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Review Article

A Literature Review of Low-Carbon Urban Tourism Indicators and Policy

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ABSTRACT

Low-carbon tourism (LCT) should be promoted in the development of the tourism sector, particularly in urban tourism, associated with the issue of high carbon dioxide emissions from human transportation-related activities and environmental pollution. Unfortunately, until today, there are still no specific guidelines for developing LCT in urban areas on the implementation or assessment criteria for determining the low carbon level. In consequence, the goal of this article is to discuss low-carbon indicators and policies used in the development of urban tourism. We identified 159 low-carbon indicators through content analysis, after reviewing reliable resources from four journal articles and a government policy paper validated using qualitative methods. Some suggested strategies and policies for LCT activities, actions and cooperation from the authorities and residents in implementing LCT as a new tourism development model. The results can be used globally as a basis for the formation of policies and studies related to LCT in urban areas.

Keywords: Carbon dioxide, low-carbon, low-carbon indicators, policy, urban tourism

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INTRODUCTION

Tourism development is proven to have advantages and disadvantages. The advantages include promoting economic and infrastructure development, creating various employment opportunities, providing economic incentives for a place to preserve, maintain, and regenerate the environment in urban and rural settings, cross-cultural, and promoting the advantages of the area (Comerio & Strozzi, 2019; Mayer & Vogt, 2016). The disadvantages of tourism include environmental damage, cultural clashes, low wages, low-skill workers, seasonal fluctuations, inequitable funding, foreign poaching, and tourism reliance (Postma & Schmuecker, 2017). The thriving and sustainable tourism industry has already demonstrated its ability to contribute to socioeconomic development, benefiting local communities and tourists. Tourism has the potential to have a positive impact on the environment if environmental protection and conservation measures are implemented. Therefore, tourism and the environment have a complex relationship because many tourism developments and activities have a detrimental effect on the environment, gradually destroying environmental resources. For example, constructing tourism infrastructures such as airports, roads, hotels, shops, restaurants, and other facilities adversely or indirectly affects the environment. The natural environment and manufactured elements need to be cared for and preserved for the benefit of the tourism industry and to create healthy living for people. Tourism development must involve stakeholders, including state governments, district and local community planning, and economic development to create sustainable tourism activities (Siti-Nabiha et al., 2008). Consequently, efforts to promote low-carbon tourism (LCT) and a sustainable environment globally are necessary to maintain the tourism industry as a key industry for the long term (Tang et al., 2018).

LCT is a mechanism for achieving maximum travel experience with new travel planning for the tourism industry and achieving economic, environmental, and social benefits for all communities by reducing tourism activities that contribute to carbon emissions (Luo et al., 2016). Activity clusters in the travel and tourism sector contributing to carbon emissions include water and land transportation, accommodations, and other tourism activities. Each cluster contributes direct and indirect greenhouse gas (GHG) emissions to the environment. Most carbon dioxide emissions are contributed by tourism transport (75%), followed by accommodation and catering (21%) and tourism activity (4%; Tang et al., 2018). In an earlier study, the Organisation for Economic Co-operation and Development (OECD, 2010) estimated that the tourism industry contributes 5.3% of global anthropogenic greenhouse gas emissions. Direct carbon emissions are from primary sources, such as transportation that uses fuel and energy, electricity or gas consumption for the restaurant and accommodation sector, and other tourism activities. Meanwhile, indirect

carbon emissions are not produced from immediate tourism activities but from other sources, such as manufacturing processes, infrastructure development, airline offices, or travel agencies, which are indirectly involved in tourism activities (Kitamura et al., 2020). These indirect carbon emissions need to be accounted for and addressed when calculating the tourism industry's carbon footprint, as its effects can also lead to high emissions (Ya-Yen, 2019). Thus, new tourism approaches in construction and planning are necessary to conserve the environment and develop a city.

Several research approaches on LCT are recorded in the literature (Chiesa & Gautam, 2009; Fang, 2011; Han & Li, 2021; Huang & Deng, 2011; Kitamura et al., 2020; Mao et al., 2022; Shi & Peng, 2011; Thongdejsri et al., 2016; Xiong, 2017; Yang, 2015; Ya-Yen, 2019). However, limited guidelines are available for reference in Low-Carbon City (LCC) development. These include the Low-Carbon Cities Framework (LCCF) by the Ministry of Energy, Green Technology and Water (Kementerian Tenaga, Teknologi Hijau dan Air [KeTTHA], 2017) and Low-Carbon Society Blueprint for Iskandar Malaysia 2025 (UTM-Low Carbon Asia Research Centre, 2013). Throughout the literature, there are no specific guidelines on developing LCT in urban areas for the implementation process and assessment criteria to assess the level of low-carbon practices.

Thus, this article aims to identify low-carbon indicators and policies for LCT, including the activities, actions, and cooperation from the authorities and residents by going through the implementation process of LCT as a new tourism development model focusing on an urban area. The study suggests a list of critical low-carbon indicators to serve as a platform for policy development and further research on LCT in industrial sub-sectors globally. The findings can help future studies identify a comprehensive framework for developing successful LCT destinations and serve as a guide for LCT development, particularly in urban areas. This research also can be seen as an extension of the existing framework, such as from a low-carbon city that allows for an urban tourism context. The article's contribution also could pave the way for systematic LCT management that applies to large-scale urban destinations.

Literature Review

Definition of Urban Tourism. Increasing demand for urban tourism has begun over the past few decades. Urban tourism refers to activities conducted in areas with extensive amenities, such as transportation, hotel infrastructure, and events (Kitamura et al., 2020; Razali & Ismail, 2014). According to H. N. Ismail (2016), the main important context for urban tourism is to develop large-scale infrastructure, especially airports, transportation systems, and indoor accommodation. In Malaysia, such infrastructure can be seen in Kuala Lumpur and Penang, which have major airports. In addition, highway development increases rapid inter-city transportation.

Two key factors influence the development of Malaysia's urban tourism (H. N. Ismail, 2016) as follows:

1. People awareness:
   Awareness of urban conservation is important to all parties, including governmental and non-governmental organisations and tourists.

2. Promote tourism products and services:
   Diversify tourism products and services to build an identity or image of tourism in Malaysia.

According to Hairul et al. (2003), Malaysian urban tourism can be divided into two stages: after independence in 1957 and after the 1990s. Following the country's independence in 1957, several cities served as a gateway for international tourists, as a point of distribution or connection to tourist destinations throughout the country, as a national symbol, as company and government headquarters, and as a location for business and diplomatic interactions in meetings and communications. Tourism became a rapidly growing industry in Malaysia after the 1990s. The main images promoted to attract international tourists are culture and nature. At the time, the government prioritised the preservation of historic buildings in the city as a tourist attraction. Furthermore, the government has broadened the city's tourism offerings to include events such as meetings, incentives, conferences, and exhibitions. Following the 2000s, the notion of urban tourism in Malaysia can be divided into two major areas. Kuala Lumpur urban tourism focuses on modern urban tourism products. It is seen in the growth of amenities, such as luxury hotels, shopping malls, sports centres, MICE, and entertainment. Penang, Malacca, and Kuching focused on urban tourism based on culture and history because the cities were founded during colonial times. Hence, the produced product is displayed at galleries, museums, souvenir stores, boutique hotels, and visitors. Urban conservation and heritage tourism were introduced at potential centres such as Malacca, Penang, and Kuching to support the efforts to preserve historical and cultural heritage. In comparison, the main tourism activities in Kuala Lumpur are shopping, MICE (meetings, incentives, conferences, and exhibitions), leisure, and mega-events. Many other important elements attract people to travel to the city.

According to Ruetsche (2006), urban tourism elements in large cities fall into three categories (Figure 1): primary, secondary, and supplementary. The primary or key elements provide the main reason tourists visit the city, which is driven by the activity place factor, consisting of cultural-based activities facilities, such as museums and art galleries, concert halls, and nightclubs. At the same time, physical characteristics, such as historic street patterns, buildings, monuments, parks and green areas, and others, can entice tourists to visit the city. The secondary and supplementary elements support the

primary activities in providing provision for complete facilities and amenities. These include accommodation and shopping malls and the function of additional elements, such as tourist information and transportation facilities, that promote the successful development of urban tourism. The element of city tourism is important not only to boost the number of visitors but also to stimulate the economy and foster positive effects on the image of a city.

Many Malaysian cities have tourism products, especially those rich in history and heritage and with a multicultural society and famous tourist destinations. The city of Malacca is a fitting example. Tourism products are developed for several population centres, including Baba Nyonya, Malay, Portuguese, and Chitty. Tourism in the city has provided them with the opportunity to engage in entrepreneurship, which has improved their socioeconomic status. Previously, several of them worked in tertiary sectors unrelated to tourism before transitioning to jobs in the tourism business, such as tourist guides, travel agencies, hotels, and transportation. For policymakers, urban tourism is an economic resource that drives urban regeneration to reinvigorate life in historic and often declining urban areas (Rogerson & Rogerson, 2014).

Besides creating employment opportunities and expanding economic resources, urban tourism enhances the

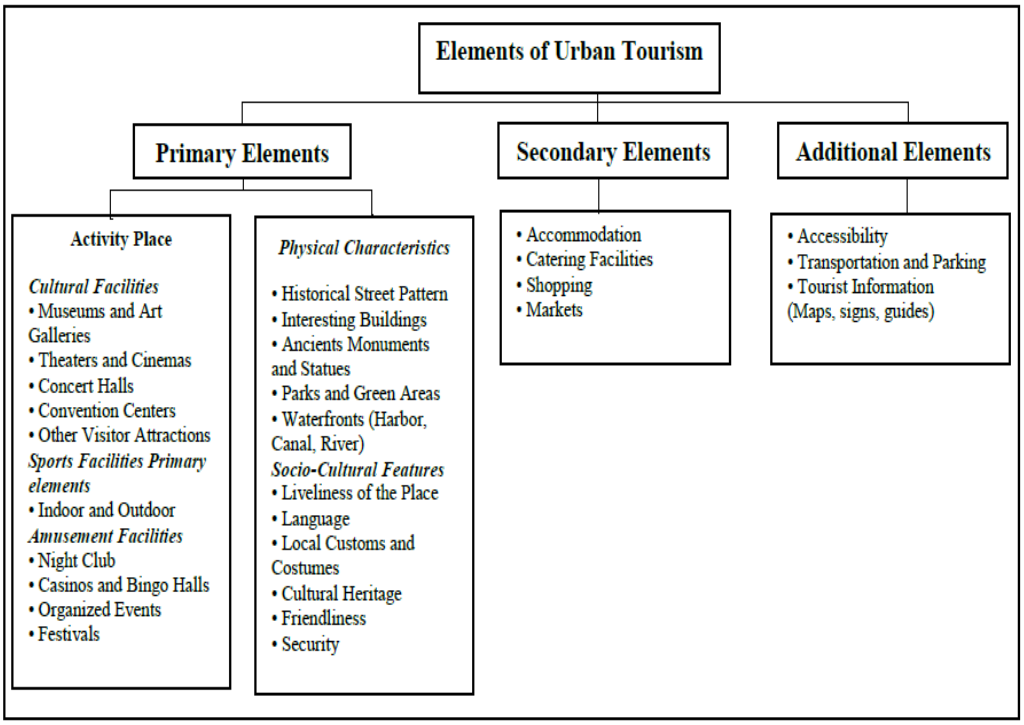

Figure 1. Elements of urban tourism
Source: Ruetsche (2006, p. 2)

area's image, physicality, and environment. A refurbished city image can attract more investors, creative industries, and talented individuals to increase the economic level and development of the city. Thus, urban tourism development is an important tool for economic growth, job creation, promotion of places, and reshaping the city's image, which helps create a national identity attractive to foreign tourists.

Maintaining cultural assets in urban locations presents several issues. The first is a fund to manage the historic structure. If done by an individual, maintaining a structure is expensive. Government agencies or private organisations typically grant these monies. Second, educate stakeholders on the significance of historical structures and traditional customs in attracting tourists. They must be clear about the goals and objectives of preservation to protect the authenticity of the building's design and culture. Conflicts of interest between stakeholders are common, resulting in the inadequate implementation of the preservation of structures and cultures. Third is the government's role in determining development decisions in a city. Conflict of interest, whether profit or maintenance, frequently arises, causing many historic urban places to be sacrificed for development reasons. Fourth is vandalism among tourists when visiting urban cultural attractions. They damaged some monuments by scratching, painting, and stealing (N. Ismail et al., 2014).

Razali and Ismail (2014) conducted a study that critically reviews indicators for measuring sustainable urban tourism development in Malaysia. The study's findings indicate that determining the contribution of urban tourism to the economy and development of the local community is difficult due to the various disciplines that obscure the existence of urban tourism as an independent sector. This indicator does not accurately reflect the level of achievement of urban tourism activities, and the economic term is inappropriate. Since the concept of sustainable tourism was introduced, the role of indicators in measuring economic and social benefits has grown in importance. Hence, urban development must also be monitored with appropriate indicators. The goal is to assess and track changes in the city's economy to track progress toward sustainable development. As a result, identifying and measuring the entire range of environmental, social, and economic impacts interconnected in tourism development and obtaining accurate information for responsible decisions is central to the debate on developing urban tourism indicators. Several approaches have been developed in the Malaysian context, even though the indicators are not directly comparable.

Low-Carbon Tourism and Urban Tourism Development. The concept of LCT was formally proposed in a report on low-carbon travel and the tourism industry at the World Economic Forum in May 2009 (Huang & Deng, 2011). However, the idea of LCT was sparked following the proposal of a low-carbon economy concept in "The

Energy of Our Future" by the British in 2003 (Huang & Deng, 2011). The concept of LCT can improve living standards by consuming fewer natural resources, reducing environmental pollution, and positively impacting the economy. Malaysia introduced the concept of sustainable development in 1970 in the Seventh Malaysia Plan by adopting short-term and long-term planning, which focused on sustainable development (Othman & Pereira, 2005). In addition, several government agencies also supported the low-carbon expansion efforts. The KeTTHA, for example, issued guidelines for the Low-Carbon City Framework (LCCF). In line with the Sustainable Development Goals (SDGs), the LCCF guidelines are the national framework and assessment system for sustainable urban development.

Low-carbon cities address the problem of carbon emissions by controlling and reducing total carbon emissions in all sectors involved to achieve better quality and healthier lifestyles. However, urban carbon emissions must be reduced to achieve this goal, and the city's low-sustainable economy can be enhanced. LCT is one key to achieving this objective. Based on the Green Technology Master Plan (GTMP), there are six key sectors (manufacturing, energy, building, waste, transportation, water) and six strategic thrusts (promotion and awareness; market enablers; human capital development; research, development, and commercialisation; institutional framework) that can be addressed (Ministry of Natural Resources & Environment [NRE], 2015). However, the growing demand for travel to the city covers many purposes, which include running businesses, attending seminars and conventions, cultural matters, and entertainment. A wide variety of attractions offered as tourist destinations make it unique to visit the city while attending to official business or formal matters. The uniqueness of urban tourism offers city-based diverse and heterogeneous cultural, architectural, technological, social, and natural experiences and products other than the long-established nature-based rural tourism in rural and natural settings. Based on Cave and Jolliffe (2012), urban tourism comprises the following:

1. Primary elements: elements that attract tourists to a particular place, such as sports facilities, cultural facilities, physical characteristics, amusement facilities, and sociocultural features.

2. Secondary elements: elements that support and complement primary tourism, such as transportation or services required by tourists at tourism destinations—for example, accommodation, catering facilities, shopping, and the market.

Many studies were conducted on LCT in urban destinations. A case study in Chiang Mai, an urban tourist destination in Northern Thailand, has identified the development of non-motorised transportation (NMT) systems to reduce emissions (Kumar et al., 2016). Several types of NMTs are introduced, including walking, cycling,

small-wheeled transport, low-emission or battery-powered cars, and others. This sustainable urban tourism (SUT) project initiative discovered that NMT could reduce 230–570 tons of CO_2-eq per year by replacing between 535,820 and 1,339,550 kilometres of mileage traversed by local diesel-powered vehicles if promoted in popular urban attractions such as the Three King Monument in Thailand. NMT provides flexible urban transportation options for visitors while simultaneously reducing the percentage of GHG emissions resulting from traditional transportation.

In addition, the garden house concept is another initiative to reduce carbon emissions in urban areas. According to Kumar et al. (2016), this concept has been promoted in the small town of Hue, Vietnam, as a tourist attraction since 2002. Garden houses can lower GHG emissions in various ways, including carbon's photosynthetic absorption. In addition, household food waste is recycled through composting or animal feed. This process can reduce the number of domestic animals, thus reducing the amount of domestic waste that needs to be disposed of. The various products the garden house produces, such as fruits and vegetables, can reduce emissions from ambient transportation while increasing local income. Nevertheless, the garden house approach requires strong collaboration between residents, the government and the active involvement of relevant stakeholders to ensure that the initiative can significantly contribute to urban tourism development.

Urban waste management can also substantially contribute to LCT efforts. Obersteiner et al. (2021) suggested several potential strategies to lower carbon footprint through waste management, including efficiently controlling food waste, reducing plastics usage, and sorting and recycling waste. The strategies on GHG emissions were estimated to save between 4 and 189 kg of CO_2-eq per 1000 visitors based on the waste management system practised. However, these strategies require strict implementation of waste segregation to support sustainable development efforts. In addition, the use of plastics for packaging should be reduced and replaced with products or other alternatives that are more environmentally friendly and biodegradable or recyclable. Waste management in urban tourist spots, including bio-wastes, must be considered and addressed with practicality and scalability to reduce carbon footprint and save the earth from further pollution (Kitamura et al., 2020).

The United Nations Development Programme (UNDP; "Goal 11: Make cities inclusive", 2015) predicted that by 2030, 60% of the world's population would migrate and live in city areas. The tourism sector has become one of the critical elements in urban development policy, as it is a key component of economic, social, and urban geography (Mao et al., 2022). In this regard, LCT can contribute to meeting the 17 Sustainable Development Objectives, particularly Goal 11, which is to provide peaceful, inclusive, sustainable, and resilient cities and human settlements ("Goal 11:

Make cities inclusive", 2015). However, the development and management of sustainable tourism in the city require a multi-stakeholder and multi-level approach apart from the full cooperation of the administration and tourism agencies, including the private sector, local communities, and tourists. Thongdejsri et al. (2016) and Mao et al. (2022) revealed that a key factor in the success of LCT is the cooperation of business owners, local people, and stakeholders, as well as the relevant government agencies. The development of eco-tourism indicators should therefore focus on the measurement, evaluation, and monitoring of efforts needed to reach the level of LCT standards and to gauge their effectiveness.

Policy in Low-Carbon Tourism. In facing globalisation and challenges in the tourism industry, various aspects need to be considered that require the support of all stakeholders, especially in formulating relevant policies. Cooperation from all government departments is crucial to find solutions to every problem related to tourism issues for the improvement and development of the industry towards a sustainable approach. Therefore, LCT's policy development and implementation efforts should encompass comprehensive principles and consider every element involved. Recent studies have identified several low-carbon policies (Han & Li, 2021; Mao et al., 2022; Tan et al., 2017). Further research is required to identify a comprehensive framework for developing successful LCT destinations.

Among the important elements in ensuring the effectiveness of policy implementation is coherence and consistency in policy planning and application between all levels of government. Besides governments, other related industries, communities, and stakeholders also need to take part in developing and defining the direction, identity, vision, and mission of long-term tourism development by incorporating elements of sustainable concepts in the tourism sector. Hence, the discussion on the strategies and policies of the LCT concept will be elaborated on next.

METHODS

This study employed a qualitative and content analysis technique to analyse and interpret all technical reports, policy papers, action plans, and relevant literature. A literature search was conducted using leading electronic journal databases (Science Direct and Scopus) using five related keywords: tourism development, carbon dioxide, LCT, low-carbon indicators, and LCT policy. A content analysis develops a list of indicators for LCT strategies and policy in urban tourism development. Forty-five articles were reviewed, but only a few were concerned with low-carbon indicators, mainly from Chinese sources (Table 1). The articles reviewed were on low-carbon urban tourism published between 2006 and 2022, comprising journal papers (24), books (2), technical reports (9), thesis (1), conference proceedings (7) and forum (2). The papers are published in 19 journals (Table 1). From these sources,

only a few articles were devoted to low carbon indicators, as reported in four article journals and one government policy paper, to assess the development of LCT. This study identified 159 reliable and validated items of low-carbon indicators through qualitative methods (Table 2). Three critical aspects can be highlighted from the indicators: economic, environmental, and social. Some policies in urban tourism development were listed, including strategies for LCT activities, actions, and cooperation from the authorities and residents, constituting a new tourism development model for the LCT. The findings of this study can help future research formulate a comprehensive framework for developing successful LCT destinations and serve as guidelines for developing LCT, particularly in urban settings.

Table 1

Titles of resources used in the literature

No.	Title of selected resources	Number of articles
1.	Technical report	9
2.	Tourism Economics	1
3.	Book	2
4.	Sustainability	3
5.	Forum	2
6.	Conference Proceedings	7
7.	Thesis	1
8.	Advances in Materials Science and Engineering	1
9.	Energy Procedia	4
10.	ASEAN Journal on Hospitality and Tourism	1
11.	Journal of Hospitality & Tourism Research	1
12.	Frontiers in Environmental Science	1
13.	*Zeitschrift für Tourismuswissenschaft*	1
14.	Environmental Development	1
15.	Journal of Tourism Futures	1
16.	Sustainable Tourism	1
17.	Urbani Izziv	1
18.	Lex ET Scientia International Journal	1
19.	Applied Energy	1
20.	Advances in Meteorology	1
21.	Open Geosciences	1
22.	Journal of Travel Research	1
23.	The Open Cybernetics & Systemic Journal	1
24.	Journal of Cleaner Production	1
Total		**45**

RESULTS

LCT is the proposed consequence of the eco-tourism concept, which is an introduction to achieving sustainable tourism targets. Several factors are necessary to support this idea, including knowledge and

understanding of LCT and cooperation from local authorities, residents, traders, and tourists for the long-term development of sustainable urban development (Huang & Deng, 2011; Pongthanaisawan et al., 2018; Wu et al., 2017). J. Zhang and Zhang (2020) stated the three critical aspects crucial for LCT indicators in urban destinations: low-carbon economic subsystems (LCT product, low-carbon input, tourism development), low-carbon environments subsystems (Low-carbon environment, Ecological environment, Low-carbon facilities), and low-carbon social subsystems (Low-carbon idea and Low-carbon management). The indicators were identified using the fuzzy Delphi method. T. H. Lee and Jan (2019) identified 40 items comprising seven constructs: sensory experience, affective experience, learning experience, sociocultural experience, behavioural experience, escapism experience, and prestige experience. These items were used to evaluate the LCT experience (LCTE) from a nature-based tourist perspective. According to Pongthanaisawan et al. (2018), there are two components to be considered for LCT monitoring, namely low-carbon cities and economic development, as presented in Table 2. There are ten low-carbon city criteria referenced from the Low-Carbon City Indicator (LCCI) framework, Carbon Footprint Indicator (CFI), and Low-Carbon City Development Indicator (LCCDI). In addition, economic development involves seven criteria that focus on general socioeconomic indicators.

Wu et al. (2017) provided four factors with 16 assessment items to gauge the emotional value of LCT, experience value, functional value (profit and loss), and functional value (quality and quantity). They also suggested 18 low-carbon travel behaviours used to identify the willingness of tourists and residents to take part in LCT. The individual's behaviour can be internally influenced, such as awareness, attitude, and ability to change. In addition, external features such as society, culture and living environment may also influence changes in individual attitudes. Behavioural factors must also be accounted for and assessed to ensure the effective implementation of LCT.

The Ministry of Energy, Science, Technology, Environment, and Climate Change has also developed the Low-Carbon City Framework (LCCF) to assess low-carbon city development (KeTTHA, 2017). LCCF comprises four elements: urban environment, urban transport, urban infrastructure and building. It also contains 13 performance criteria and 35 sub-criteria which can assist in developing LCT in urban development. The LCCF may use as the benchmark of low-carbon implementation in urban tourism. Table 2 shows the elements to evaluate LCT in an urban tourist area. The low-carbon indicators are based on four article journals and one government policy paper from the literature. A total of 159 indicators were determined as suitable for constructing LCT in urban destinations.

With reference to Table 2, all the elements collated are potential components of indicators for LCT development.

However, further testing is necessary to ensure validity before developing the LCT framework. In addition, detailed tests need to be conducted to identify indicators to be implemented according to categories such as region, climate, and sociocultural and corresponding with district-level activities that are to be developed as LCT centres. Further studies are recommended to overcome the limitations of this study to address the implications of LCT from international and global perspectives.

A total of 159 indicators were identified that can be developed, improved, and used to evaluate the effectiveness of LCT implementation in the city centre. These indicators will become the primary guidelines for constructing low-tourism indicators in the Malaysian context. Based on these LCT elements, we strongly encouraged future studies to examine and identify in more depth the relationships between indicators and influences on the environment using a long-term approach to be implemented in Malaysia.

From the literature review, 159 indicators were identified that can be used as guides in developing LCT. They cover all aspects of LCT activities based on three past studies and the LCCF framework. LCT features complement one another, which is likewise reflected in the indicators. Among these aspects include economic, environmental, social, experience (affective experience, sociocultural experience, behavioural, escapism, and prestige), values (emotional, experience, functional), behaviours (public and residents), transportation, infrastructure and building construction. These selected indicators represent every important aspect necessary for developing LCT. They will be tested further for validity and used as a benchmark for developing guidelines for expanding LCT in urban settings.

J. Zhang and Zhang (2020) constructed 33 indicators to evaluate the development of LCT in urban tourism destinations, which included LCT in economic, environmental, and social subsystems. The formulated evaluation model can transform LCT's integrated qualitative and quantitative value to drive its development. T. H. Lee and Jan (2019) developed a scale to evaluate LCT experience (LCTE) from the perspective of a nature-based tourist, comprising seven constructs: sensory experience, affective experience, learning experience, sociocultural experience, behavioural experience, escapism experience and prestige experience. We can use the LCTE scale to guide tourists and tourism managers to reduce carbon emissions and potentially contribute to sustainable tourism development.

Wu et al. (2017) focused on behavioural changes among consumers and society regarding LCT in China. Factor 1 is the emotional value which consists of five items that identify the emotional satisfaction of tourists towards LCT products and services. Factor 2 is the experience value, which includes five items on experience satisfaction and tourist satisfaction towards LCT. Factor 3 is called functional value (profit and loss), encompassing three items concerning the negative feelings of

Table 2

Indicators of low-carbon tourism in urban development

References	Indicators	Criteria of indicators
J. Zhang and Zhang (2020)	1. LCT economic subsystem i. LCT product ii. Low-carbon input iii. Tourism development 2. LCT environmental subsystem i. Low-carbon environment ii. Ecological environment iii. Low-carbon facilities 3. LCT social subsystem i. Low-carbon idea ii. Low-carbon management	1. Proportion of green hotel 2. Proportion of green catering enterprise 3. Proportion of green building 4. Low-carbon shopping 5. Proportion of low-carbon transport 6. Proportion of low-carbon tourist attractions 7. Low-carbon investment rate 8. Low-carbon marketing 9. Tourist growth rate 10. Tourism congestion index 11. Tourism carbon intensity 12. Tourism carbon footprint 13. Renewable energy usage 14. Tourism energy intensity 15. Ratio of green space 16. Air pollution index 17. Surface water quality 18. Noise pollution level 19. Trash management 20. Sewage treatment 21. Ecological environment monitoring system 22. Public infrastructure construction for low carbon 23. Water-saving technology adoption 24. Low-carbon guiding sign 25. Usage of low-carbon material 26. Education on low-carbon environment 27. Communication of low carbon 28. Carbon literacy of residents 29. Carbon literacy of tourist 30. Carbon literacy of tourism enterprise 31. Low-carbon policy & legislation 32. Special plans for LCT 33. Low-carbon technology

Table 2 *(Continue)*

References	Indicators	Criteria of indicators
T. H. Lee and Jan (2019)	Sensory experience	1. This low-carbon travel experience had a powerful impact on my visual and other senses. 2. I find this LCT experience interesting in a sensory way. 3. I feel real harmony during this low-carbon tour. 4. I felt a proper sense of harmony during this LCT experience. 5. The landscape was very charming in this LCT experience. 6. I associated sights, smells, sounds, tastes, and textures with this LCT experience. 7. The overall design of this activity can arouse tourists' interest in this LCT experience.
	Affective experience	8. This LCT experience induced feelings and sentiments. 9. This LCT experience was cheerful. 10. This LCT experience was enjoyable. 11. This LCT experience was comfortable. 12. This LCT experience was exciting. 13. I felt a sense of awe during this LCT experience. 14. This LCT experience was relaxing. 15. This LCT experience was interesting.
		16. I engaged in much thinking when I participated in this LCT experience. 17. I reflected on new ideas about animals and their environments. 18. I am being educated through this LCT experience. 19. I discussed new information with my companions. 20. It was an exploratory experience. 21. It was a new cultural experience. 22. I found a new perspective on my life. 23. I reflected more on myself. 24. I experienced different things on this trip.

Table 2 *(Continue)*

References	Indicators	Criteria of indicators
	Sociocultural experience	25. I interacted with people at the destination. 26. I understood the unique characteristics of local people at the destination. 27. I had a good impression of the local people. 28. The locals at the destination are friendly. 29. I get to meet new people and do new things.
	Behavioural experience	30. I engaged in physical actions and behaviours during this LCT experience. 31. I experienced LCT.
	Escapism	32. I completely escaped from my daily routine. 33. I experienced something new. 34. I am involved in this LCT experience. 35. Taking part in this LCT experience made me feel as if I was in another world. 36. While I was playing, I forgot that time was passing. 37. I felt I belonged in the environment.
	Prestige	38. This LCT helps me make a good impression on others. 39. With this LCT experience, I could convey social status. 40. I am proud to pay attention to environmental issues by participating in this LCT experience.
Pongthanaisawan et al. (2018)	Economic development	1. The population size 2. Density of population 3. Per capita income 4. The number of visitors 5. The number of newly registered businesses (local companies) 6. The tourism-related industry's gross provincial product (GPP) 7. The proportion of foreign and domestic capital investment
	Low-carbon city development	8. Per capita CO_2 9. The intensity of energy (energy per capita) 10. The percentage of renewable energy that is used. 11. Per capita water use 12. The amount of public green space 13. Per capita solid trash generation 14. Waste-to-energy ratio 15. Recycled waste share 16. Cars per capita vs public buses 17. Ownership of private vehicle (per capita car/motorcycle)

Table 2 *(Continue)*

References	Indicators	Criteria of indicators
Wu et al. (2017)	Emotional value	1. Low-carbon behaviour makes me leave a good impression on others. 2. Low-carbon behaviour lets me win much social affirmation and praise. 3. Low-carbon behaviour sets up a positive personal image. 4. Low-carbon travel behaviour brings about self-identity. 5. LCT behaviour can bring me an enjoyable feeling.
	Experience Value	6. I want to experience changes in the LCT community. 7. Low-carbon behaviour makes travel/service more fulfilling. 8. We could learn new things by participating in the LCT community. 9. LCT is closer to nature. 10. LCT is exciting and fresh for me.
	Functional value (Profit and loss)	11. The service of low carbon is worse than the quality of general service. 12. LCT community service projects are fewer. 13. Low-carbon travels community services prices are high. 14. The low-carbon travel community makes no sense to me.
	Functional value (Quality and quantity)	15. LCT is simple to practice. 16. Low-carbon service lets me rest assured.
	Public's low-carbon travel behaviours	17. Choose locally-produced food or products 18. Remove rubbish from tourist sites 19. Choose low-carbon modes of travel (e.g., hiking, climbing) 20. Choose environmentally friendly accommodations 21. Use recycled daily items 22. Buy tourism products with simple packaging 23. Bring your food and water 24. Refuse to use disposable tableware 25. Refuse high energy consumption appliances (e.g., air-conditioning). 26. Take the rest food
	Residents' low-carbon travel behaviour	27. Provide recycled tableware 28. Use of local, seasonal ingredients 29. Use environmentally friendly recycled construction materials 30. Refuse to use or set energy consumption appliances and equipment 31. Increase vegetation coverage 32. Waste classification and recycling 33. Use clean energy (solar energy, methane, rainwater) 34. Provide propagandise of low-carbon tourism for tourists

Table 2 *(Continue)*

References	Indicators	Criteria of indicators
KeTTHA (2017) Parameters of Low-Carbon Cities	Urban environment	**A. Site selection:** 1. Development within the defined urban footprint 2. Infill development 3. Development within transit nodes and corridors 4. Brownfields and greyfield redevelopment 5. Hill-slope development **B. Urban form** 6. Mixed-use development 7. Compact development 8. Road and Parking 9. Comprehensive pedestrian network 10. Comprehensive cycling network 11. Urban heat island (UHI) effect **C. Urban greenery and environmental quality** 12. Preserve natural ecology, water body, and biodiversity 13. Green Open Space 14. Number of Trees
	Urban transportation	**A. Shift Transport mode** 15. Single Occupancy Vehicle (SOV) dependency **B. Green transport infrastructure** 16. Public transport 17. Walking and cycling **C. Clean Vehicles** 18. Low-carbon public transport 19. Low-carbon private transport D. Traffic management 20. Vehicle speed management 21. Traffic congestion and traffic flow management
	Urban infrastructure	**A. Infrastructure provision** 22. Land take for infrastructure and utility services 23. Earthwork management 24. Urban storm-water management and flood mitigation **B. Waste** 25. Construction and industrial waste management and flood mitigation. 26. Household solid waste management **C. Energy** 27. Energy optimisation 28. Renewable energy 29. Site-wide district cooling system **D. Water management** 30. Efficient water management
	Building	**A. Low-carbon buildings** 31. Operational energy emissions 32. Operational water emissions 33. Emission Abatement through retrofitting 34. Building orientation **B. Community services** 35. Shared facilities and utilities within the building

tourists towards LCT revenue. Factor 4 is the functional value (quality and quantity), which includes two items regarding tourist satisfaction with the quality and current quantities of low-carbon tourism. The study established that most visitors were not concerned about the environment and were oblivious to low-carbon activities. As such, guidance and knowledge on low-carbon appreciation should be nurtured in the community by changing operations and professional training to develop diverse and attractive low-carbon service patterns. Therefore, awareness, intention and practice of individual behaviour are critical elements that must be considered in an LCT economy.

To mitigate climate change and reduce CO_2 emissions, the Government of Malaysia has launched the National Green Technology Policy (KeTTHA, 2017). As a result, various sustainable development initiatives are developed where policies focusing on technology, solutions and roadmaps to reduce the impact of development on the environment are formulated (refer to Figure 2). The Green city policy development holistically offers long-term sustainability, with similar goals as sustainable cities, which comprises three principles of sustainable development, namely environmental, economic, and social perspectives. The Ministry of Energy, Green Technology and Water (KeTTHA) has developed a framework for low-carbon cities that drive the implementation of low-carbon development measures in cities and towns. In recognising the importance of measuring urban performance, particularly its contribution to the country's carbon emission levels, the government is committed to reducing carbon emissions. KeTTHA has developed a framework for low-carbon driving in cities and towns and implementation of carbon reduction measures by introducing an evaluation system to measure and monitor the development of the Low-Carbon Cities Framework (LCCF) issued in 2011 (LCCF version 1) and 2017 (LCCF version 2). Figure 3 shows the summary of the LCCF criteria issued by the ministry.

The LCT shown in Table 2 identified all necessary indicators in developing urban LCT destinations. However, implementing the LCT development project depends on tourism practices, the population and the decision-makers in handling the problem of emissions produced by the population and industries. The focus, therefore, should not be solely on the tourism sector. Many other factors need to be considered in developing LCT management. Among these is the measurement of CO_2 emissions related to tourism, efforts to reduce CO_2, policies, LCT knowledge and other factors contributing to carbon emissions in urban areas (J. Zhang & Zhang, 2020).

M. Zhang et al. (2021) adopted the low-carbon sustainability index method in a study of four selected Chinese cities. Results showed that all four cities failed the test for sensible low-carbon sustainability rules. They showed weak low-carbon sustainable development despite significant progress in capacity building in pollution control, wastewater treatment, major pollutants

removal, domestic waste treatment and disposal of hazardous waste. The cities faced significant challenges in using sustainable energy, offsetting CO_2 emissions and adopting nature-based solutions. In light of these findings, this study can serve as a pioneer in creating systematic LCT management that can be expanded to large-scale urban destinations.

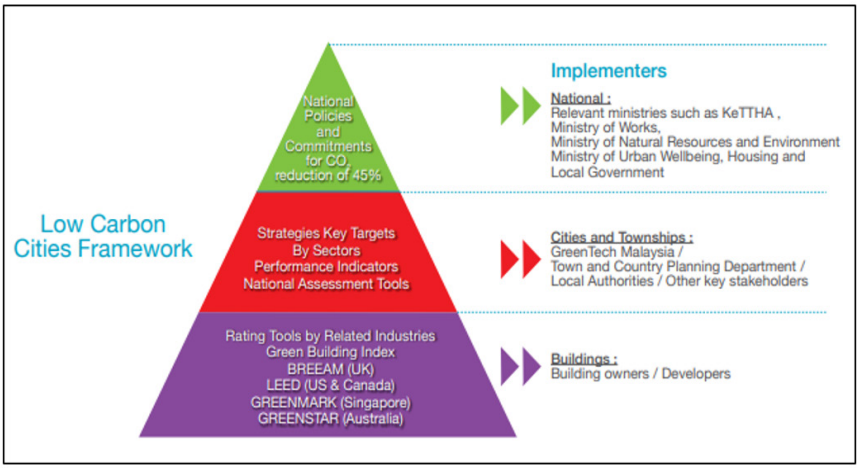

Figure 2. LCCF concerning national policies and rating tools
Source: KeTTHA (2017)

Figure 3. Breakdown of performance criteria and sub-criteria of LCCF
Source: KeTTHA (2017)

The Policy of Low-Carbon Tourism Development

The low-carbon principle can be used in adopting and proposing several policies in tourism development. According to Yang (2015), developing LCT involves

several steps, which include economic, technological, and social change. Additionally, the indicators must meet development objectives and eco-tourism requirements reflected in economic development, environmental protection, and legislation. Malaysia's energy consumption increased from 13 million cubic feet in 1990 to roughly 53 people one million cubic feet in 2013, with an average yearly growth rate of 6.3%. The GDP recorded an annual average growth rate of 5.7% over the same period (KeTTHA, 2015). For Malaysia to sustain economic growth in the next decade, it must ensure its energy supply is sufficient to maintain growth productivity and economic competitiveness. Low-carbon efforts were emphasised in the *Tenth Malaysia Plan 2011–2015* (2010), although only a few resorted to using renewable energy sources. Much greater support from all relevant parties and stakeholders is thus needed for renewable energy to be utilised and promoted in the tourism sector to reduce the carbon footprint that is harmful to the environment.

Renewable energy has the potential to be commercialised as an alternative energy source in the resort and hotel development in Malaysia. For example, photovoltaic technology and wind energy can be introduced in tourism facilities, especially in island resorts on the peninsula's east coast (Darus et al., 2008). Wind turbines and photovoltaic panels can produce 74kW, which meets the daily electricity requirement for the resort facility. Renewable energy can meet the needs of tourism and local domestic use. The relevant authorities and ministries should introduce policies that promote LCT destinations and attractions (Shi & Peng, 2011). Tang et al. (2018) suggested that in formulating a carbon tourism policy, several factors need to be considered, such as the level of social development, economy, and tourism resources according to region. Accordingly, the relevant government departments should formulate appropriate motivation, management, certification, and evaluation policies to develop more standardised LCT destinations.

W. H. Lee (2011) suggested three phases of development required as guidelines for developing green tourism resources: planning, construction and maintenance. In the planning phase, public facilities are encouraged to use new renewable energy such as solar, bioenergy, water, wind, fuel cells, ocean, waste and geothermal to reduce greenhouse gas emissions. Construction work during maintenance should use environmentally friendly structures to save energy and resources in planning, design, construction, maintenance and disposal. Environmentally friendly structures preserve the environment and improve human health and comfort. In the maintenance phase, low-carbon green events such as conferences, performances, and festivals. Hold a green event should also be supported. The source of greenhouse gas emissions must be identified and its impact reduced. Knowledge of this procedure needs to be made accessible to the public.

Various guidelines are provided by the Ministry of Energy, Science, Technology, Environment and Climate

Change (MESTECC) and the Ministry of Housing and Local Government (KPKT) for promoting low-carbon green events and reducing carbon footprints that could lead to climate change. Policymakers should thus introduce policies that encourage low-carbon construction in tourism attractions. J. Zhang and Zhang (2020) proposed several policies for LCT as follows:

1. Improve funding for low-carbon infrastructure by promoting low-carbon materials and labels in the tourism industry.
2. Spread ideas on the importance of LCT development and improving low-carbon literacy. All parties, including tour operators, administrators, and workers of tourism agencies, should get proper training on low-carbon to create a low-carbon culture for the entire society.
3. Enact relevant legislation and regulations to control and plan low-carbon development and promote low-carbon behaviour.
4. Actively introducing low-carbon innovations and technologies in the tourism carbon sector, such as replacing energy with new sustainable energy sources (solar, wind, and hydropower).

Based on research by Becken (2009), W. H. Lee (2011), OECD (2010), Shi and Peng (2011), Tang et al. (2018), and Yang (2015) on LCT development, some policies can be proposed for implementation, as follows:

1. Enhance synergistic effects by linking partial strategies to promote LCT.
2. Strengthen community understanding and expand awareness of LCT business through education and public relations.
3. Ease expenses caused by introducing green technology into the tourism business and improving sophisticated transportation systems with a low-carbon approach.
4. Provide Principles of Comprehensive Representation standards to illustrate economic outcomes from LCT from each perspective according to the respective indicators of LCT.
5. Combine indicators of Qualitative and Quantitative Evaluation so that it is valid and practical. Quantitative principles ensure aim and reasonable objectives, while qualitative principles solve various problems.
6. Developing LCT based on dynamic and stable processes. First, economic, technological, and social change indicators must be considered. Second, strengthening indices ensures current LCT growth and summarises future development perspectives.
7. Foster scientific use in selecting qualitative changes that need to be based on statements. For example, the power of eco-tourism, status, filtering, and other negative understandings and analyses.

8. Upgrade systems, indicators, and data for LCT assessment.
9. Provide an evaluation system that covers all design and LCT features, including macro and micro, according to their function.
10. Promote energy-efficient transportation to manage travel demand to ensure the safety of the transportation sector's short-term oil supply and various fuel supplies.
11. Increase allocation and research and development (R&D) in energy-efficient technologies, minimise carbon emissions, optimise utilisation and improve energy efficiency, especially for the tourism industry, using science and technology.
12. The government, including the administration division and the tourism department, should improve the management of LCT by effectively monitoring and managing tourist attractions for effective results.
13. Provide incentives for additional capital, technology, and more careful management to encourage the construction of LCT areas such as financial subsidies, tax incentives, and others.
14. Provide standardised assessment standards for LCT certification and evaluation as current industry-wide attractions, making it a future trend.
15. Draw general principles and minimum standards in the project process, including location selection, planning, construction, and maintenance.
16. Provide programmes to support workforce education, training, innovation, and development in LCT.

To succeed in LCT, it is paramount that individuals should increase their awareness of the positive effects and responsibilities of conserving the environment. The OECD (2010) embraced the importance of policies on LCT to raise awareness of employment potential, centred on low-carbon activities, in creating key growth opportunities for global employment in the future. Consequently, responsible parties need to study and introduce LCT standards and establish regulations on the use of carbon energy to encourage low-carbon practices in transportation, recreation areas, hotels, eateries, and entertainment venues. The development of LCT destinations can accordingly be fostered, such as the low-carbon construction of cities. In Malaysia, tourist destinations that promote LCT include Langkawi Island, Perhentian Island, Malacca City and Putrajaya. In sum, the existing low-carbon tourist spots can be improved based on proposed policies and guidelines for their development.

DISCUSSION

Tourism activities contribute to carbon emissions into the atmosphere. According to OECD (2010) records, the tourism industry contributes as much as 75%

towards global greenhouse gas emissions, mainly from transportation. A study by Chen et al. (2018) found that from 2001 to 2015, transportation involving urban tourism activities was the major contributor to CO_2 emissions in China, amounting to over 72% of the total. Implementing a low-carbon economy is thus one alternative to curb the problem of carbon emissions. Sustainable efforts in curbing carbon emissions may simultaneously contribute towards energy savings and emission reduction on national and global scales. There have been many policy developments in the low-carbon economy over the years that have been implemented in China to green the tourism sector. From this perspective, it is similarly appropriate and necessary for Malaysia to establish a comprehensive policy and framework to realise the national goal of minimising carbon emissions and promoting low-carbon development in urban centres.

Malaysia announced the development of sustainable indicators in 1997 by introducing the Malaysian Sustainable Development Indicators (MSDI; Razali & Ismail, 2014). Since then, the country has produced many indicators as guides for sustainable development. The federal and state governments and non-governmental organisations, with different objectives and purposes, implement and develop these indicators. In the process, there are several frameworks issued to measure the development of low-carbon in urban areas, such as the Malaysian Urban Indicator Network (MURNInet) and the Malaysian Quality of Life Index (MQLI), Summary of Environmental Statistics (CES), Low-Carbon City Framework (LCCF; KeTTHA, 2017; Razali & Ismail, 2014). Since the objective and scope of investigation differ, the indicators thus vary according to the pertinent scientists and institutes. These indicators mainly focus on the problems of the environment, society, infrastructure and building structures in urban areas. There are no specific indicators to measure carbon emissions within Malaysia's sustainable tourism context. The country already has many low-carbon city frameworks, which might suit low-carbon urban tourism development. Thus, policy formulation and development of LCT indicators are crucial for urban tourism development so that economic changes can be assessed and monitored to track sustainable tourism development. This study can be viewed as an extension of the existing framework on carbon measurement, such as from a low-carbon city making room for an urban tourism context.

LCT is an initiative that positively impacts the environment and is responsible for managing tourism. Consequently, increased awareness and knowledge of LCT must be communicated to all stakeholders, including the government, tourists and the public. This study aims to introduce the elements of accomplishing LCT to curb carbon emissions from various tourism activities, such as the management of hotels, transportation, dining, recreation, and entertainment venues. This study could stimulate subsequent trials for LCT destinations and assist in formulating

LCT guidelines, especially in urban areas. The results can contribute to constructing an LCT framework suitable for urban tourism activities and generating important information on the concept while contributing towards sustainable urban development.

CONCLUSION

LCT requires joint efforts from the government, tourism sector and research faculty for tourism to grow efficiently, be energy-saving and be environmentally friendly. It proves that implementing LCT can help reduce carbon dioxide emissions and energy consumption while supporting efforts toward realising sustainable economic and environmental development. In addition, LCT offers a high-quality and sustainable tourism experience by reducing the impact of pollution and carbon emissions in all leisure activities, facilities and infrastructure.

Indicators were selected to assess the implications of LCT to ensure effectiveness in the implementation. A comprehensive LCT framework must be identified to address the relevant factors and criteria, including awareness, behaviours, policies, infrastructure, institutional systems and mechanisms at all levels.

An in-depth study of the methods and structure and the expansion of knowledge on the concept of LCT is also suggested since it may further improve the standard of the tourism sector. Studies on the effectiveness of LCT in reducing GHG emissions need to be enhanced to provide the impetus for developing and promoting sustainable tourism while simultaneously saving the environment from worsening pollution.

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