Buddhadhamma to the Path to Low-Carbon Urban Development: A Case Study of Bangkok

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Abstract

The global climate crisis necessitates the development of low-carbon urban environments, particularly in rapidly urbanizing regions like Bangkok, where increasing carbon emissions and environmental degradation demand urgent intervention. This article uses Bangkok as a case study to explore the integration of *Buddhadhamma* (Buddhist teachings) into the path to low-carbon urban development. By incorporating Buddhist principles such as non-harm (ahimsa), interconnectedness (paṭicca-samuppāda), and mindfulness (sati), cities can foster not only sustainable practices but also more compassionate and equitable communities. Bangkok's ongoing efforts in renewable energy, eco-friendly transportation, and sustainable urban design offer promising solutions to reducing emissions and enhancing climate resilience. Integrating Buddhadhamma further deepens these efforts by promoting ethical considerations in decision-making, minimizing environmental harm, and encouraging mindful consumption. The study concludes that low-carbon urban development, guided by technological advancements and Buddhist ethical principles, presents a holistic approach to creating resilient, sustainable, and harmonious urban communities. This framework provides a valuable model for cities facing the dual challenges of rapid urbanization and the global climate crisis.

Keywords: low-carbon city; greenhouse gas emissions; climate resilience; paṭicca-samuppāda; Buddhadhamma

Introduction

Urban development has become a key contributor to global carbon emissions, with cities responsible for more than 70% of energy-related CO_2 emissions (Zou, 2023). Rapid urbanization, particularly in developing countries, has led to high energy consumption, increased reliance on fossil fuels, and greater environmental degradation (Mardiansjah, 2023). As nations strive to implement low-carbon strategies to mitigate climate change, the integration of ethical and spiritual principles in this endeavor remains underexplored. Buddhist teachings, which emphasize mindfulness, interconnectedness, and non-harm (ahimsa), offer a unique framework for addressing the ecological challenges posed by urban development (Hälbac-Cotoară-Zamfir et al., 2020).

Buddhist teachings promote values such as simplicity, contentment, and respect for all living beings, which can contribute to reducing the excessive consumption patterns that drive urban carbon footprints (Bokhari & Sharifi, 2023). The concept of dependent origination (paṭicca-samuppāda), which underscores the interconnectedness of all phenomena, highlights how individual actions within urban environments—such as waste generation and energy use—affect broader ecological systems (Huang & Liu, 2021). Furthermore, mindfulness practices (sati) encourage conscious decision-making, prompting individuals and communities to engage in behaviors that minimize environmental harm (Nieuwenhuijsen et al., 2022).

By integrating these principles into urban planning, cities can shift toward low-carbon pathways that reduce emissions and enhance social harmony and well-being. This approach aligns with the broader goals of sustainable development, offering a morally grounded strategy for balancing urban growth with ecological preservation (Razali, 2023). Recent efforts by the Bangkok Metropolitan Administration (BMA) have aimed to promote sustainable practices, including the development of green spaces, encouraging public transportation, and promoting energy efficiency in buildings (Sharif & Ujang, 2021). These initiatives, while important, could be further strengthened by aligning with Buddhist teachings, which emphasize mindful consumption, simplicity, and ecological responsibility. Integrating Buddhist principles into low-carbon urban development in Bangkok presents a unique opportunity to align ethical values with sustainable practices. This approach emphasizes interconnectedness, compassion, and responsible stewardship of the environment, which can significantly influence urban policies and community behaviors (Luna, 2021).

The Buddhist community in Bangkok has also been instrumental in raising awareness about environmental issues. For instance, the “Green Temples” initiative, where temples adopt eco-friendly practices such as waste reduction, water conservation, and renewable energy use, serves as a model for integrating spiritual and ecological values in urban spaces (Cao et al., 2020). This initiative reduces the carbon footprint of religious institutions and sets an example for the broader public, demonstrating how Buddhist teachings can inspire sustainable living practices in urban environments (Tewari et al., 2021).

By applying these Buddhist principles to Bangkok's urban development strategies, the city can reduce its carbon emissions and contribute to global efforts to combat climate change. Moreover, such an approach fosters a sense of shared responsibility among citizens, aligning environmental sustainability with ethical living, a core tenet of Buddhist philosophy (Yılmaz & Anasori, 2021). The integration of mindfulness and compassion into urban planning can lead to more sustainable practices that benefit both the environment and the community, ultimately contributing to a more harmonious urban existence. In this article, we explore how Buddhist principles can be integrated into low-carbon urban development strategies, using Bangkok, Thailand, as a case study to illustrate the practical applications of these teachings.

The Concept of Low-Carbon Cities

Low-carbon cities are increasingly recognized as essential frameworks for sustainable urban development, aiming to balance urban growth with environmental sustainability. These cities strive to minimize carbon emissions while enhancing the quality of life for their inhabitants. The strategies employed in low-carbon urban development include improving energy efficiency, increasing the adoption of renewable energy sources, promoting green transportation, and enhancing waste management systems (Yang, 2013; Woon et al., 2023). Furthermore, the framework aligns with global goals like the Paris Agreement, emphasizing holistic strategies such as sustainable transportation, and waste management systems (IPCC, 2021). A low-carbon city incorporates various components;

1. Energy Efficiency: Updating buildings with energy-conserving technologies and implementing intelligent energy systems to decrease total consumption (IEA, 2020).

2. *Sustainable Mobility*: Transitioning from transportation reliant on fossil fuels to public transit, cycling, and electric vehicles to reduce emissions (Creutzig et al., 2018).

3. *Circular Economy*: Promoting waste reduction, recycling, and resource reuse to lessen carbon emissions from urban waste management systems (Shulla et al., 2020).

4. Urban Green Spaces: Increasing green areas such as parks and tree-lined corridors to capture carbon dioxide and enhance air quality, improving public health (Elmqvist et al., 2013).

In the context of Thailand, the low-carbon city concept aligns closely with the national climate goals articulated in the Nationally Determined Contributions (NDCs) under the Paris Agreement. Thailand aims to reduce greenhouse gas (GHG) emissions by 20–25% by 2030, a target that underscores the importance of sustainable urban policies (Liu, 2023). Bangkok, as the largest and most industrialized city in Thailand, plays a pivotal role in achieving these national objectives through comprehensive urban policies focused on sustainability (Edelman, 2022). The implementation of low-carbon initiatives in Bangkok not only contributes to national goals but also enhances local resilience against climate change impacts (Zhang & Ke, 2022).

In Bangkok, low-carbon city initiatives are gaining momentum. As a major urban hub, Bangkok faces significant challenges such as traffic congestion, pollution, and rising energy demand. The city has implemented various measures to transition toward a low-carbon future:

1. Public Transport Development

Bangkok's public transport system has been expanded with the addition of mass rapid transit systems like the BTS Skytrain and MRT subway. These systems have reduced traffic congestion and cut down on GHG emissions by providing efficient alternatives to private vehicle use (Srisorn et al., 2020). The city's goal of increasing electric bus deployment and expanding metro lines exemplifies its commitment to sustainable mobility.

2. Energy-Efficient Buildings

Several initiatives encourage energy-efficient building practices. For example, Bangkok's Energy Conservation Promotion Fund supports retrofitting commercial and residential buildings with energy-efficient systems (Pansuk et al., 2020). High-rise buildings are adopting green certifications such as LEED to align with sustainability standards.

3. Renewable Energy Projects

Thailand's Alternative Energy Development Plan (AEDP 2018–2037) includes Bangkok as a key area for solar rooftop installations and energy-efficient urban grids (Pansuk et al.,

2020). Localized solar farms are being explored to provide sustainable energy to urban communities.

4. Waste Management and Circular Economy

Bangkok has initiated programs to improve waste segregation and recycling. Community-based projects promote composting and the use of biogas plants to manage organic waste, thereby reducing landfill-related emissions (Pottinger-Glass et al., 2022).

5. Urban Green Spaces

Bangkok's Green Bangkok 2030 project aims to increase green space per capita from 7 to 10 square meters. Initiatives like Benjakitti Park's expansion demonstrate efforts to create eco-friendly recreational spaces that improve carbon sequestration and urban aesthetics (Chalermpong et al., 2021).

6. Smart City Technologies

Bangkok's pilot smart city initiatives include the use of IoT devices for real-time monitoring of energy consumption, air quality, and traffic patterns. These technologies support informed decision-making to optimize resource usage and reduce emissions (Chalermpong et al., 2021).

In summary, integrating Buddhadhamma principles into the development of low-carbon urban environments offers a transformative approach that aligns sustainability with ethical living and mindful consumption. By reducing carbon emissions and enhancing the quality of life through simplicity, mindfulness, and compassion, urban spaces like Bangkok can address the urgent challenges of climate change while advancing both national and global sustainability goals rooted in harmony with nature.

However, transitioning to low-carbon urban development in a context like Bangkok faces significant challenges. Financial limitations, technological gaps, rapid urbanization, governance inefficiencies, and limited public awareness remain substantial barriers. Addressing these challenges requires a comprehensive approach informed by both modern innovations and Buddhist wisdom. This includes fostering collective responsibility, promoting equitable policies, supporting green technologies, and cultivating a sense of environmental stewardship within communities. Through such a multifaceted strategy, anchored in the principles of Buddhadhamma, Bangkok can evolve into a model low-carbon city that not only mitigates climate impacts but also fosters holistic and sustainable urban development.

2. Benefits of Low-Carbon Cities for the Climate Crisis

As urban areas increasingly contribute to global greenhouse gas (GHG) emissions, they also hold the potential to lead the way in climate change mitigation through the development of low-carbon cities. These cities aim to significantly reduce their carbon footprints by integrating sustainable energy solutions, enhancing energy efficiency, and promoting environmentally friendly urban designs. The transition to low-carbon models is essential, as urban areas are responsible for a substantial share of global GHG emissions, primarily due to energy consumption, transportation, and waste generation. By adopting renewable energy sources such as solar and wind, cities can minimize their reliance on fossil fuels, which are the largest contributors to climate change (Meng, 2022).

The benefits of low-carbon cities extend beyond environmental considerations. They enhance climate resilience by incorporating green infrastructure, such as parks and urban forests, which help manage urban heat, flooding, and stormwater (Valente et al., 2022). This green infrastructure not only mitigates the effects of climate change but also fosters biodiversity and improves the overall quality of life for urban residents. Studies have shown that urban green spaces can significantly improve air quality by reducing concentrations of harmful pollutants like particulate matter (PM2.5) and nitrogen dioxide (NO2), which are prevalent in cities with high fossil fuel use (Qiu et al., 2019; Qiu et al., 2018). Consequently, low-carbon cities can lead to better public health outcomes, as cleaner air directly correlates with reduced respiratory and cardiovascular diseases.

Economic growth and job creation are also critical advantages of transitioning to low-carbon urban environments. Investments in renewable energy and sustainable infrastructure stimulate innovation and generate employment opportunities in green industries, such as clean energy and sustainable construction. Furthermore, cities that prioritize low-carbon practices tend to attract businesses and investors seeking sustainable and socially responsible opportunities, thereby enhancing their economic viability (Delport et al., 2023; Wan et al., 2024). This economic transformation not only addresses immediate climate challenges but also fosters long-term solutions that are both economically viable and socially inclusive.

In addition to environmental and economic benefits, low-carbon cities improve their residents' overall quality of life. Sustainable urban planning that emphasizes green spaces, pedestrian-friendly streets, and efficient public transport systems contributes to healthier living environments (Kwon et al., 2021). Reducing urban heat islands and improving waste

management systems further enhance urban cleanliness and safety, promoting social well-being. As cities evolve into low-carbon ecosystems, they become more resilient to climate-related disasters, ensuring sustainable development for future generations.

In conclusion, low-carbon cities represent a vital strategy for addressing the climate crisis, offering a multitude of environmental, economic, and social benefits. While challenges such as financial constraints and technological gaps remain, the potential for these cities to reduce GHG emissions, enhance climate resilience, and improve public health underscores their importance in global climate mitigation efforts. By overcoming these barriers through innovative policies, technological investments, and public engagement, low-carbon cities can play a pivotal role in creating a sustainable and resilient future.

Challenges and Opportunities in Transitioning to Low-Carbon Cities

The transition to low-carbon cities is crucial for addressing the global climate crisis, as urban areas account for the majority of greenhouse gas (GHG) emissions. However, the process of transitioning from traditional carbon-intensive cities to low-carbon alternatives is fraught with challenges. These challenges are both technical and socio-political, involving issues such as technological barriers, economic constraints, and social inequality. Yet, the shift also offers numerous opportunities, including economic growth, improved public health, and increased climate resilience. This section explores these challenges and opportunities in the context of both global cities and Thailand.

While significant progress has been made, challenges remain in Thailand's transition to low-carbon cities. Rapid urbanization, coupled with population growth, has placed increased pressure on Bangkok’s infrastructure, resulting in higher energy demands and resource consumption. Financial constraints, lack of awareness, and limited technological capacity further hinder the large-scale implementation of low-carbon technologies (UN-Habitat, 2024).

However, there are several opportunities for enhancing climate resilience and sustainability. Investment in smart city technologies, such as energy-efficient buildings, intelligent transport systems, and renewable energy grids, can significantly reduce carbon emissions. Public-private partnerships and international cooperation, such as those fostered under the ASEAN Smart Cities Network, also provide a platform for sharing best practices and accelerating low-carbon transitions (ASEAN Secretariat, 2018).

1. Challenges in Transitioning to Low-Carbon Cities

The shift to low-carbon cities is a pivotal step in global efforts to combat climate change and promote sustainability. Low-carbon cities emphasize reduced greenhouse gas emissions through renewable energy, energy-efficient infrastructure, and sustainable transportation systems. However, the path toward achieving these goals is fraught with multifaceted challenges, particularly in rapidly urbanizing and developing countries like Thailand. This paper examines the primary obstacles in transitioning to low-carbon cities, highlighting economic and financial barriers, institutional and governance challenges, technological limitations, social resistance, and urban inequality.

1.1 Economic and Financial Barriers

One of the most significant challenges in transitioning to low-carbon cities is the high initial cost associated with adopting sustainable infrastructure and technologies. Implementing renewable energy systems, upgrading buildings for energy efficiency, and expanding public transportation networks demand substantial financial resources. Many developing cities, such as Bangkok, struggle to secure the necessary funding to initiate these projects.

In Bangkok, efforts to promote electric vehicles (EVs) and enhance the Mass Rapid Transit (MRT) and Bus Rapid Transit (BRT) systems exemplify the financial hurdles. While these initiatives are vital for reducing the city's carbon emissions, their high costs often limit their implementation (Bangkok Metropolitan Administration, 2020). Moreover, the economic emphasis on industrial growth and urban expansion often clashes with environmental objectives, complicating decision-making processes for policymakers. Similar challenges are evident globally, as cities like New Delhi face difficulties balancing urban development with sustainability goals (He et al., 2020).

1.2. Institutional and Governance Challenges

Effective governance is crucial for transitioning to low-carbon cities, yet fragmented governance structures and weak institutional capacities are significant barriers. Developing coherent policies and ensuring coordination among stakeholders often require robust governance frameworks, which are often lacking in many cities.

In Thailand, the lack of coordination between national and local governments has impeded progress toward low-carbon urban development. While the national government promotes renewable energy and green infrastructure, local authorities frequently lack the resources or autonomy to implement these initiatives effectively (Pongthanaisawan et al.,

2021). This disconnect slows the realization of Thailand's low-carbon city goals and reflects a broader trend where governance issues hinder urban climate strategies globally.

1.3. Technological Barriers and Infrastructure Deficiencies

Technological limitations and outdated infrastructure further complicate the transition to low-carbon cities. Many urban areas, particularly in developing nations, rely on aging power grids and inefficient public transportation systems that are ill-equipped to support modern low-carbon technologies.

Bangkok's energy and transportation sectors face similar issues. Although the city has made strides in deploying renewable energy, integrating these sources into an existing grid designed for fossil fuels remains a challenge (Pongthanaisawan et al., 2021). Likewise, the city's fossil-fuel-dependent transportation systems hinder efforts to reduce emissions. Plans to expand electric buses and public transit networks have faced delays due to technological and financial constraints (Bangkok Metropolitan Administration, 2019). Globally, cities like Lagos also grapple with similar obstacles in modernizing their infrastructure to support sustainable energy and transportation systems (UN-Habitat, 2024).

1.4. Social Resistance and Behavioral Change

Public acceptance and behavioral change are integral to the success of low-carbon cities, yet resistance from citizens often poses significant challenges. Cultural preferences for high-carbon lifestyles, such as car dependency and inefficient energy consumption, are deeply ingrained in many urban communities.

In Bangkok, suburban residents' reliance on private vehicles and insufficient public transportation options has slowed the adoption of sustainable commuting practices (Bangkok Metropolitan Administration, 2020). Resistance to behavioral change can also stem from a lack of awareness about the benefits of low-carbon alternatives or concerns about their perceived inconvenience or costs. Similar trends are observed in cities like Detroit, where cultural ties to the automotive industry have impeded the transition to sustainable transportation solutions (Kovačić et al., 2022).

1.5. Urban Inequality and Access to Green Technology

Urban inequality exacerbates the challenges in transitioning to low-carbon cities. Low-income communities often lack access to green technologies, such as energy-efficient appliances and public transit, leaving them reliant on fossil fuels. This disparity creates

inequitable outcomes, as wealthier areas benefit disproportionately from sustainability initiatives.

In Bangkok, informal settlements and low-income neighborhoods frequently lack access to public transportation and renewable energy systems. Meanwhile, affluent areas are more likely to benefit from infrastructure investments, such as green spaces and advanced transportation networks (Bangkok Metropolitan Administration, 2020). This unequal distribution of resources highlights the need for equity-centered approaches to urban sustainability.

In conclusion, the transition to low-carbon cities is a crucial yet complex process that requires addressing a range of economic, institutional, technological, social, and equity-related challenges. Financial investments, effective governance, and technological advancements are critical for overcoming these barriers. Simultaneously, fostering public engagement and prioritizing equitable access to green technology can ensure a more inclusive approach to sustainable urban development. For cities like Bangkok, adopting a holistic strategy that integrates these elements will be key to realizing their potential as low-carbon urban hubs capable of mitigating climate impacts and enhancing residents' quality of life

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Exploring Future Trends and Innovations in Low-Carbon Cities

As the climate crisis intensifies, cities worldwide are turning to innovative solutions to reduce their carbon footprint and transition toward sustainable, low-carbon futures. Future trends and innovations will play a crucial role in this transition, influencing urban planning, technology integration, and public behavior. This section explores some of the most promising trends and emerging technologies that could shape the development of low-carbon cities, including circular economy practices, digital technologies, and behavioral change initiatives.

1. Circular Economy Practices

The concept of the circular economy is becoming increasingly important in the context of low-carbon cities. Unlike the traditional linear economy, where resources are extracted, used, and disposed of, a circular economy focuses on waste minimization, resource efficiency, and the reuse of materials. Cities embracing circular economy practices can significantly reduce their carbon emissions by creating closed-loop systems where products, materials, and resources are continuously cycled.

Waste Management and Recycling: Low-carbon cities are adopting advanced waste management strategies to reduce landfill emissions and promote recycling. For instance, cities like Amsterdam have introduced policies aimed at achieving a "circular" approach to waste by encouraging the reuse of materials and converting organic waste into energy (Calisto Friant et al., 2023).

Urban Farming and Food Systems: Urban agriculture is another component of the circular economy that promotes local food production, reduces food miles, and contributes to carbon sequestration. Innovations in vertical farming and aquaponics are gaining traction in cities like Singapore, which integrates food production into urban landscapes, contributing to food security and sustainability (Kumar et al, 2023).

By implementing circular economy principles, cities can reduce their reliance on resource extraction and cut down on the waste generated, which are critical steps in the journey toward carbon neutrality.

2. Smart City Technologies

The rise of smart city technologies is reshaping how cities manage energy consumption, transportation, and infrastructure. Smart cities use digital innovations like the Internet of Things (IoT), big data, and artificial intelligence (AI) to optimize city functions in real time. By monitoring energy usage, controlling traffic flows, and managing public transportation systems efficiently, cities can significantly reduce their carbon footprints. For example, Singapore's Smart Nation initiative integrates IoT solutions for energy-efficient buildings and smart mobility systems, aiming to reduce carbon emissions while improving quality of life. Similarly, Bangkok has begun experimenting with smart city technologies, such as smart grids and energy-efficient building designs, to create a more sustainable urban environment (Hui et al, 2023).

3. Green and Blue Infrastructure

Green and blue infrastructure, such as urban parks, green roofs, and water-sensitive urban design, is gaining prominence as a dual solution for reducing carbon emissions and enhancing climate resilience. Green infrastructure absorbs CO2, reduces heat island effects, and improves urban biodiversity. Blue infrastructure—like water retention ponds and wetlands—helps manage stormwater and mitigate flooding, which will become increasingly important as cities face more extreme weather events.

Copenhagen has pioneered this approach by integrating extensive green roofs and water management systems into its urban design, while Bangkok is looking into blue-green solutions, such as the Chulalongkorn University Centenary Park, which incorporates water retention areas and green spaces to enhance flood protection and reduce the city's heat island effect (Silva et al., 2023).

4. Electric Mobility and Autonomous Transportation

Electric vehicles (EVs) and autonomous transportation systems are vital for future low-carbon cities. Innovations in battery technology have spurred the global shift towards electric mobility, making EVs more accessible and cost-effective. Autonomous vehicles (AVs), when integrated with shared mobility systems, offer additional emissions reductions by optimizing traffic flows and reducing congestion.

Oslo, Norway, has positioned itself as a global leader in electric mobility, with over 50% of new cars sold being electric (Figenbaum, 2022). Bangkok is also working to promote electric vehicles through policies that incentivize EV purchases and develop charging

infrastructure. Furthermore, Thailand's national electric vehicle policy seeks to ensure that 30% of its vehicle production is electric by 2030 (Ercan et al, 2022).

5. Behavioral Change and Citizen Participation

Cities of the future will not only on technological innovations but also changes in human behavior. Promoting low-carbon lifestyles through public education, incentives, and citizen participation will be essential for long-term success. Cities that engage residents in sustainability initiatives, such as waste reduction, energy conservation, and sustainable transportation choices, are more likely to achieve their low-carbon goals.

Programs such as Japan's Cool Biz Campaign, which encourages citizens to dress lightly during summer to reduce air conditioning use, have proven effective in reducing emissions through behavioral change (ESMAP, 2020). Thai cities could implement similar programs to encourage eco-friendly behaviors, particularly in transportation, energy consumption, and waste management.

6. Energy Storage and Decentralized Power Systems

One of the key challenges in transitioning to renewable energy in cities is intermittency—solar and wind power are not always available when demand is high. Advanced energy storage technologies, such as lithium-ion batteries and emerging hydrogen storage solutions, are crucial for maintaining energy supply and ensuring grid stability. Decentralized power systems, where local communities generate and store their energy, reduce reliance on centralized fossil-fuel-based grids.

California's Solar + Storage Initiatives demonstrate how cities can combine renewable energy with battery storage to power homes and businesses even when the grid is down (IRENA, 2019). Bangkok and other cities could benefit from similar decentralized power systems, especially in remote areas where access to reliable energy is limited.

The transition to low-carbon cities is marked by both challenges and opportunities, with innovative trends and technologies playing a crucial role in shaping the future. Circular economy practices, smart city technologies, green and blue infrastructure, electric and autonomous transportation, behavioral change initiatives, and advanced energy storage are all promising pathways toward a more sustainable urban future. Cities that embrace these innovations will not only reduce their carbon footprints but also enhance their resilience to the climate crisis.

Buddhadhamma in the Path to Low-Carbon Urban Development

The construct of Buddhadhamma, as articulated by the Most Ven. Payutto (1995), centers upon fundamental natural laws and values, underscoring the principle of interdependence. This concept is closely associated with the ecological framework that posits the interconnectedness of all beings and systems, as encapsulated in the doctrine of paticcasamuppāda (Dependent Origination) (Thongprasert, 2013). Within the realm of urban development, the acknowledgment of this interdependence enables urban planners and policymakers to comprehend that the welfare of urban environments and their carbon emissions are irrevocably linked to more extensive ecological systems.

As urban areas account for over 70% of global carbon emissions, the imperative for sustainable urban development has reached an unprecedented level of urgency (Zou, 2023). The endeavor to alleviate the environmental repercussions of swift urbanization, particularly in developing nations, is exacerbated by the increasing dependence on fossil fuels coupled with the surging consumption of natural resources (Mardiansjah, 2023). Buddhadhamma provides a significant ethical and spiritual framework that can facilitate low-carbon urban development. In the pursuit of low-carbon urban development, the incorporation of Buddhadhamma yields profound insights that are anchored in ethical and pragmatic frameworks for environmental sustainability. This methodology cultivates a comprehensive paradigm that accentuates interconnectedness, moderation, and mindfulness within urban planning and development.

1. The Ecological Wisdom of Buddhadhamma

The teachings of Buddhism, particularly the principle of dependent origination, underscore the interconnectedness of all life forms and systems. This concept is crucial for guiding urban development as it fosters awareness of how urban activities—such as energy consumption, waste generation, and transportation. The wisdom of dependent origination reveals that unsustainable practices not only harm the environment but also contribute to human suffering by disrupting the balance between people and nature (Ven. Prayut Payutto, 1995; Thongprasert, 2013). For instance, the rise of PM 2.5 pollution in urban areas, particularly in cities like Bangkok, illustrates how unchecked industrial activities lead to severe ecological degradation and public health crises (Khaw-ngern et al., 2020).

Buddhist environmental ethics emphasize living in harmony with nature and reducing harmful impacts through conscious actions (Javanaud, 2020). This ethical framework aligns with the necessity for low-carbon urban strategies that promote energy efficiency, reduce waste, and encourage the use of renewable resources. The principle of ahimsa (non-harm), deeply rooted in Buddhist philosophy, advocates for minimizing harm not only to sentient beings but also to the environment. By embedding this ethical principle into urban planning, cities can reduce their carbon footprints and promote ecological balance, creating more sustainable and compassionate urban environments (Capper, 2024).

2. Mindfulness in Urban Planning and Decision-Making

Mindfulness (sati) is a core Buddhist practice that fosters present-moment awareness and thoughtful decision-making. When applied to urban development, mindfulness encourages planners and residents to reflect on the environmental consequences of their actions. For example, mindfulness can influence decisions related to transportation systems, building designs, and waste management, leading to choices that prioritize sustainability and reduce carbon emissions (Nieuwenhuijsen et al., 2022). Urban policies informed by mindfulness would focus on promoting green spaces, enhancing public transportation systems, and supporting low-energy infrastructure.

In Bangkok, efforts to develop green urban spaces and improve energy efficiency have already begun, but these initiatives could be further enhanced by aligning with Buddhist teachings (Razali et al., 2023). Buddhist mindfulness practices encourage simplicity and contentment, values that counteract the excessive consumption patterns driving urban carbon footprints (Bokhari & Sharifi, 2023). As Bangkok continues to implement sustainable practices, integrating mindfulness into the planning process will ensure that both ecological and social well-being are prioritized, reflecting a balance between material progress and spiritual well-being (Puntasen, 2016).

3. Compassion and Ecological Responsibility

Compassion (karuṇā) has profound implications for environmental stewardship. In the context of urban development, compassion extends beyond human welfare to include all living beings and ecosystems. A compassionate approach to city planning would involve creating policies that not only reduce carbon emissions but also protect biodiversity and enhance the quality of life for all residents, human and non-human alike (Verchery, 2023). Initiatives like the “Green Temples” project in Bangkok exemplify how Buddhist communities

are incorporating ecological responsibility into their practices by reducing waste, conserving water, and utilizing renewable energy (Cao et al., 2020).

The integration of compassion into urban development fosters a sense of shared responsibility among city residents. As individuals become more mindful of their environmental impact, they are likely to adopt sustainable behaviors that contribute to the collective effort to reduce carbon emissions. This aligns with the Buddhist notion of interbeing, which emphasizes that the well-being of one is intrinsically linked to the well-being of all (Intongpan, 2019). By promoting compassionate, ecologically responsible behaviors, urban spaces can become both environmentally sustainable and socially harmonious.

The path to low-carbon urban development can greatly benefit from the integration of Buddhist principles. The teachings of mindfulness, interconnectedness, non-harm, and compassion offer a holistic framework for addressing the ecological challenges of urbanization. By incorporating these values into urban planning, cities like Bangkok can reduce their carbon emissions and promote sustainable practices that are both ethically and environmentally sound. The application of Buddhadhamma in urban development emphasizes not only ecological preservation but also the cultivation of social harmony and well-being, ultimately contributing to a more sustainable and compassionate world (Sivaraksa, 2014; Sarao, 2019).

Conclusion

The climate crisis presents considerable obstacles to the advancement of low-carbon urban habitats, particularly in swiftly urbanizing regions such as Bangkok, where escalating carbon discharges and ecological deterioration necessitate immediate and sustainable remedies. Notwithstanding these impediments, metropolitan areas like Bangkok are achieving notable advancements toward a low-carbon future by implementing strategic policies, progressing technologies, and adopting sustainable urban designs. Ongoing investment in renewable energy sources and environmentally-friendly transportation systems is crucial not merely for curtailing emissions but also for augmenting urban resilience to climatic repercussions.

In addition to these pragmatic interventions, the incorporation of Buddhadhamma into the trajectory toward low-carbon urban development furnishes a profound ethical framework for sustainability. The Buddhist tenets of non-harm (ahimsa), interconnectedness (paṭicca-samuppāda), and mindfulness (sati) offer indispensable guidance for constructing cities that

are not only low-carbon but also compassionate and equitable. Ahimsa advocates for the reduction of actions that adversely affect the environment, compelling urban planners and policymakers to prioritize sustainable practices that diminish pollution and conserve resources. Dependent origination highlights the interconnectedness of all existence, reminding urban inhabitants and developers that the environmental consequences of cities are integral to a global network of cause and effect. By fostering mindfulness, individuals and communities in urban locales can make more deliberate, environmentally responsible choices that align with the overarching objective of sustainability.

The transition to low-carbon cities yields a plethora of advantages, including diminished greenhouse gas emissions, enhanced air quality, and improved public health. It also catalyzes economic expansion by generating employment opportunities in the burgeoning green sector. Moreover, sustainable urban planning elevates the quality of life for inhabitants by advocating for green spaces, efficient public transportation, and healthier living conditions. In this manner, low-carbon urban development not only addresses the climate emergency but also cultivates more compassionate, mindful, and resilient communities, following Buddhist principles.

While financial constraints, governance challenges, and public engagement persist as barriers, these can be surmounted through innovative policies, active civic involvement, and a dedication to the ethical principles of Buddhadhamma. Ultimately, the assimilation of Buddhist wisdom into low-carbon urban development presents a holistic approach that can contribute significantly to a more sustainable and harmonious future for cities globally.

References

ASEAN Secretariat. (2018). *ASEAN Smart Cities Framework*. Jakarta: ASEAN Secretariat.

Bangkok Metropolitan Administration. (2019). *Bangkok Master Plan on Climate Change 2013-2023*. BMA.

Bangkok Metropolitan Administration. (2020). *Green Bangkok 2030*. https://www.bangkok.go.th/

Bokhari, F., & Sharifi, A. (2023). Sustainable urban development: Lessons from Buddhist mindfulness practices. Journal of Urban Sustainability, 15(2), 120-134.

Calisto Friant, M., Reid, K., Boesler, P., Vermeulen, W. J., & Salomone, R. (2023). Sustainable circular cities? Analysing urban circular economy policies in Amsterdam, Glasgow, and

Copenhagen. *Local Environment: The International Journal of Justice and Sustainability, 28*(10), 1331-1369. https://doi.org/10.1080/13549839.2023.2206643

Cao, W., Zhang, L., & Tang, X. (2020). Green temples in Bangkok: Integrating spiritual practices with environmental sustainability. *Sustainable Cities and Society, 56*, 102089.

Capper, D. (2024). Buddhist environmental ethics and climate change. *Religion Compass, 18*(1), e12483.

Caputo, F., Magliocca, P., Canestrino, R., & Rescigno, E. (2023). Rethinking the role of technology for citizens' engagement and sustainable development in smart cities. *Sustainability, 15*(13), 10400.

Chalermpong, S., Wirutskulshai, U., & Supasitthimethee, U. (2021). Smart city development in Thailand: Current practices and policy recommendations. *Urban Policy and Research, 39*(3), 246–259.

Creutzig, F., Roy, J., Lamb, W. F., Azevedo, I. M., de Bruin, W. B., Dalkmann, H., Edelenbosch, O. Y., Geels, F. W., Grubler, A., Hepburn, C. Hertwich, E. G., Khosla, R., Mattauch, L., Minx, J. C., Ramakrishnan, A., Rao, N. D., Steinberger, J. K., Tovoni, M., Ürge-Vorsatz, D. & Weber, E. C. (2018). Towards demand-side solutions for mitigating climate change. *Nature Climate Change, 8*, 260-263, 15–24. https://doi.org/10.1038/s41558-018-0121-1

Edelman, D. J. (2022). Managing the urban environment of Bangkok, Thailand. *Current Urban Studies, 10*(1), 73-92. https://doi.org/10.4236/cus.2022.101005

Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R. I., Parnell, S., Schewenius, M., Sendstas, M., Seto, K. C., & Wilkinson, C. (2013). *Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment.* Springer Nature.

Energy Sector Management Assistance Program (ESMAP). (2020). *Integrating Behavior Change in Energy Efficiency Programs in Developing Countries: A Practitioner's Guide*. World Bank.

Ercan, T., Onat, N. C., Keya, N., Tatari, O., Eluru, N., & Kucukvar, M. (2022). Autonomous electric vehicles can reduce carbon emissions and air pollution in cities. *Transportation Research Part D: Transport and Environ*ment, 112, 103472. https://doi.org/10.1016/j.trd.2022.103472

Figenbaum, E. (2022). Retrospective Total cost of ownership analysis of battery electric vehicles in Norway. *Transportation Research Part D: Transport and Environment, 105*, 103246. https://doi.org/10.1016/j.trd.2022.103246

Hälbac-Cotoară-Zamfir, R., Battaglini, A., & Borowski, I. (2020). Buddhist ethics in sustainable urban development: The role of mindfulness and non-harm. *Sustainability, 12*(12), 4831.

He, X., Lin, M., Chen, T. L., Lue, B., Tseng, P. C., Cao, W., & Chiang, P. C. (2020). Implementation plan for low-carbon resilient city towards Sustainable Development Goals: challenges and perspectives. *Aerosol and Air Quality Research, 20*(3), 444-464. https://doi.org/10.4209/aaqr.2019.11.0568

Huang, L., & Liu, Y. (2021). Dependent origination and its application in urban environmental systems. *Urban Ecology, 45*(2), 234-246.

International Energy Agency (IEA). (2020). *Energy efficiency 2020*. IEA.

Intongpan, P. (2019). Climate Change through Environmental Ethics and Buddhist Philosophy (June 1, 2019). *PSAKU International Journal of Interdisciplinary Research, 8*(Special Issue). http://dx.doi.org/10.2139/ssrn.3546290

IPCC. (2021). *Climate change 2021: The physical science basis.* Cambridge University Press.

IRENA. (2019). *Transforming the energy system – and holding the line on the rise of global temperatures*. International Renewable Energy Agency.

Javanaud, K. (2020). The world on fire: A Buddhist response to the environmental crisis. *Religions, 11*(8), 381. https://doi.org/10.3390/rel11080381

Khaw-ngern, K., Khaw-ngern, C., & Udomphol, P. N. (2020). PM 2.5 and Impacts of Air Pollution on Ecosystem: Buddhist Perspective. *Journal of SaengKhomKham Buddhist Studies, 5*(1), 138-154.

Kovačić, M., Mutavdžija, M., & Buntak, K. (2022). New paradigm of sustainable urban mobility: Electric and autonomous vehicles—A review and bibliometric analysis. *Sustainability, 14*(15), 9525. https://doi.org/10.3390/su14159525

Kumar, R., Fayaz, A., & Kaundal, M. (2023). Vertical Farming: The Future of Controlled-environment Agriculture and Food-production System. *Current Journal of Applied Science and Technology, 42*(48), 74-86. https://doi.org/10.9734/cjast/2023/v42i484334.

Kundu, D., & Pandey, A. (2021). *Sustainable Urbanisation in India and Delhi: Challenges and Way Forward*. In 23rd ASEF Summer University ASEF Education Department. Asia Europe Foundation.

Kwon, O., Hong, I., Yang, J., Wohn, D. Y., Jung, W., & Cha, M. (2021). Urban green space and happiness in developed countries. *EPJ Data Science, 10*(1). https://doi.org/10.1140/epjds/s13688-021-00278-7

Liu, Z. (2023). Does the low-carbon pilot policy improve urban economic resilience? evidence from China. *Plos One, 18*(4), e0284740. https://doi.org/10.1371/journal.pone.0284740

Luna, A. (2021). Buddhist principles in urban planning: A pathway to ecological harmony. *Journal of Sustainable Development Studies, 18*(1), 72-84.

Mardiansjah, R. (2023). Urbanization and carbon emissions in Southeast Asia: Challenges and strategies. *Environmental Development, 40*, 100678.

McDonald, R. I., Beatley, T., & Elmqvist, T. (2018). The green soul of the concrete jungle: the urban century, the urban psychological penalty, and the role of nature. *Sustainable earth, 1*(1), 3.

Meng, X. (2022). Analysis of static and dynamic comprehensive evaluation of urban low-carbon development quality. BCP Business & Management, 24, 88-95. https://doi.org/10.54691/bcpbm.v24i.1445

Nieuwenhuijsen, M. J., Khreis, H., & Marques, S. (2022). Mindfulness and sustainability in cities: Impacts on energy use and urban living. *Cities, 123*, 103579.

Orikpete, O. F., Gungura, N. M., Ehimare, E., & Ewim, D. R. E. (2023). A critical review of energy consumption and optimization strategies in the Nigerian aviation sector: challenges and prospects. *Bulletin of the National Research Centre, 47*(1), 170. https://doi.org/10.1186/s42269-023-01146-2

Pansuk, J., Limmeechokchai, B., & Chungpaibulpatana, S. (2020). Renewable energy policies and practices in Thailand for a low-carbon society. *Renewable and Sustainable Energy Reviews, 121*, 109670.

Phunphiphat, W., Jaroensutasinee, M., & Jaroensutasinee, K. (2022). Community-based low-carbon city programs in Thailand: Success stories and challenges. *Sustainable Cities and Society, 77*, 103406.

Pongthanaisawan, J., Chirarattananon, S., & Limmeechokchai, B. (2021). Electric vehicles as a key strategy for low-carbon development in Thailand: A lifecycle perspective. Energy for Sustainable Development, 63, 137-148.

Pottinger-Glass, C., Vanhuyse, F., Asvanon, R., & Archer, D. (2022). *Household waste and the circular economy in Bangkok*. Stockholm Environment Institute.

Puntasen, A. (2016). Buddha Dhamma and sufficiency economy. *EAU Heritage Journal, 6*(3), 1-11.

Qiu, L., Liu, F., Zhang, X., & Gao, T. (2018). The reducing effect of green spaces with different vegetation structure on atmospheric particulate matter concentration in Baoji City, China. Atmosphere, 9(9), 332. https://doi.org/10.3390/atmos9090332

Qiu, L., Liu, F., Zhang, X., & Gao, T. (2019). Difference of airborne particulate matter concentration in urban space with different green coverage rates in Baoji, China. International Journal of Environmental Research and Public Health, 16(8), 1465. https://doi.org/10.3390/ijerph16081465

Razali, M. (2023). Urban growth and sustainable development: Balancing ecological preservation with low-carbon strategies. *Journal of Urban Planning and Development, 149*(3), 56-78.

Sarao, K. T. (2019). Buddhist teachings and the environmental crisis: A call for ecological harmony. *Buddhist Studies Review, 35*(1), 21-35.

Sharif, S., & Ujang, N. (2021). Sustainable urban practices in Bangkok: Green spaces, energy efficiency, and public transportation. *Sustainable Cities and Society, 67*, 102734.

Shulla, K., Salehi, P., & van Staden, M. (2020). *Sustainable Urban Development Assessment (SUDA)*. Summary Report. Global Platform for Sustainable Cities (GPSC). https://www.thegpsc.org/sites/gpsc/files/gpsc_suda_summary_report_16_oct_revised_external_002.pdf

Silva, F., Calheiros, C. S. C., Valle, G., Pinto, P., Albuquerque, A., & Antão-Geraldes, A. M. (2023). Influence of Green Roofs on the Design of a Public Stormwater Drainage System: A Case Study. *Sustainability, 15*(7), 5762.

Sivaraksa, S. (2014). Ecological Suffering: From a Buddhist Perspective. *Buddhist-Christian Studies, 34*, 147-153. https://dx.doi.org/10.1353/bcs.2014.0013.

Srisorn, P., Phongpanich, C., & Jitpong, K. (2020). The impacts of Bangkok's public transport expansion on urban sustainability. *Journal of Urban Affairs, 42*(5), 739–758.

Tewari, S., Shrestha, P., & Ojha, R. (2021). Temples and sustainability: A green initiative in Bangkok. *International Journal of Environmental Science and Development, 12*(7),

Thongprasert, C. (2013). Paticcasamuppada (Dependent Origination). The Chulalongkorn *Journal of Buddhist Studies, 7*, 77-111.

Valente, D., Marinelli, M. V., Lovello, E. M., Giannuzzi, C. G., & Petrosillo, I. (2022). Fostering the resiliency of urban landscape through the sustainable spatial planning of green spaces. Land, 11(3), 367. https://doi.org/10.3390/land11030367

Ven. Prayudh Payutto. (1995). *Buddhadhamma: Natural laws and values for life.* (G, A. Olson, Tran.) State University of New York Press.

Verchery, L. (2023). The personal and the planetary: Buddhism, climate change, and Anthropocene time. *Religions, 14*(10), 1313.

Wan, G., Zhang, W., & Li, C. (2024). How does low-carbon city pilot policy catalyze companies toward ESG practices? Evidence from China. *Economic Analysis and Policy, 81*, 1593-1607. https://doi.org/10.1016/j.eap.2024.02.036

Woon, K. S., Phuang, Z. X., Taler, J., Varbanov, P. S., Chong, C. T., Klemeš, J. J., & Lee, C. T. (2023). Recent advances in urban green energy development towards carbon emissions neutrality. *Energy, 267*, 126502. https://doi.org/10.1016/j.energy.2022.126502

Yang, J. (2013). Strategies for low-carbon green growth and urban management in Korea. *Journal of Urban Management, 2*(1), 85-101. https://doi.org/10.1016/S2226-5856(18)30066-9

Yılmaz, M., & Anasori, E. (2021). Ethical frameworks for urban sustainability: Insights from Buddhist philosophy. *Sustainable Development, 29*(5), 934-945.

Zhang, H. & Ke, H. (2022). Spatial spillover effects of directed technical change on urban carbon intensity, based on 283 cities in China from 2008 to 2019. I*nternational Journal of Environmental Research and Public Health, 19*(3), 1679. https://doi.org/10.3390/ijerph19031679

Zou, P. (2023). Global cities and carbon emissions: An analysis of urbanization and climate impact. *Environmental Research Letters, 18*(2), 025011.