (BERDE) recognised by the Department of Energy (DOE) as the National Voluntary Green Building Rating System. BERDE was developed in accordance with international green building best practices like the Quality Assurance for Green Building Rating Tools [43], the International Framework for Socio-Economic Factors for Green Building Rating Tools in Developing Countries (WGBC & GBCSA, 2013). PHILGBC administers the development, certification, and education activities of BERDE [43].

BERDE is Philippines' representative to the WGBC which is composed of an international community of Green Building Councils (GBC) [44]. Currently, the WGBC has 70 member councils which aim to make its members to be more equipped to address climate change. The organisation pushes the countries to develop their own local GBCs with coverage in the following sectors: residential, office or commercial, leisure, hospitals/healthcare and educational sectors. The parameters that BERDE uses are like other countries and is based on global green rating system consensus, however it differs from other GBCs on its weights given for each category. This is to consider the sustainable living priorities that might be different in the Philippines compared to more developed countries.

As the standards are established and developed, certification also evolves. Green building certification includes various residential buildings, office buildings, commercial buildings (shopping centres, hotels), public buildings (schools, hospitals, transport stations) and mix-type buildings. Certification of buildings usually depends on the green building standards set by the city or national governments. In terms of building life cycle, buildings could be certified at different stages. This includes the pre-occupancy stage which is before project is handed over. For new projects, there is the post-occupancy stage which happens after the handover stage and in operational stage. Fig. 2 shows the different stages and timing of green building certification.

Building development and construction involves a long complex process and includes different stakeholders. In some cases, commercial building developers get certification during the design stage as they could use it for promotional and marketing advertisements of their green building. Few of the building developers get certification twice within the different stages of the building cycle [45–48]. In the case of the BERDE framework, projects may undergo the certification under each of the assessment stages depending on the project's life cycle. Below is the summary table of the certification process of BERDE shown in Table 3:

3. Theoretical framework

This study provides two-tier analysis as shwon in Table 4 to further understand the implications of the green building development to achieve sustainable development in Metro Manila. The first tier presents the opportunities and challenges of implementing the green building, its standards and certification process. It also considers the political, economic, social, technological, and environmental dimensions of the policy. Second is a more in-depth and critical analysis of the policy using the risk and consequence framework advanced by Justen et al. (2014) [50]. This framework is chosen for the following reasons: 1) it gives a systematic categorisation of policy effects from the perspective of the policymakers, 2) it simulates the policy-making process where a decision-maker deliberates on the potential benefits and consequences of implementing a certain policy and finally, 3) apart from the cost-benefit analysis, this framework drives a deeper contemplation of the unintended impacts and consequences of a policy, in the present case is the development of green building sector in the Manila.

The risk and consequences framework is organised into two categories: 1) intended and 2) unintended consequences and its possible implications. The implication sub-category is further analysed into first and second-order effects to provide a layered analysis of the policy's unintended consequences. The knowledge dimension manifests the information about the policy known and unknown to the policymakers. The known realm represents the realised or the anticipated effects of green building development. On the other hand, the unknown realm examines the impacts that may be unknown from the policymakers' perspective or possibly be unheeded by them [50].

Both frameworks mentioned above are important in evaluating the appropriate policy design to analyse the implications any policy intervention to achieve sustainable development, in this case is the green building development Metro Manila. It is also important to note that although Manila is the focus of the current analysis, the authors also referred to and drew conclusions from the experiences of various cities with green building standard and certification to identify the best practices and lessons that could be learned from other cities' policy framework. In this manner, the study can evaluate and apply the best practices from the cities which may be applicable and could be adapted to the local context of Manila.

Table 2
Comparison of green building standards in the world.

Country	Name of Green Building Standards	Schemes	Logo	Scope of application	Agency/ Organization who publish the standard	Number of buildings certified till now	Starting year
Singapore	Green Mark	• New Buildings • Existing Building • Beyond Buildings • Occupant-Centric		Buildings located in Singapore and internationally	Building Construction Authority (BCA)	2166 [35]	2008
Philippines	Building for Ecologically Responsive Design Excellence (BERDE) (serves as a National Voluntary Green Building Rating System	• new construction, retrofits and renovations, operations, and existing buildings • commercial buildings, vertical residential buildings, clustered residential buildings and educational buildings		Buildings located in the Philippines	Philippine Green Building Council (an NGO in the Philippines, member of World Green Building Council and accredited by the Philippines Dept of Energy)	43 [36]	2018
China	Assessment Standard for Green Building (GB/T 50378)	• New Buildings		Civil buildings located in China	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	4515 [37]	2006
Germany	DGNB Certification System	• Existing Buildings • New Construction • Interiors • Districts		Buildings and urban districts located in German or internationally.	German Sustainable Building Council (DGNB)	1,168 [38]	2007
The US	Leadership in Energy and Environmental Design (LEED)	• BD + C (Building Design and Construction) • Interior Design and Construction (ID + C) • Building Operations and Maintenance (BO + M) • Neighbourhood Development (ND) • Homes • Cities and Communities • LEED Recertification • LEED Zero		Buildings located world widely and all building types	U.S. Green Building Council (USGBC)	104,699 [39]	1998
The UK	Building Research Establishment Environmental Assessment Method (BREEAM)	• New Construction • New Construction: Infrastructure • Communities • In-Use • Refurbishment		Buildings located internationally and all building types	Building Research Establishment (BRE)	570,411 [40]	1990
Japan	Comprehensive Assessment System for Built Environment Efficiency (CASBEE)	• Pre-Design • New Construction • Existing Building • Renovation		Buildings located in Japan	Institute for Building Environment and Energy Conservation(IBEC)	541 [41]	2002
Australia	Green Star	• Communities • Design & As Built • Interiors • Performance		Buildings located internationally	Green Building Council Australia (GBCA)	2353 [42]	2003

The article and the theoretical frameworks used in the study are not without gaps and limitations. As mentioned in Section 1, the study makes use the case study approach as the main research methodology of the study. Although it is useful to have in-depth analysis of a particular event or set of events, it has been criticised in terms of the generalisability of the study's findings as it involves

Table 3
BERDE certification process per project type [49].

If your project is:	*Then use:*
A new construction or fit-out project	The project must undergo assessment and certification under both Stage 1 – design and Stage 2 – construction and show compliance with the requirements of BERDE in the design and construction of the project. In addition, the project must successfully complete Stage 1 — design before undergoing Stage 2 — construction assessment and certification.
Undergoing renovations	The project must undergo assessment and certification under both Stage 1 – Design and Stage 2 – construction and show compliance with the requirements of BERDE in the design and construction of the project. In addition, the project must successfully complete Stage 1 — Design before undergoing Stage 2 — Construction assessment and certification.
An existing project improving only its operations	The project must undergo assessment and certification and show compliance with the Stage 3 — operations requirements through the planning and implementation of the policy and procedures for the project.

a smaller sample size. However, the case study approach can be used to provide depth and thickness of understanding and critical analysis despite its limitations in generality [51]. The authors have addressed this limitation by complementing the single case (within-case analysis) with cross comparative analysis of various cities in the world. The triangulation method of data collection has also been implemented to address external validity issues. This process involved verifying the collected evidence from two other research tools or sources. For example, the findings from a secondary resource (news article or publication) was substantiated through 1) an interview with a local building and construction expert in the Philippines and 2) official documents from a government agency.

Meanwhile, the relationship of the intended to the unintended consequences and its implications in Justen et al (2014) theoretical framework may always not be one is to one. An intended effect can result to multiple unintended consequences, as well as, few first and second-order effects. Justen et al. (2014) elaborates on the effect by referring to the risk and consequence framework similar to building a web-like structure which is comprised of nodes and linkages between these nodes [50]. A node can be connected to several nodes, but the linkages are varied. The risk and consequence framework like other policy assessment tools and models, have limited capacity to provide all the possible policy implications in scope or depth or in different societal context. As policy making and implementation is a multifaceted and intricate process, the study might only represent a certain portion of the complexity. Considering all the fore-mentioned limitations, the authors offer a comprehensive analysis of the risks, intended and unintended consequences of green building, its standards, and certifications in the context of Metro Manila.

4. Results and findings

The section below explores the opportunities and challenges of green building development in the case of the Philippines. The section takes a multi-dimensional analysis approach, namely – political, economic, social, technological, and environmental. As mentioned above, the following sections also drew from the policy experiences of various cities that implemented green building standards and certifications to have comprehensive understanding of the best practices and lessons could be learned from these cities.

4.1. The political dimension

There is a presence of supportive policy framework for green building standards and certification both at the national and local levels in the Philippines. Currently, there are two overarching frameworks for energy efficiency and green building standards in the Philippines – the Energy Efficiency and Conservation Act (Republic Act No. 11285) and the Philippine Green Building Code (GB) 2015. As mentioned in Section 2.2, RA 11285 emphasises the institutionalisation of energy efficiency and conservation as a way of life for the citizens in the Philippines. The scope of this Act is to establish a framework that implements policies on,

> *"promotion of efficient and judicious utilisation of energy, increase in the utilisation of energy efficiency and renewable energy technologies, and the delineation of responsibilities among various government agencies and private entities."* [33, p. 2]

The different national government agencies, like the DOE and Department of Interior and Local Government (DILG) are expected to work closely with the local government units (LGUs) to implement the Act. On the other hand, GB is a referral code to the National Building Code of the Philippines created by the Department of Public Works and Highways. The GB provides minimum standards aimed to decrease GHG and introduce electricity and cost saving measures for buildings falling under certain gross floor area. The main objectives of the GB is to improve "energy efficiency, water and wastewater management, materials sustainability, solid waste management, site sustainability and indoor environmental quality" [52, p. 1]. Guided by the existing national laws and guidelines, each local government of a city could tailor their specific city-level green building requirements based on local city conditions. For example, the cities within Metro Manila like Quezon City, Mandaluyong, Pasig and Taguig cities have established their own green building policies and requirements as well as incentives to promote the construction of green building. In Quezon City,

Table 4
Modified risks and consequences framework of Justen et al. (2014) used to analyse the impacts of green building, its standards and certification development in Manila [50].

		Consequence dimension		
		Intended Consequence	Unintended Consequence	
Knowledge dimension				
		Unintended consequences	Implications (to be categorised into first-, second- etc.... order implications if need be.)	
	Known	The consequence that decision- makers intend with the intervention	Unintended consequences that were anticipated at the time of decision	Impact of the unintended consequences that were anticipated at the time of the decision
Unknown		Advantageous effects that are not known; serendipitous effect	Unintended consequences that were not known at the time of decision	Impact of unintended consequences that were not anticipated at the time of the decision

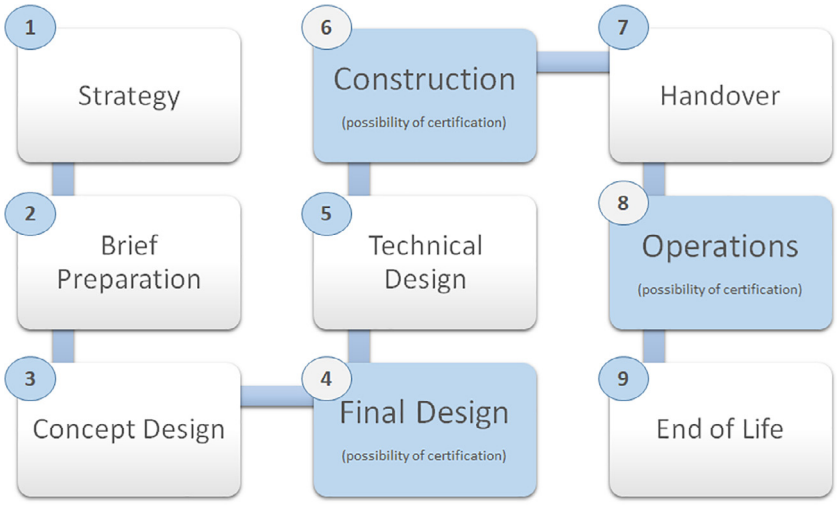

Fig. 2. Timing of certification.

"a green building tax credit is available to a taxpayer for either the construction of a new green building, rehabilitation or retrofitting of an existing building" [53, p. 14].

Collaboration with external parties like NGOs or international organisations in terms of policy planning and implementation are also present in Manila. In addition, the DOE also recently released the Energy Efficiency Conservation Roadmap 2017–2040 in collaboration with EU SWITCH-Asia Programme[2]. This roadmap is a detailed outline of the policy targets, priority areas and strategic plans *"to create a more energy-efficient Philippines across all sectors of economic activity*" [54, p. 6]. Commercial and residential buildings are integral parts of the energy efficient and conservation program of the government.

The provision of incentives to encourage green buildings are also apparent in different cities across the globe. In Singapore, various types of incentives schemes were launched for building owners and tenants like Building Retrofit Energy Efficiency Financing Scheme, Enhanced Green Mark Incentives for New and Existing Buildings and Green Mark Gross Floor Area Incentive Scheme [55]. Beijing and Munich also have financial supports for building and construction sectors to push for new buildings to comply with green building targets. Incentives and fiscal arrangement can create an encouraging environment for the private sector as these policy tools can compensate for the additional costs and overcome economic barriers of developing green buildings [56]

The Table 5 below summarises the different incentive schemes to green building development in selected cities:

On the other hand, even with the presence of supportive policies for green building in Manila, the challenge is to tie these policies to address the other existing issues in the city. Metro Manila's historical and physical context critically shape the infrastructure planning of the city [62]. This includes,

"the convergence of multiple interacting factors such as urban sprawl, lack of affordability of housing near the centres of employment, high dependence of commuters on public transports, longer distance travel by commuters, and low fuel efficiency of the public utility vehicles." [63, p. 99]

As such holistic urban sustainable planning which includes green building development has not been a high priority in Metro Manila. The political environment is highly decentralised and privatised – the local city government has taken a back seat while the less coordinated private sector takes lead in urban planning and implementation [62]. These resulted in fragmented governance and physical infrastructure systems that hinders the city's ability to attain sustainable development. Moreover, most of the green building developments are in the richer municipalities within Metro Manila where higher income households can afford the extra cost of green building. According to scholars, environmental deterioration in urban areas is closely connected to poverty and impoverishment of the less income sector of the population [64, p. 11]. In addition, there is also a lack of policies that targets the wider population of the city to raise awareness about the cost and benefits of green buildings. Sharing knowledge and technical know-how could help ease people's notion that developing green building, standards and the certification process are complicated, "tech-heavy" or "tech-driven." Accurate information and knowledge can raise confidence to potential green building developers, potential investors and even tenants to be part of developing the green building sector.

4.2. The economic dimension

With the existing and continuous supportive policies on green building, it is estimated that the green building market can increase from 20% to 25% by 2025 [65]. According to International Finance Corporation (IFC), investments for low-carbon buildings can reach $2 billion by 2020 [65]. This can potentially contribute to growth of job employment opportunities in the green sector. In 2016, the national government has passed the Green Jobs Act which recognises the potential of the green building sector to bring about a sustainable economic development. The Act gives special tax deductions of approximately 50% of the total cost of training and research development to companies that generate and sustain green jobs [66]. Another benefit of developing green buildings is that they can contribute to energy savings for occupants (translating energy savings to monetary savings for owner and tenants). It is estimated that the first three years of the green building implementation in the Philippines resulted to around PhP 335 million (approximately USD 67 million) in cost savings [67]. In 2019, the IFC had introduced a "resilience tool" that can help the financial

[2] The SWITCH Policy Support Component Philippines is part of the EU SWITCH-Asia Programme. EU SWITCH-Asia is the largest programme in Asia which focuses on sustainable consumption and production (SCP) to achieve development. It promotes economic prosperity and poverty reduction in Asia by encouraging a sustainable approach to growth with positive environmental and social impacts.

Table 5
Summary of incentive schemes to encourage green building development in selected cities.

City	Carbon Emission Target		By year	Policy Mandates		Incentives
	National / Country Level	*City Level*		*National / Country Level*	*City Level*	
Beijing	40–45% carbon emission by 2020; further reducing 60–65% by 2030	NA	2020 & 2030	Energy Conservation Law of the People's Republic of China was launched in 2007 and started to act since April 2008. Then followed by Act 530: Regulations on Energy Saving for Civil Buildings and Act 531: Regulations on Energy Conservation in Public Institutions were published by State Council on Oct 2008. [29,30]	n/a	Incentive scheme from financial perspective was developed by government as well to promote green buildings to achieve at least 30% of the total new buildings by 2020 [29,30]
Manila	70%	NA	2030	Green Building Act and the Philippine Green Building Code; Building for Ecologically Responsive Design Excellence (BERDE) [33,52]	Quezon City, Mandaluyong City, Manila City, Pasig City, Makati City and Taguig City have established their own green building policies, identifying their own requirements and incentives for green buildings for their cities	Incentives are different per city in Metro Manila; project owners may apply for incentives if they achieve a higher rating under BERDE for their buildings.
Munich	40%, 55% 95% (compared to 1990 levels.	10% every 5 years since 2010	2020, 2030, 2050	"The Energy Saving Act ("Energieeinsparungsgesetz" (EnEG)) was issued in 1976 to improve the balance of trade, more precisely to reduce the dependency of the Federal Republic of Germany on imported energy carriers" [57]. "The Energy Conservation Act (EnEG), the Energy Conservation Ordinance (EnEV) and the Renewable Energies Heat Act (EEWärmG) regulate the same subject matter: energy for buildings." [57]	The City Council "adopted the "Munich Climate Neutral Scenario" from the Öko-Institute's study Climate Protection Goal and Strategy Munich 2050" [58]. The study "recommends that heat-related CO2 emissions (space heating and hot water from private households) must be reduced by around 70% between 2014 and 2040." [58]	Incentives through funding such as CO2 building renovation programme, KfW programmes and Market Incentive Programme (MAP) [59,60]
Singapore	Decrease emission intensity by 36 percent	Singapore's target of greening 80% of our building stock by 2030	from 2015 level by 2030	Building Control Act (Chapter 29)	A legislation was passed in 2008 which "required new buildings with Gross Floor Area (GFA) of more than 2000 square metres to attain a Green Mark certified rating through the Building Control (Environmental Sustainability) Regulations. Building owners are required to conduct energy audits every three years on the building cooling systems. Utilities suppliers, like SP Services, are required to provide the annual electricity consumption data of individual buildings while specific building owners are required to provide other building data such as GFA, tenancy composition and building system details." [61]	Various types of incentive schemes were launched in Singapore for building owners and tenants: Building Retrofit Energy Efficiency Financing Scheme. Enhanced Green Mark Incentive Scheme for New Buildings. Green Mark Gross Floor Area Incentive Scheme. Green Mark Incentive Scheme for Existing Buildings. Green Mark Incentive Scheme for Existing Buildings and Premises [55]

and investment sectors to assess the impact of climate change and disaster risks to green project financing [68].

While there are economic benefits to developing the green building sector, one should also be critical of the various costs that comes along with the benefits. Reaping the economic opportunities are dependent on the overall socio-economic environment and conditions of the city. Aside from those mentioned in the previous section, scholars pointed out the "hidden" costs associated with development of a new business sector [56]. These are the cost of dealing with inflexibility of building codes and regulations and the integration of the sustainable design elements into existing building infrastructures. One should also take into consideration the structural difficulties and additional cost in retrofitting existing buildings as Metro Manila also faces both too much traffic congestion and space may be limited to carry out the retrofitting activities. In addition, there are also non-economic barriers, i.e. administrative and regulatory barriers that can hinder the growth of low carbon industry like the green buildings. Examples are lack of coordination between the authorities, lack of experience among policy makers and regulators, complexity of the regulatory and support framework for green buildings and complexity of permit approval and legal processes to initiate the project [69].

In order to create a green building sector, there is also a need for the finance and banking sectors of the city to have confidence in supporting green building projects. Although there are on-going projects funded by international private organisations like IFC, the challenge is to scale up the associated climate and disaster. Metro Manila can learn from the experiences of Tokyo, which is also frequently affected by natural disasters, yet has managed to encourage investments in green buildings and energy-efficient technologies. Some of the policies that were put in place to create a positive and supportive environment for green and energy efficiency related investments were the cap and trade system (Tokyo

CTP), Tokyo Green Building Program and the mandatory emission reduction system.

4.3. The social dimension

In general, there is an increasing number of tenants who are looking for green office building as they prefer to work in a "healthier and environmentally-friendly spaces" in the Philippines [70]. Because of the economic savings incurred from the energy-efficient technologies like high-performance air conditioning, LED lights and other smart appliances, tenants are willing to pay a premium price on the rental rate of green office spaces [70]. This shows the increasing number of people who express a desire to improve their overall well-being. Studies have shown that green spaces within and around built environment can increase one's efficiency and productivity [71]. The development of proper green building standards and certification does not only lessen the carbon emissions but also provide opportunities for quality life to its occupants – healthier, happier, and more productive lives.

An underlying social dimension of green building development is public acceptance and the other cultural norms that might impact the development of green buildings. According to Engr. Marivic Aringo,[3] a building practitioner in the Philippines and Singapore, green building materials are not readily available in the Philippines, and as such the mentality of the construction sector is to prefer the "widely-used traditional construction methods" rather than choosing a "more expensive but efficient new system." The drive to adapt a new and innovative norm is still missing in the Philippines [72]. In addition, there is also a local mind-set of the citizens i.e. "going green is expensive" that needs to be addressed with examples of green building practices that are not necessarily expensive. For example, the simple orientation of windows facing the north- south direction can maximize the opportunities for wind driven natural ventilation [73]. Social awareness of the environmental and economic benefits as well as improvement in health of green building needs to be emphasized to increase public acceptance. Green building developers also need to take into consideration the cultural norms of the Filipinos like disaster resilience. Although the trait is positive in many instances, it can also result in complacency where there are no incentives to improve the current building's structural strength so as to not get destroyed by the typhoon again [73].

4.4. The technological dimension

Metro Manila as the capital of the country is a "fertile ground for the development of a strong green building industry" [68]. The country is frequently battered by strong typhoons creating opportunities for development and employment of innovative and resilient green building technologies, strategies and construction processes. Presently, the country is still using outdated and inefficient building technology which often fails when disaster strikes. A recently conducted public survey of the International Finance Corporation (IFC) points out that current buildings could adopt the following strategies that are not necessarily expensive, but can lead to energy efficiency and savings. Below is the summary of the survey findings [74]:

- Usage of sunshades to block the sun from overheating the building envelope, specifically the windows
- Efficient chillers which can replace the old-fashioned air conditioning that accounts for up to 60% of the energy consumption (due to high demand for dehumidification in the tropics). Efficient chillers can save up to 32% of operational energy.
- Installing the most relevant type of glazing system, creating building designs that maximize natural ventilation and optimizes daylighting opportunities, adopts energy recovery systems for elevators in tall buildings and self-regulating lighting power density software for daylighting availability and occupancy- based lighting design.
- Installing elevators, escalators and other electrical and mechanical services such as artificial lights and ceiling fans based on motion detectors and occupancy sensors

On the other hand, one of the main technological challenges in the collective development of green building sector is the perception that green building technologies and the process of certification are complex. To streamline the process and establish a general sense of uniformity, non-profit organizations such as LEED were established by various countries [73]. Although building experts can comprehend such processes, it is a challenge to relay the information to laymen who are generally the individual owners and tenants of the buildings. Understanding of the building standards and certification by occupants is critical. Efficient building performance is just as dependent on the technological innovation of a building as it is on the behaviour of the end-user. From a design and construction perspective, the greater the number of mid-level engineers who are professionally trained in green building practices would be an added advantage. Their employment can ensure the best standards of energy-efficiency and building performance can be achieved at every stage of planning and construction.

4.5. The environmental dimension

The Philippines is one the most vulnerable countries to face the impact of climate change due to its geography and geographical location. The country lies the pacific typhoon ally and its long coastline makes it susceptible to the disasters. The country also relies highly on agriculture for economical purposes. The increased frequency of disastrous typhoons occurrences (due to climate change) play a havoc on the stability of crop production and have a direct effect on the economy [73]. Therefore, it makes a strong argument for the prospect of developing low carbon technologies especially in the building and construction sector. There is a high potential to reduce carbon emission to achieve national and international climate targets. As summarised by a review on green buildings, below are the advantages of green buildings to lower carbon emission and mitigating the effects of climate change,

> *"Interestingly, green buildings have the potential to reduce the negative effects on the environment and offer business and occupant health related benefits. Sustainable buildings use energy, land, and water more efficiently, and produce less waste and pollution than conventional buildings. In green buildings, often the used materials are recycled, and low or non-toxic materials."* [75, *p. 7]*

However, the use of new green building technologies and process might cause potential challenges. Firstly, there is a potential that the actual construction method is not mature enough to follow the design and secondly, there might always be a gap between the prediction and actual consumption which must be considered carefully by building developers and owners [76]. Table 6 presents the summary of opportunities and challenges described in Section 4.

[3] Engr. is shortened version of "engineer" which is often used as a salutation in the Philippines for people who finished an engineering degree and passed the board exams to attain a professional license.

5. Discussion

The next section presents a deeper understanding of the possible implications of developing a green building, standards, and certification sector in Metro Manila. The section analyses the risks and unintended consequences using the analytical framework presented in Table 1. This article categorises the findings below in (1) known and (2) unknown dimensions from a policy maker's stance while the consequences dimension presents the possible intended and unintended consequences of green building development in Metro Manila.

5.1. Known intended and unintended consequences of green building sector in Metro Manila and their implications

5.1.1. Addresses climate change and disaster vulnerabilities of Metro Manila

The intention of developing the green building sector is to help lessen the impact of climate change especially to a disaster-prone city like Metro Manila. Green buildings utilise materials that are not carbon intensive, while energy-efficient technologies in green buildings can decrease excessive energy and resource consumption by the occupants and bring about financial savings for building owners in the long run. Learning from experiences of cities which are also disaster-prone, e.g. Tokyo, green buildings can also be made resilient to typhoons and earthquakes.

The unintended consequence of this is a possible "disruption" to existing political and regulatory framework as well as the local capacity of the city to adapt to green building technologies and the necessary institutions and processes that accompany its development. As mentioned in the previous section, there are political and social challenges that might impact the advancement of the green building sector in Metro Manila: fragmented governance of LGUs and private sector, public acceptance, and existing infrastructures. This disruption can fasten the development of the sector if policy makers and building developers see this as an opportunity to change and address the existing issues; however, it might further slowdown the sector's development if the other social and political issues are left unresolved.

5.1.2. Promotion of energy efficient and renewable energy technologies

The development of the green building as a sector comes together with the promotion of energy efficient and renewable energy technologies specifically designed to accommodate the physical and infrastructural conditions of Metro Manila. These technologies can help decrease carbon emissions and reliance to the traditional sources of energy like coal, oil, and gas. From the energy production standpoint, current technology suppliers in the green economy (e.g. existing solar PV suppliers, smart grid, smart sensors) can take advantage of green buildings to scale up and commercialise further; while for the demand side, more end-users can have first-hand experience on working or living in green buildings. This can help them assess the costs and benefits that such sector can bring not only in economic terms but most importantly, in the day-to-day experience of the end-users.

On the other hand, the readiness of both the technological aspect, economic market and policy framework of Metro Manila will be tested once the green building sector develops rapidly. The recent pandemic crisis posed a great challenge in terms of the mobility of citizens and adherence to social distancing measures within and outside the buildings. This situation, on top of the existing conditions of the city – archaic buildings, traffic congestions, air and noise pollution, and the urban sprawl are other crucial aspects that green building sector can have an impactful influence on. A coordinated urban planning policy and market incentives to develop a sustainable and smart city should be together in the development of the green building sector.

Table 6
Multidimensional analysis on developing green building sector in Metro Manila.

Dimension	Opportunities	Challenges
Political	Existing supportive policy frameworks on both national and local levels and encourages public and private partnerships with existing incentive policies present from the current national laws	Existing historical and physical contexts in Metro Manila; over reliance to LGUs and private sector for implementation which are fragmented and less coordinated
Economic	Economic incentives both from demand and supply sides are present. Green building sector can bring in employment opportunities.	Other "hidden costs" associated with the development of the green building sector need to be considered. Confidence among investors to current political actors and environment is crucial to reap off the benefits of green buildings.
Social	Heathier and environmental-friendly spaces improve quality of life and overall well-being of residents; increase in productivity that brings benefit to individuals and organisations.	Public acceptance of the technology and the implications to everyday life. "Going green is expensive" mentality needs to be changed.
Technological	The country is disaster vulnerable and the development of innovative and resilient green building technologies, strategies and processes could be an opportunity	Perception that green building technologies and the process of certification are complex
Environmental	Energy efficient technologies and resilient green buildings can help address the disaster vulnerability of Metro Manila	Actual construction method is not mature enough to follow the design of green buildings and to bridge the gap between predicted vis-à-vis actual consumption.

5.1.3. Streamlining the process of certification, verification, and implementation of green buildings

As the technology and deployment of green building technologies increases, the standardisation and certification development organically follow. This has been a trend in the development of the green building sector globally. The intended impact of the standardisation and certification is to ensure that the quality of the green buildings is according to the standards, conditions and needs of the local context. Green building standards also make sure that the buildings perform consistently with globally accepted standards adapted by a country. The standardisation and certification processes (given the appropriate incentives) could encourage building developers to achieve the highest credential for energy and sustainability performance of buildings. According to one of our interviewees,

> *"Having a green building sector in Metro Manila will encourage and challenge many private and public sectors such as developers, designers and contractors to practice a system of standard that can help the city to develop an energy-efficient, lesser water usage and reduced construction maintenance cost projects. This sector will create opportunities for innovation and adaptability."* [72]

Standards and certifications may encourage the streamlining of the green building sector if they are done clearly and efficiently. A possible unintended consequence of the standardisation is that it

may discourage building owners who are not familiar or capable of handling the different requirements and procedures to get the certifications. In case of Manila, the impact of green standards and certification depends highly on the readiness, awareness, and local capabilities of building owners and developers. In addition, there is also a need to enhance the knowledge and skills of LGUs in the standards and certification processes of green buildings. According to RA 11285, the LGUs will be at the centre of the implementation of green building standards and certification. There is a need to ensure that the different stakeholders like buildings owners, tenants and policy implementers understand how the green building sector works.

5.2. Unknown intended and unintended consequences of green building sector in Metro Manila and their implications

5.2.1. Contribution to socio-economic growth and development

The development of the green building sector can push socio-economic growth through the creation of job markets. According to a study by the US Green Building Council, the green building industry has supported around 2 million workers in 2014 [77]. The sector was also expected to contribute around US $ 30 billion to the country's GDP and create 1.1 million jobs by 2018 – 386,000 of which were from LEED [77]. In addition to economic opportunities, the energy efficient technologies of the green building sector can also increase savings for building owners and tenants in the long term. According the same study, the LEED-certified buildings were expected to save US $ 1.2 billion in energy costs and $149.5 million in water costs because of energy efficient technologies [77]. A real estate developer and certified LEED Green Associate, claims that the rise of green buildings in Manila is a "good news" for the tenants:

> *"Tenants can take advantage of lower operating costs, higher worker productivity and reputational benefits associated with the superior environmental performance of green buildings."* [70, p. 1]

To reap the socio-economic benefits mentioned above, it is implied that there is a supportive political and financial climate in a city for the green building sector to thrive. As mentioned in the previous section, investors' confidence and the effective implementation of existing green building policies are crucial aspects to ensure the sustainability of the green building industry. The existence of non-economic barriers like burdensome regulations and permits and the instability of governing leadership of green building initiatives can largely affect the long-term development of the sector.

5.2.2. Development of other related technologies and innovations

Like emerging sustainability-related industries, the green building sector may encourage the development of nascent and unique energy efficient technologies and innovations that cater specifically to the physical and infrastructural conditions of Metro Manila. Different local universities, academic and research institutes from different fields collaborate with international organisations on research, development and demonstration of energy efficient technologies, capacity-building of local stakeholders and training for LGUs. An example of this is the "Access to Sustainable Energy Programme-Clean Energy Living Laboratories" (ASEP-CELLs). The project is funded by EU and implemented by different local institutions across the Philippines. The main objective of ASEP-CELLs is "to increase the share of renewable energy in the country's energy mix and promote energy efficient technologies to achieve sustainable and inclusive growth" [78]. One of their main projects is the development of a master's and training programmes dedicated to clean energy transition in the Philippines. The emerging green building industry in the Philippines may serve as living laboratories for these types of collaboration. Students and early career professional are encouraged to do study visits in green building complex, discuss and learn from the green building experts and professionals.

The technological facets of the green building sector need to collectively develop with the other development aspects of the city, especially in the case of Metro Manila. Disaster vulnerability, urban sprawl, traffic congestion and lack of accessible public transportation are only few of the pressing issues in the city that need to be considered in the development of green buildings. The technological solutions are more effective and can bring about long-term impact if they are developed alongside an inclusive, holistic and sustainable urban planning.

5.2.3. Impacts to end-user behaviour and perspective towards green buildings

Public acceptance is a key aspect of successful socio-technical transition [79–82]. These according to the Diffusion of Innovations Theory (DOI) developed by E.M. Rogers (1962), is an idea or a product, (that is green building technologies in the present context) "...gains momentum and diffuses (or spreads) through a specific population or social system. The result of this diffusion is that people, as part of a social system, adopt a new idea, behaviour, or product" [83, p. 1]. This means that a successful adoption is when a person changes their behaviour or does something differently (despite the uncertainty) compared to what they usually behaved before [81]. For example, an officemate turns off the light switch even when he is not told to do so, he acquires and performs a new set of behaviour towards energy efficiency. There is a need for continuous effort from green building developers and policy makers to make the public more aware about key facts and figures about green buildings. There is a need to have transparency and accountability in the planning and implementation of the green building projects to earn the citizen's trust and support towards the development of the sector. Without these two crucial elements, public acceptance may not be fully achieved. Metro Manila can learn from cities like Singapore in promoting the green building sector by providing platforms for dialogue among the different stakeholders of the building, construction and urban planning sectors. In this way, inter-sectoral and industry learning can be achieved with potential ways to collaborate [72]. The summary of the intended and unintended consequences of developing a green building sector in Metro Manila is summarized in Table 7.

6. Conclusion and recommendations

This article has looked at the current status and developments in the green building sector through a comparative lens. It systematically presented various elements of green building policies, standards and certifications with examples from developed and developing countries. Using the experiences from various cities in green building development, the authors have critically analysed the possible impacts of a similar sector in Metro Manila. The authors have laid out the costs and benefits of the green building sector through multiple lenses – political, economic, social, technological and environmental. First, there are supportive policies in Manila to drive the growth of the green building sector, however one must be mindful of the existing historical, physical and social contexts of the city. There is also an over reliance on the LGUs and the private sector in implementing of the green buildings development policies. Second, although there are economic incentives present in Metro Manila to encourage green building investments, current political conditions of the country may impact the confidence of the business sector to invest in green buildings. Third,

Table 7
Summary of the intended and unintended consequences of developing a green building sector in Metro Manila.

	Consequence Dimension			
	Intended Consequence	Unintended Consequence		
		Unintended Consequence	First-Order Implications	Second-Order Implications
Known	To address climate change and disaster vulnerabilities of Metro Manila	Possible disruption to existing political and regulatory framework	Forces the building stakeholders and policy makers to address other issues; Slow down the development of the sector because current issues remain unresolved	Development of the green building sector with a strong and effective standards and certification; No progress in the movement of the sector
	Promotion of energy efficient and renewable energy technologies	Readiness of the economic market and the political framework maybe put to test	The strengths and weaknesses of the current institutions may show; pressing societal issues may be highlighted more if not addressed.	A coordinated urban planning policy and market incentives to develop a sustainable and smart city should be hand-in-hand in the development of the green building sector.
	Streamlining the process of certification, verification and implementation of green buildings	May discourage local stakeholders (public and private) who are not familiar or capable of handling the different requirements and procedures to get the certifications.	Local capacity, knowledge and skills of stakeholders including building developers, LGUs and possible tenants must be developed	Long-term sustainability of the green building sector can be achieved.
Unknown	Contribution to socio-economic growth and development	The need to have supportive political and financial climate in place.	Current political and social issues may be highlighted more	Failure to ensure supportive institutions may slow down sector's development.
	Development of other related technologies and innovations	Intra and inter-collaborations among multi stakeholders	Emerging green building industry in the Philippines may serve as living laboratories for these types of collaboration	Development of technologies that are suitable to local conditions through inter-sectoral collaborations
	Impacts to end-user behaviour and perspective towards green buildings	Need to have transparency and accountability in the planning and implementation of the green building projects	Builds citizens trust, knowledge and awareness about the sector	Public acceptance and support towards the development of the sector

public acceptance is the key to reap the social benefits of green and energy efficient technologies, e.g. improve quality of life and well-being. Fourth, there is an opportunity to develop green building technologies that are not only energy-efficient but also disaster resilient. Local perception and capabilities must be honed to encourage out-of-the-box thinking when it comes to green building technologies. Finally, the green building sector can be a positive force to drive Metro Manila to be a low-carbon and natural disaster resilient city once mature construction methods, forecasting and predictions tools are developed and deployed.

Besides presenting the opportunities and challenges, this article further contributes to the literature by mapping out the intended and unintended risks and consequences of the green building sector development in Metro Manila. Using the framework of risks and consequences, the article moves beyond a simple cost and benefit analysis but also shows the possible unintended implications of green buildings from its intended impact. Future research agenda could be an analysis of a larger city sample using the risks and consequences framework. This would be useful to know the best practices and policy lessons from one city to another.

Based on the discussion mentioned above, the following next steps are recommended: A coordinated urban planning policy and market incentives to develop a sustainable and smart city should be together in the development of the green building sector. This policy recommendation is in the forefront as it brings to light the need to address the existing political, social and environmental challenges that might hinder the growth of green buildings. As mentioned above, Metro Manila is faced with other pressing issues like poor traffic management, flood vulnerabilities, and urban densification. All these factors should be taken into consideration while designing and implementing green buildings. Local capacity, knowledge and skills of stakeholders including building developers, LGUs and the general public should also be developed. In this way, the various stakeholders would be ready for any disruptions that the rapid development of green building might bring. The awareness of the advantages and disadvantages of the sector can help (1) decision-makers to implement policies that are suitable to the local conditions of Metro Manila and (2) to garner public acceptance and support towards the development of the sector. Finally, inter-industry learning, sharing of knowledge and technical skills, and collaboration should be highly encouraged. The further development of green buildings, certification and standards can be tweaked from the experiences of other cities around the world. Metro Manila can learn from the best practices of cities like Tokyo, Singapore or Beijing. One needs to keep in mind the inherent risks and consequences of any policy and technological diffusion as presented in this article. In summary, there is potential to further develop the green building sector in Metro Manila. However, an inclusive and holistic approach must be taken to effectively drive the sector forward.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors are currently fulfilling their requirements for a doctoral degree at their respective institutes. They would like to take this opportunity acknowledge the support lend to them by their doctoral supervisors, institutes and universities to carry out the research required to materialize this publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enbuild.2020.110561.

References

[1] C2ES, "Outcomes of the UN Climate Change," Centre for Climate and Energy Solution, Arlington, 2015.

[2] Ministry for Europe and External Affairs - France, "COP21: The key points of the Paris Agreement," 2016. [Online]. Available: https://www.diplomatie.gouv.fr/en/french-foreign-policy/climate-and-environment/2015-paris-climate-conference-cop21/cop21-the-paris-agreement-in-four-key-points/#:~:text=The%20purpose%20is%20to%20hold,increase%20to%201.5%20%C2%B0C. [Accessed 13 July 2020].

[3] IPCC, "IPCC Fourth Assessment Report: Climate Change," 2007. [Online]. Available: http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml. [Accessed 24 April 2020].

[4] IEA, "Global Status Report for Buildings and Construction," 2019. [Online]. Available: https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019. [Accessed 24 April 2020].

[5] UNEP SBCI, "Buildings and Climate Change- Summary for Decision-Makers," Unite Nations Environment Programme, Paris, 2009.

[6] UN, "Revision of World Ubanisation," 2018. [Online]. Available: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html. [Accessed 24 April 2020].

[7] M. Ives, "Singapore Takes the Lead in Green Building in Asia," 13 Dec 2013. [Online]. Available: https://e360.yale.edu/features/singapore_takes_the_lead_in_green_building_in_asia. [Accessed 24 April 2020].

[8] ASEAN Secretariat, "ASEAN Sustainable Urbanisation Strategy," October 2018. [Online]. Available: https://asean.org/storage/2018/11/ASEAN-Sustainable-Urbanisation-Strategy-ASUS.pdf. [Accessed 24 April 2020].

[9] P. Akadiri, E. Chinyio, P. Olomolaiye, Design of a sustainable building: a conceptual framework for implementing sustainability in the building sector, Buildings 2 (2012) 126–152.

[10] S. Vierra, "Whole Building Design Guide- Green Building Standards and Certification Systems," 8 May 2019. [Online]. Available: https://www.wbdg.org/resources/green-building-standards-and-certification-systems. [Accessed 24 April 2020].

[11] Arcadis, "Citizen Centric Cities The Sustainable Cities Index 2018," Arcadis, 2018.

[12] D. Esguerra, "Manila among world's least sustainable cities," Inquirer, 2 November 2018.

[13] R. Yin, Case study research: design and methods: 3rd edition, CA: Oaks, 2003.

[14] UN Environment and International Energy Agency, "Towards a zero-emission, efficient, and resilient buildings and construction sector: Global Status Report 2017," 2017. [Online]. Available: https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf. [Accessed 13 July 2020].

[15] IEA, "Tracking Buildings," IEA, Paris, 2019.

[16] IEA, "World Energy Model," IEA, Paris, 2019.

[17] European Commission, "Energy efficient buildings," 06 04 2020. [Online]. Available: https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings_en?redir=1.

[18] B. Sovacool, M. Brown, Twelve metropolitan carbon footprints: a preliminary comparative global assessment, Energy Policy 38 (2010) 4856–4869.

[19] Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme, "2019 global status report for buildings and construction: Towards a zero-emission, efficient and resilient buildings and construction sector," 2019.

[20] Y. He et al., How green building rating systems affect designing green, Build. Environ. (2018) 19–31.

[21] X. Wu, B. Peng, B. Lin, A dynamic life cycle carbon emission assessment on green and non-green buildings in China, Energy Build. 149 (2017) 272–281.

[22] World Green Building Council, "About Green Building," 07 04 2020. [Online]. Available: https://www.worldgbc.org/what-green-building.

[23] U.S. Green Building Council, "LEED What is green building?," 07 04 2020. [Online]. Available: https://www.usgbc.org/articles/what-green-building.

[24] U.S. Environmental Protection Agency, "Green Building," 07 04 2020. [Online]. Available: https://archive.epa.gov/greenbuilding/web/html/about.html.

[25] D. Crawley, I. Aho, Building environmental assessment methods: applications and development trends, Build. Res. Inf. 27 (4–5) (1999) 300–308.

[26] GBPN, "Germany - Summary," 2020. [Online]. Available: https://www.gbpn.org/databases-tools/bc-detail-pages/germany. [Accessed 8 June 2020].

[27] O. Balaban, J. Puppim de Oliveira, Sustainable buildings for healthier cities: assessing the co-benefits of green buildings in Japan, J. Clean. Prod. 163 (2017) S68–S78.

[28] Allouhi et al., Energy consumption and efficiency in buildings: current status and future trends, J. Clean. Prod. 109 (2015) 118–130.

[29] State of Council of PRC, "Energy Conservation Law of the People's Republic of China," 1 April 2008. [Online]. Available: http://www.gov.cn/ziliao/flfg/2007-10/28/content_788493.htm. [Accessed 1 April 2020].

[30] State Council of PRC, "Civil Building Energy Saving Regulations," 1 October 2008. [Online]. Available: http://www.gov.cn/flfg/2008-08/07/content_1067062.htm. [Accessed 24 April 2020].

[31] ADB, "Pathays to Low-Carbon Development for the Philippines," 2017. [Online]. Available: https://www.adb.org/sites/default/files/publication/389806/pathways-low-carbon-devt-philippines.pdf. [Accessed 8 June 2020].

[32] Reuters, "Philippines aims to cut carbon by 70 percent by 2030, if it gets help," 2 October 2015. [Online]. Available: https://www.reuters.com/article/us-climatechange-summit-philippines/philippines-aims-to-cut-carbon-by-70-percent-by-2030-if-it-gets-help-idUSKCN0RW0KN20151002#:~:text=%E2%80%9CThe%20Philippines%20is%20committed%20to,Coloma%20said%20in%20a%20statement. [Accessed 8 June 2020].

[33] Philippine Congress, "Energy Efficiency and Conservation Act," July 23 2018. [Online]. Available: https://www.officialgazette.gov.ph/downloads/2019/04apr/20190412-RA-11285-RRD.pdf. [Accessed 24 April 2020].

[34] House of Representatives, "House approves proposed "Green Building Act"," 11 August 2018. [Online]. Available: http://www.congress.gov.ph/press/details.php?pressid=10810&key=Green%20Building%20Act. [Accessed 24 April 2020].

[35] BCA, "Green Mark Buildings Directory," 2019. [Online]. Available: https://www.bca.gov.sg/green_mark/. [Accessed 30 April 2020].

[36] M. Suelto, "BERDE Program," 7 Mar 2019. [Online]. Available: https://philippinen.ahk.de/fileadmin/AHK_Philippinen/PhilGBC.pdf. [Accessed 30 April 2020].

[37] Chinese Green Building Evalutation Level, "National Green Building Logo Project Statistics," September 2016. [Online]. Available: http://www.cngb.org.cn/index.action?sid=402888b74f68e52e014f696c7643000c. [Accessed 7 July 2020].

[38] DGNB, "DGNB pre-certified and certified projects," 2020. [Online]. Available: https://www.dgnb-system.de/en/projects/. [Accessed 30 April 2020].

[39] LEED, "LEED," LEED, 2020. [Online]. Available: https://www.usgbc.org/projects. [Accessed 30 April 2020].

[40] BREEAM, "BREEAM," BREEAM, 2020. [Online]. Available: https://www.breeam.com/. [Accessed 30 April 2020].

[41] CASBEE, "CASBEE," CASBEE, 2019. [Online]. Available: http://www.ibec.or.jp/CASBEE/english/certificationE.htm. [Accessed 30 April 2020].

[42] Green Star, "Green Star A year in focus FY 2019 Report," 2019. [Online]. Available: https://gbca-web.s3.amazonaws.com/media/documents/green-star-annual-report-2019-fa.pdf. [Accessed 30 April 2020].

[43] BERDE, "About BERDE," BERDE, 2019. [Online]. Available: https://berdeonline.org/#education-training-courses-berde-foundation-course. [Accessed 30 April 2020].

[44] Lamundi, "Going Green: The BERDE Certification and What it Means for Property Developers," 12 Oct 2018. [Online]. Available: https://www.lamudi.com.ph/journal/going-green-the-berde-certification-and-what-it-means-for-property-developers/. [Accessed 30 April 2020].

[45] J. Scofield, Do LEED-certified buildings save energy? Not really…, Energy Build. 41 (12) (2009) 1386–1390.

[46] G. Newsham, Mancini, B. Birt, Do LEED-certified buildings save energy? Yes, but…, Energy Build. 41 (8) (2009) 897–905.

[47] S. Zaid, A. Rad, N. Zainon, Are green offices better than conventional? Measuring operational energy consumption and carbon impact of green office in Malaysia, Facilities 35 (11–12) (2017) 622–637.

[48] J. Liang, Y. Oiu, M. Hu, Mind the energy performance gap: evidence from green commercial buildings, Resour. Conserv. Recycling 141 (2019) 364–377.

[49] BERDE, "BERDE Certification process," 6 Feb 2020. [Online]. Available: http://docs.berdeonline.org/userguide/latest/#about-berde-certification-how-can-you-get-berde-certified. [Accessed 30 April 2020].

[50] A. Justen, J. Schippl, B. Lenz, T. Fleischer, Assessment of policies and detection of unintended effects: guiding principles for the consideration of methods and tools in policy-packaging, Transp. Res. Part A 60 (2014) 19–30.

[51] G. Sartori, Comparing and miscomparing, J. Theoretical Politics (1991) 243–257.

[52] DPWH, "The Philippine Green Building Code," June 2015. [Online]. Available: http://www.iibh.org/kijun/pdf/Philippines_05_Green_Building_Code_of_Philippones_Y2015.pdf. [Accessed 30 April 2020].

[53] Quezon City Council, "Ordinance no SP 1917 S-2009," 2009. [Online]. Available: https://quezoncity.gov.ph/images/embed/QC-GREEN-BUILDING-ORDINANCE-1917-s-2009.pdf.

[54] DOE, "The Philippines Energy Efficiency and Conservation Roadmap," 2017. [Online]. Available: https://policy.asiapacificenergy.org/sites/default/files/Philippines%20Energy%20Efficiency%20and%20Conservation%20Roadmap%202017-2040.pdf. [Accessed 30 April 2020].

[55] Building and Construction Authority Singapore, "Green Mark Incentive Schemes," Singapore BCA, September 2-19. [Online]. Available: https://www1.bca.gov.sg/buildsg/sustainability/green-mark-incentive-schemes. [Accessed 13 July 2020].

[56] K. Fan, E. Chan, C. Chau, Costs and benefits of implementing green building economic incentives: case study of gross floor area concession scheme in Hongkong, Sustainability (2018) 1–19.

[57] Info Portugal Energieeinsparung, "EnEG - Energy Savings Act," Info Portugal Energieeinsparung, 2013. [Online]. Available: https://www.bbsr-energieeinsparung.de/EnEVPortal/EN/Archive/EnEG/eneg_node.html. [Accessed 17 July 2020].

[58] FfE, "Heat Transition in Munich 2040 – Action Recommendations," FfE, 27 Oct 2018. [Online]. Available: https://www.ffegmbh.de/en/areas-of-expertise/scientific-analysis-of-system-and-energy-markets/energy-system/890-heat-transition-in-munich-2040-action-recommendations. [Accessed 17 July 2020].

[59] Federal Ministry for Economic Affairs and Energy, "Energy Efficiency Strategy for Buildings," 18 November 2015. [Online]. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/energy-efficiency-strategy-buildings-short-version.pdf?__blob=publicationFile&v=4. [Accessed 17 July 2020].

[60] BWWi.de, "FAQs," BMWI, 2020. [Online]. Available: https://www.bmwi.de/Redaktion/EN/FAQ/Market-Incentive-Programme-MAP/faq-map-02.html. [Accessed 17 July 2020].
[61] BCA, "Landmark legislation to green existing buildings under Building Control Act," BCA, 10 Sept 2012. [Online]. Available: https://www1.bca.gov.sg/about-us/news-and-publications/media-releases/2012/09/09/landmark-legislation-to-green-existing-buildings-under-building-control-act. [Accessed 17 July 2020].
[62] S. Meerow, Double exposure, infrastructure planning and urban climate resilience in coastal megacities: a case study of Manila, Environ. Plann. (2017) 2649–2672.
[63] R. Andong, E. Sajor, Urban sprawl, public transport, and increasing CO2 emissions: the case of Metro Manila Philippines, Environ. Dev. Sustain. (2015) 99–123.
[64] K. Doi and T. Kurokawa, "Integrated Design of Lucc Policies and Environmental Simulation in Metro Manila," 2001. [Online]. Available: https://www.researchgate.net/publication/228914146_Integrated_design_of_LUCC_policies_and_environmental_simulation_in_metro_manila.
[65] R. Quintos, "IFC Encourages More Investments in Green Buildings and Marks Progress of Green Building Sector," 27 November 2017. [Online]. Available: https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/C6FACF72A8FC44CD852581E5001F1461?OpenDocument.
[66] Philippine Congress, "Republic Act No. 10771," July 2015. [Online]. Available: https://www.officialgazette.gov.ph/2016/04/29/republic-act-no-10771/.
[67] IFC, "Green Building Market Intelligence: Philippines Profile," International Finance Corporation - World Bank Group, Manila, 2017.
[68] C. Valencia, Philippines seen as fertile ground for green building industry, PhilStar Global (2019) 1–2.
[69] M. Quirapas, H. Lin, M. Abundo, S. Brahim, D. Santos, cean renewable energy in Southeast Asia: a review, Renew. Sustain. Energy Rev. (2015) 799–817.
[70] KMC, "The Next Big Thing: Opportunities in Green Buildings," 13 September 2016. [Online]. Available: https://kmcmaggroup.com/research-insights/2016/the-next-big-thing-opportunities-in-green-buildings/.
[71] WorldGBC, "Benefits of Green Building," 2019. [Online]. Available: https://www.worldgbc.org/benefits-green-buildings.
[72] Interviewee 1, Interviewee, Green Buildings in Singapore and Philippines. [Interview]. 27 June 2020.
[73] R. Abad, The Filipinos' 'green' scare, Business Mirror (2017).
[74] Asia Green Buildings, "Philippines: Need to Prepare For Challenges Like Energy Poverty and Climate Change," 29 July 2013. [Online]. Available: http://www.asiagreenbuildings.com/6595/philippines-need-to-prepare-for-challenges-like-energy-poverty-and-climate-change/.
[75] B. Neyestani, "A Review on Sustainable Building (Green," Social Science Research Network (SSRN), 2017.
[76] Zhang et al., A survey of the status and challenges of green building development in various countries, Sustainability (2019) 1–29.
[77] US BGC, "Infographic: USGBC's Green Building Economic Impact Report," 16 Sept 2015. [Online]. Available: usgbc.org/articles/infographic-usgbc's-green-building-economic-impact-report. [Accessed 22 June 2020].
[78] ASEP-CELLs, "About Us," 2020. [Online]. Available: https://asepcells.ph/about-us/. [Accessed 22 June 2020].
[79] M. Lie, K. Sørensen, Making Technology Our Own? Domesticating Technology into Everyday Life, Scandinavian University Press, Oslo, 1996.
[80] L. Haddon, Domestication analysis, objects of study, and the centrality of technologies in everyday life, Can. J. Commun. (2011) 311–323.
[81] E. Rogers, Diffusion of Innovations, The Free Press, New York, 1983.
[82] B. Sovacool, D. Hess, Ordering theories: typologies and conceptual frameworks for sociotechnical change, Soc. Stud. Sci. (2017) 703–750.
[83] Boston University School of Public Health, "Diffusion of Innovation Theory," 2016. [Online]. Available: http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories4.html. [Accessed 27 April 2020].