

EVALUATION OF SOCIETY'S PARTICIPATION AND PERCEPTION IN THE LOW-CARBON CITY (LCC) INITIATIVE IN THE KAJANG MUNICIPAL CITY (MPKJ) AREA

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Abstract: Low-Carbon City (LCC) is an effort to create a sustainable urban plan that stops the growing carbon footprint of cities by reducing or eliminating fossil fuel use. Malaysia joined the LCC initiative at the 15th Conference of the Parties (COP15) in 2009, setting a goal to reduce carbon emissions by 45% by 2035. However, limited studies have examined LCC progress in Selangor. The main objective of this study is to understand the current potential participation of society and the efforts of the local authorities to encourage participation to achieve LCC within the Kajang Municipal Council (MPKj) area. Correspondingly, this study evaluates three themes to identify the current LCC progress of the MPKj society: Knowledge, perception, and participation. Thematic analysis of qualitative data from five informants' semi-structured interviews revealed an apparent gap in knowledge with regard to the LCC effort, underscoring the need for more transparent communication of sustainable practices. According to quantitative survey data from 273 respondents, only 46.9% of respondents separate their waste, while 24.4% were unaware of the LCC effort, and 31.3% had never heard of it, despite the fact that 92.7% of respondents support the addition of recycling centres close to residential areas. Thus, to encourage LCC participation, a shift from top-down to bottom-up approaches is required to better educate the community in MPKj.

Keywords: Low-carbon City (LCC), participation, sustainability, awareness, carbon emissions.

Introduction

The term Low-carbon City (LCC) was initially introduced by the World Wildlife Fund (WWF) branch in China in 2008 (Sarker *et al.*, 2018). LCC is defined as a dedicated effort towards building a sustainable urbanisation plan that mitigates or halts the increasing carbon footprints of cities through the minimisation or elimination of fossil fuel use (Rimi & Aliyu, 2019). In particular, the term "carbon" in LCC refers to the cumulative content of carbon emissions, which constitute the majority of Greenhouse Gas (GHG) emissions. Accordingly, the LCC policy was proposed in response to the evident negative effects of GHG emissions resulting from rapid urbanisation. Approximately 46% of global GHG emissions originate from urban areas, necessitating an action plan for sustainable urban development and maintenance (Sarker *et al.*, 2018). Currently, China leads research on LCC

initiatives due to its high per capita energy consumption compared to the global average.

In rapidly urbanising nations such as China and Malaysia, economic and social development heavily depend on urban expansion. However, this progress comes at the cost of increased carbon emissions, exacerbating global warming. The consequences include rising sea levels, extreme weather events, droughts, reduced agricultural productivity, threats to ecological security, and other negative impacts on human life (Shen *et al.*, 2021). To counter these issues, the LCC policy was introduced alongside a low-carbon lifestyle that promotes sustainable energy, community participation in reducing carbon footprints, and proactive initiatives by city officials to foster a low-carbon economy. Nonetheless, in the Kajang Municipal Council

(MPKj) area, public awareness and engagement in low-carbon initiatives remain limited due to a lack of education and accessible facilities that encourage low-carbon practices.

Malaysia adopted the LCC policy in 2009 during the 15th Conference of the Parties (COP15) to the United Nations (UN) Convention on Biological Diversity (CBD) in Copenhagen, Denmark. The country pledged to reduce Carbon Dioxide (CO₂) emissions by 40% by 2020, based on 2005 levels. In 2008, Malaysia's CO₂ emissions were estimated at ~2,000,000 tonnes, with projections indicating a fivefold increase by 2020 (Rahman, 2020). Currently, Malaysian cities such as Subang Jaya, Kinrara, Puchong, Seri Kembangan, and Putra Permai are undergoing assessments to evaluate their progress in implementing the Low-Carbon City Framework (LCCF) (Juhari *et al.*, 2019; Juhari *et al.*, 2023). Furthermore, the adoption of LCCF in urban areas offers potential economic benefits through green technology, including advancements in the hydrogen economy.

Several urban areas in Selangor, including Ampang Jaya and Kajang, have undergone research and implementation regarding the LCC initiative. This study focuses on cities governed by MPKj, Selangor, where the Smart Selangor Action Plan and LCCF aim to reduce carbon emissions by integrating three key principles: Low-carbon townships, low-carbon societies, and smart municipalities. Notably, the Kajang area comprises seven sub-districts, with a population of 1,047,356 according to the 2020 housing census, making it the second-highest populated city in Malaysia (DOSM, 2022). Considering the extremely high population density in Kajang, this also suggests that it is one of the top cities that generates the most carbon emissions in Malaysia. These principles address urban environment, infrastructure, transport, and building design within the LCCF framework. A 2017 pilot study in Kajang reported that approximately 80% of the city's CO₂ emissions originated from building and infrastructure development (Ramli *et al.*, 2022), emphasising the need for effective intervention.

The success of Malaysia's LCC initiatives depends on governmental policies and the active participation of society. Despite the global rise in sustainable living awareness, engagement in low-carbon activities remains insufficient in MPKj, Selangor. As such, many residents lack knowledge about the LCC initiatives or access to educational resources that would enable them to adopt a low-carbon lifestyle. Thus, increasing community involvement is essential, and a more effective strategy could involve widespread public outreach through social media, educational programmes, community-driven initiatives, and direct engagement with city officials.

A 2011 LCCF checklist set Kajang's carbon reduction target at 45% by 2035 (Ramli *et al.*, 2022). This study differs from previous research on LCC initiatives by focusing specifically on the integration of both qualitative and quantitative data to assess community participation and perception within the MPKj area. In particular, this study offers a unique perspective on the real-life challenges and societal response to LCC implementation in an urban Malaysian context by pairing quantitative survey data with community-driven insights accumulated from semi-structured interviews. This contrasts with previous research, which has primarily focused on policy evaluation or the adoption of technology. Additionally, no clear studies are tracking the current progress in carbon reduction in Selangor. Therefore, this study seeks to fill that gap by assessing the participation of MPKj residents in LCC initiatives. The study defines "society" as individuals involved in city planning, organising public programmes, or residing in the MPKj area for at least five years.

Using semi-structured interviews, qualitative data were collected from five informants. They make up various sectors of society to explore their understanding of Sustainable Development Goals (SDGs), approaches to promoting LCC, strategies for enhancing community engagement, and their aspirations for the initiative's future. A survey questionnaire was administered to 273 residents,

collecting quantitative data on the MPKj residents' knowledge, perceptions, and participation in LCC programmes. Furthermore, this study integrates qualitative and quantitative findings by comparing emerging themes from both data sets.

Without direct engagement through face-to-face interviews, the LCC initiative would lack insight into the practical challenges faced by the community. Hence, interviews provide the essential context and firsthand perspectives that quantitative data alone cannot capture. Additionally, by incorporating community input, the study ensures that the future proposed interventions target real needs rather than hypothetical and general scenarios to achieve LCC. In line with this, qualitative insights contextualise the quantitative results, offering a more nuanced and comprehensive understanding of community perceptions and participation in the LCC initiative within the MPKj area.

Embodied carbon remains the primary source of emissions in Bandar Baru Bangi, accounting for 90.6% of the total, with emissions reaching 37,826.23 metric tonnes in 2017, excluding water, electricity, and transportation (MPKj, 2017). While the findings indicate that the MPKj area has initiated various LCC-related programmes, including the "Morning Without Cars" (2017) and the "Section 8, Community Garden Programme", these efforts have had limited impact due to insufficient community engagement and inadequate awareness. In contrast, the Selangor Green Technology Action Plan (2016-2018) introduced 33 programmes aimed at promoting sustainable practices, such as bicycle lanes and improved public transport, yet the practical implementation at the community level remains a challenge. Note that enhancing LCC implementation requires a strategic focus on elevating public awareness and improving accessibility to sustainable practices. This approach ensures that local initiatives are more effectively aligned with the specific needs and participation of the community.

Methodology

Research Framework, Sampling, and Data Analysis

The data for this research project were collected through semi-structured interviews for qualitative in-depth analysis and structured survey questions for quantitative analysis. In particular, the semi-structured interview was conducted with local authorities from the MPKj, specifically with selected representatives who are knowledgeable about the drafting of Malaysia's policies and serve as leaders of the MPKj's public affairs. Meanwhile, regarding the survey questionnaire, it was distributed to the society to obtain quantitative data to represent the sample population of the MPKj cities for this study. In addition, the society in this study is defined as any individual who has worked or resided in the MPKj area for a minimum of five years.

Qualitative Approach

The sampling method for this qualitative study will be purposive sampling. It is a non-probability sampling method in which the researcher can select a sample of subjects from a population that is well-informed or has knowledge of the research topic (Etikan *et al.*, 2016). Accordingly, the data collection is conducted through an in-depth, semi-structured interview approach.

Moreover, the selected informants for the interview must meet the informant criteria of having worked or lived in the MPKj area for more than five years and be able to provide detailed information on the development projects related to LCC for the area. The informants involved in the interview sessions are listed according to their respective backgrounds, and the semi-structured questions asked are presented in Tables 1 and 2. In addition, this study conducted interviews with a representative of the MPKj city council, a representative of a local Non-Governmental Organisation (NGO), and three informants who represent members of society. This was achieved using a stakeholder-based sampling method to obtain a clearer

understanding of the various official efforts to achieve LCC in the MPKj area.

In this study, five informants were selected based on their relevance and expertise related to the LCC initiative in the MPKj area. These informants included representatives from local authorities, environmental NGOs, and community members actively involved in sustainability practices. Although the sample size may appear limited, it was deemed sufficient for qualitative research due to the principle of data saturation (Mason, 2010; Hennink *et al.*, 2017).

Accordingly, data saturation was achieved as no new themes or perspectives emerged after analysing the interviews. This approach aligns with established qualitative research practices, where the depth and relevance of the data take precedence over sample size. It also explores the latest nuances towards achieving the LCC initiative in the MPKJ area. Additionally, this approach achieves “meaning saturation” from the theme-focused and thorough analysis of the participants’ experiences, ensuring the reliability and depth of the findings.

Table 1: Informants who were involved in the interview session

Informants	Background Experience
P1	Material Science Researcher in the Oil and Gas Industry.
P2	Corrosion and Material Science Engineer in the Oil and Gas Industry.
P3	Retired Environmental Researcher.
P4	The Secretary of Persatuan Pencinta Alam Sekitar Selangor, a Malaysian Environmental NGO.
P5	MPKj City Council Official from the Department of City Planning and Development.

Table 2: Semi-structured interview questions

No.	Questions
1	What programme is suitable to be implemented in the effort to create an LCC in the MPKj area?
2	What programme is suitable to be implemented in the effort to create an LCC in the MPKj area?
3	How can your management/agency increase community participation towards creating an LCC in the MPKj area?
4	What is your hope to achieve an LCC in the MPKj area?

As for the interview questions, they were prepared in advance by the interviewer to gather clear data on the targeted topics. The questions serve as clear yet flexible guidelines for the interview session. This allows for the addition of new questions related to the study that were not prepared beforehand, providing the interviewees with a less rigid and more comfortable interview session while ensuring the main focus of the study remains on track (Ruslin *et al.*, 2022). At any point during the interview session, the interviewee is allowed to ask the interviewer any questions for clarification regarding the prepared questions. Notably, the main questions focus on

understanding the SDG, the programmes that are or should be conducted in the MPKj area, methods to increase society’s participation, and future hopes in working to achieve the LCC initiative. Conversely, the interview sessions were conducted online as the data collected required a recorded voice transcript.

All interview sessions were voice-recorded and later transcribed to properly document and analyse the array of information discussed within each interview session for each interviewee. Correspondingly, the qualitative data from the survey will be categorised under

thematic analysis according to the different sections of the survey, in order to identify the dimensions, themes, and subthemes discussed in relation to the study. The organised information from the transcripts was then compared to current

published research studies on LCC development for each theme. The research framework for the qualitative analysis of this research project is illustrated in Figure 1.

Research Design

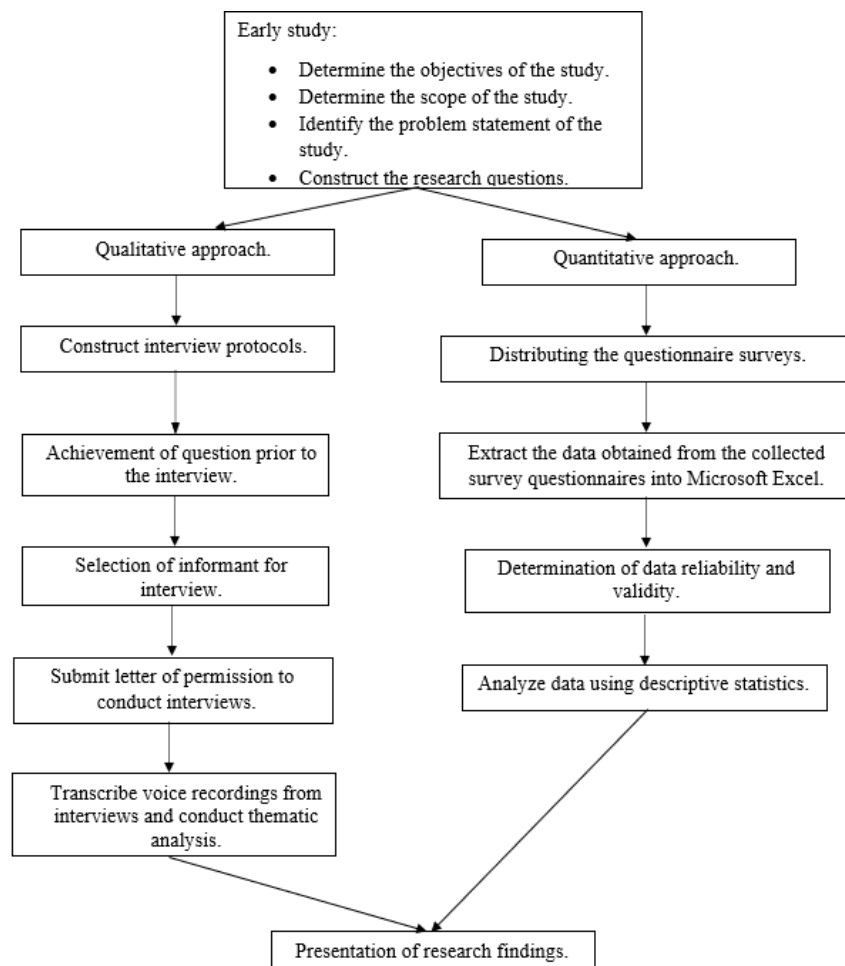


Figure 1: Qualitative (left side) and quantitative (right side) study research framework

Quantitative Approach

The sampling method used for the quantitative approach of this study is simple random sampling, as the questionnaire was randomly distributed to individuals living in any of the cities within the MPKj area. Although this study did not explicitly stratify respondents by locality, the survey was distributed widely across MPKj through online platforms and social networks to reach individuals who met the basic participation criteria. Simple random sampling, also known as

probability sampling, ensures that each population item has an equal chance of being included in the sample, and each sample has an equal chance of being selected throughout the sampling process (Mishra & Alok, 2022). Considering the exploratory nature of the study, it is reasonable to employ non-probability methods such as convenience sampling when a complete sampling frame is unavailable (Mishra & Alok, 2022). Additionally, online distribution

provides an economical means to reach a wide range of respondents in extensive urban regions, especially when there are limitations in resources or time that hinder controlled sampling methods (Evans & Mathur, 2005; Bryman, 2016). While this approach yields meaningful insights, future research may enhance geographic balance by including stratified or quota sampling. The minimum requirement to complete the survey questionnaire is to have lived in any of the MPKj cities for a minimum of five years, since most low-carbon pilot cities were studied for five years to observe any progress (Yue *et al.*, 2022). This is performed in multiples of five in reference to the commonly set goals for percentages of reduced carbon emissions for the years 2030 and 2050.

For this study, a structured survey questionnaire was employed, in which the questions were prepared beforehand, as it would be a set of predetermined questions. The survey questions were developed with reference to journals, articles, and books on LCC to create questions that target the main concepts for the thematic quantitative analysis. Accordingly, the questions were phrased in a simple yet concise manner as if the surveyor were having a conversation with the respondents. The prepared questions are also rigid, as they cannot be adjusted and follow a flow of the main concepts, making it easy for the respondents to understand and answer the survey. It consists of a single section containing 14 brief questions. As such, the survey begins with demographic questions, followed by a simple definition of the SDGs and their relationship to LCC, the challenges, and daily practices, and concludes with opinion questions.

The prepared questions underwent a pilot study with 40 students from the National University of Malaysia (UKM). This is to evaluate the face validity and clarity of the survey among participants. This step ensured that the questions were well understood and aligned with the objectives of the study. Regarding the definite number of survey responses collected from the society for the final questionnaire, it will be

based on the population size of the MPKj area. It requires a minimum of 273 respondents with an error margin of 5% and a confidence level of 90%. This is attributed to the fact that the MPKj area holds a population of over 1 million. A research study with a similar population size had a sample size of 400 respondents (Krejcie & Morgan, 1970). Hence, the total sample size set for this research study is deemed sufficient.

Since the survey questionnaire is in digital form, it will be distributed online through various platforms, including WhatsApp, Twitter, Instagram, LinkedIn, and via email to UKM Bandar Baru Bangi students until the minimum number of respondents has been collected. The use of Google Forms as the software medium to distribute and collect quantitative data will also allow for easy data transfer into Excel worksheets and the creation of simple statistical graphs. From the data extracted into an Excel sheet, appropriate data summaries were constructed to simplify the analysis and discussion of the collected primary and secondary data. Note that the use of sections to divide the text of the paper is optional and left as a decision for the author. Where the author wishes to divide the paper into sections, the formatting presented in Table 2 should be used.

Results and Discussions

Participation of City Councils

Qualitative Approach

In a qualitative approach, a thematic analysis was performed to observe the participation of the five informants in developing the MPKj area into an LCC. The participation of the informants was assessed on one dimension, specifically their individual participation, based on their individual societal backgrounds. To analyse the top-down participation, the themes were examined from the perspective of an MPKj city official representative and an environmental NGO. Conversely, to analyse the bottom-up participation, the themes were analysed from the perspective of three random members of society. Correspondingly, the themes were studied and

compared to identify the similarities and differences, highlighting the key points of information.

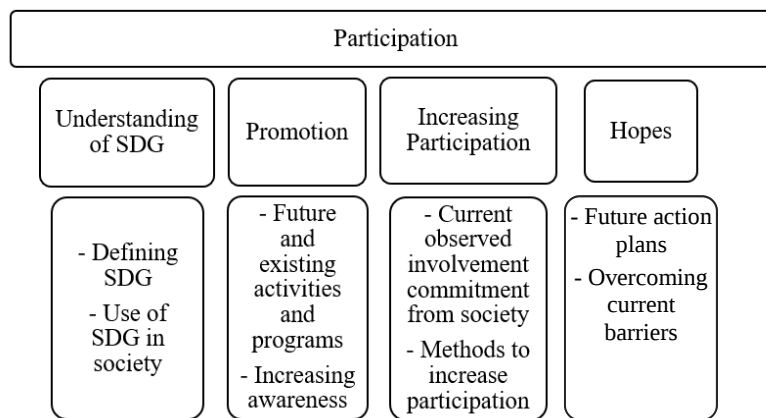


Figure 2: Summary of perceptions by the informants' dimensions, themes, and the related subthemes

Thematic Analysis

Understanding of SDG

The theme of understanding the definition and use of SDGs in achieving LCC was identified to determine the level of comprehension required for achieving a sustainable and low-carbon society. The SDGs comprise 17 distinct aspects that focus on sustainably developing the economic, social, and environmental aspects of participating countries, which were proposed during the UN Summit in 2015. These goals are supplemented by 169 targets and 232 indicators used to measure the progress towards achieving the global 2030 Agenda for Sustainable Development (He *et al.*, 2020). From the 17 SDGs, the focus mainly centres on SDGs 11 and 13, which are goals related to developing sustainable cities and communities, as well as addressing climate change, respectively. Notably, informants [P1] and [P2] had a sufficient understanding of SDGs, as both informants work in the oil and gas sector.

Meanwhile, informants [P3] and [P4] elaborated on the long-standing presence of SDGs since Malaysia's participation during the COP15 in 2009, as both informants have work experience in the environmental field. At the same time, informant [P5] provided the most

precise explanation of the SDGs, according to current research, in terms of the requirements to achieve LCC, as the informant is involved in the city planning and development of the MPKJ government.

"SDG is about sustainability. Sustainability covers all aspects, lah. It's not just about LCCF. Low-carbon is just one part under SDG 13, which focuses on climate change, and SDG 11, which is about sustainable cities, lah. So, SDG actually encompasses all 17 goals—it covers all aspects of human life. It's not just focused on LCCF alone...LCCF is an approach. It's a method to achieve SDG... this LCCF".

"If we look at SDG 11, it focuses on sustainable cities and communities, while SDG 13 is more about climate change. So, how do we reduce heat levels? By reducing carbon emissions, lah. And we do that through methods outlined in the Low-Carbon Cities Framework (LCCF). The LCCF book itself has various strategies. These strategies are implemented to achieve sustainability indicators, mainly the indicators under SDG 13 and SDG 11. Those are the key ones, lah. Even SDG 6 is involved as well, covering water usage, electricity

consumption, and things like that. So, it's interconnected in many ways..." [P5].

Promotion

Informants explained the current programmes and activities being executed by the MPKj local government, as well as suggesting new systems and alternatives that could be adopted by society to achieve LCC. There are various suitable methods to promote an initiative in an urban city area, such as MPKj. During current times, the most obvious methods include spreading awareness on social media platforms, city billboards, and even television commercials. In line with this, informant [P1] expressed a lack of effectiveness in reducing carbon emissions, while [P2] and [P3] expressed a lack of noticeable promotion regarding the action plan for achieving LCC from a societal perspective.

"At the rate of what we're going right now, we're not...doing anything in terms of emissions. Curbing our emissions, that is one of the things. Another thing that we need to look at is...what is our emission rate, relative to the whole world? Malaysia. Why are we so...why are we caught up about reducing emissions? So, one point is, let's say tomorrow, Malaysia, Singapore, or, plus Brunei, maybe, and plus Indonesia, becomes net zero. We're still not gonna stop the 2% increase, sorry, 2°C increase in the temperature. Because who are the key players in terms of...who are the major contributors of carbon emissions around the world? You have to ask for that. But why are we doing it? Because there's financial pressure from the...financial institutions...It's going to be a lot harder to make business if you don't have a carbon mitigation, sorry, carbon mitigation plan" [P1].

"...So, for example, right now, we're in MPKj, lah. In this area, MPKj. So, uh...it's just that, if you ask me, from my perspective, I don't see it yet, I don't see Kajang Municipal Council's...like, any promotions or anything. It's just, like, there's that one banner, lah...From MPKj's side, if Uncle says... solar streetlights, haven't seen them yet, right? Solar energy,

haven't seen it yet. If we talk about...EV garbage trucks, none. Electric buses, also none. But maybe in Putrajaya or KL, they already have electric buses. Ha...they have. Like Rapid KL buses, but electric ones, they have. But Kajang, not yet... So, very little, lah. For me, it's lacking. Even banners, there's just one banner. Just that one board, right? Ha...only that. Because sometimes, even the programmes in parks, if there's like...some sort of community event or something. Even if they do programmes, uh...what...gotong-royong (community clean-up), but they don't link it to SDG. Gotong-royong is just for cleanliness, for mosquitoes, lah. Right? Just mosquito gotong-royong. But there's no gotong-royong linked to SDG. None. So far...quite disappointing, lah, in MPKj. In Bangi...That's donation. Later, there's one company that collects it. Whether the clothes are reused or something, ha... but that's more for donation, lah. It's not really recycling...That's probably more NGO-driven, since it's donation, right? Not from the Kajang Municipal Council. No. So far, haven't seen anything, lah..." [P2].

"...Aunty really understands. This is Aunty's field. So, Aunty understands what the goal is, right? That we want to achieve neutrality by 2050... and reduce carbon emissions by 2030. That part, Aunty understands, lah. But... this is Aunty's opinion, Aunty doesn't think the public, [the] others, understand. Because, from Aunty's understanding, right, Aunty has asked many people. It's displayed there, right? Ha... 'Bandar Kajang Bandar Bersih... Low-carbon.' But then people ask, what is low-carbon about Kajang? They don't see it. We know Malaysia's goal, it's big, lah, we know the goal. But what are the initiatives for each city? For Kajang residents, ha... we don't see Kajang's promotion. They should say, 'We want this.' Because Aunty went to Jogja, you know Jogja, Jakarta?...They have signboards, like...signboards...and then, uh...EVs and all that, right? Oh, we need to plant more trees. We need to reduce waste. So, the people understand what actions to take. But in Kajang, they just write "Low-Carbon City". People don't understand. What is a Low-Carbon

City? What do the residents need to do? What is Kajang planning to do? It's not visible. And then, Auntie has never heard anything. Don't know if Auntie just missed it or what, but Auntie asked Auntie's friends, 'Has Kajang held any initiatives, like meetings with the public, ha...or forums? Have they invited all the residents to listen to Kajang's initiatives? What are we going to do together for Kajang? Have they asked for public opinions? What proposals do the people have for Kajang?' Ha...Auntie asked many people. They said, 'Eh, never heard of it'. When we say we want to reduce carbon...by 45% in 2030. So that means, by how many tonnes [of carbon]? The public should know: How many tonnes are we currently at? What does our carbon level mean? So, the people can help, lah" [P3].

From the informants, it is evident that there is limited information available in society regarding the connection between sustainable efforts and the LCC initiative. Although there is only a general acknowledgement of the presence of the initiative, there is a lack of information and open discussion regarding an itemised action plan for society to achieve LCC.

Therefore, integrated media can be used to educate society in understanding the idea and significance of the LCC initiative in order to stimulate action. This is vital during the early stages of developing a city into an LCC, as it provides an accurate and in-depth understanding of the costs associated with failing to curb carbon emissions and the benefits to quality of life that result from success. Hence, influential people in society can act as key coordinators in promoting awareness and generating dialogue on ideas to achieve LCC in the MPKj area. Other methods, such as programmes and activities, also offer opportunities for society to engage in an open discussion with the local government. This method is preferred by climate change diplomats as it is a much more efficient way to determine and overcome the specific barriers in achieving the initiative (Sreenonchai *et al.*, 2020).

Increasing Participation

In order to further increase society's participation in achieving LCC, informants discussed various obstacles and possible solutions to overcome these barriers. Due to this, in addition to interviewing informants from the local government and an environmental NGO, informants who represented society were selected based on their background in working in the oil and gas industry. This is attributed to the fact that the oil and gas industry plays a significant role in shifting Malaysia's development towards sustainable and low-carbon living (Wong *et al.*, 2022).

Other methods of overcoming the issue of lack of participation from society include reframing the concept of sustainable living. This is done by highlighting the personal benefits of a low-carbon lifestyle, such as promoting the concept that good health is good for business and that sustainable living can reduce living costs. While these concepts were mentioned by [P3] and [P5], they are not new concepts to people involved in the environmental field. Hence, NGOs such as Persatuan Pecinta Alam Selangor conduct programmes to educate the youth in environmental issues, which was explained by [P4].

"...As a society, we can do waste reduction, waste recycling, and waste...like food waste, ha, turning it into compost at home and all that, right? But the impact is small, lah. It's really small. But if the government initiates it, this kind of thing has to come from the top. Bottom-to-top, ah, the effect is small in any field. Top-to-bottom, then people can come together..." [P3].

"...Health environment means it's for your health, lah. A healthy environment is for your health. Good health, good business. Ha, that's important. That term, Auntie likes it, good health, good business. It's really for good health. It's not for other people, because when your emissions are lower...meaning when emissions decrease a lot, right? What contributes the most to carbon? What is the main contributor to carbon? If carbon

is high, pollution is high... meaning our health [will be affected], lah.” [P3].

“...Our camp will be a training programme for students, lah. We will gather 40 students, 20 female students, and 20 male students. But we will take them from secondary schools. So that time, we will arrange everything, lah. We will arrange everything, it’s a three day, two night programme. We will do training, lah. We will do training...we will invite trainers from Sahabat Alam Malaysia. We will also invite from the ministry, uh, what is it...the Department of Environment. Training, lah. We will train them on how to take care of the environment. Training means we will give a session on how to take care of, uh, your neighbours, lah. Then, we will have one full day where we will have one or two slots. We will give them a theme, lah, on how to take care of the environment. How to, uh...make a complaint. How to deliver this message to the department or the council members, or whoever we need to work with. Everything, lah, we will cover it in the training” [P4].

“...We just want to encourage a low-carbon lifestyle. Let’s not focus on carbon calculations first. Because our society...still...if we meet someone from the village and say, ‘Come, let’s go low-carbon’, they’ll ask, ‘What’s low-carbon? What’s sustainable?’ So, you need to use simple words like ‘save’...we practice saving. Save water, save electricity. We should use the local language. Not the international-level language with our community, no. We’re not at that point yet because we haven’t taught it in the early education system...” [P5].

While approaching the issue of societal participation using such slogans simplifies the significant effects of sustainable living, it is more effective as it addresses the daily lives of society. In recent years, Malaysia has suffered from a growing number of haze episodes to the point that individuals with medical breathing difficulties suffer from illnesses, and those without them. This is in contrast to framing the idea of LCC from an environmental perspective, which is perceived as a distant factor that is not closely

involved with the daily lives of society (Sereenonchai *et al.*, 2020). Notably, by promoting awareness of how hazardous waste, air pollution, and resources and energy wastage can affect their livelihoods and health, it increases the sense of urgency and significance in achieving an LCC.

Hopes

Informants elaborated on the future hopes for societal participation and the initiatives of the local MPKj government in achieving LCC. It was observed that different informants had varying opinions regarding whether the involvement of society or the local government should be increased. [P1], [P4], and [P5] stated that there is a lack of serious participation from society, requiring an increase in the bottom-up approach.

“...Foreign workers, like in areas where they live, throw their trash everywhere...all over the place. So, when there’s new development, or even in old developments, the council members in that area, or the local municipality, need to prioritise, educating the residents there...” [P5].

Meanwhile, [P2] and [P3] mainly sided with a top-down initiative in which the local government should increase its efforts in achieving LCC. The same can also be noted for the bottom-up approach, in which the collective participation of society can foster a consensus around a resource-efficient and low-carbon lifestyle. Thus, a low-carbon lifestyle should be adopted to meet future energy demands in urban areas using internationally developed tools to help society understand its contribution to carbon emissions on an individual and household level. This will enable a more precise plan of action to effectively reduce their carbon footprint while improving their quality of life through less carbon-intensive habits (Rahman, 2020).

“...Before, there was a time when anyone who threw trash would be fined, and things were a bit cleaner then. But after that, it disappeared. They just let the fines go. Because people, humans, if you don’t hit them in their pockets, they won’t be scared. You have to do it like

Singapore. Really implement it. Implement means, you know, enforce the initiative. There should be fines and rewards when it's enforced..." [P3].

Participation of Society

Increasing Participation

The quantitative approach observed the participation of the society in the MPKj area

towards achieving LCC. To conclude that society is participating in achieving LCC in the Klang Valley, the aspects studied through the questionnaire survey included the society's knowledge, perception, and practices. Ultimately, a total of 303 respondents were collected from the survey. The summary of these aspects is displayed in Figure 3.

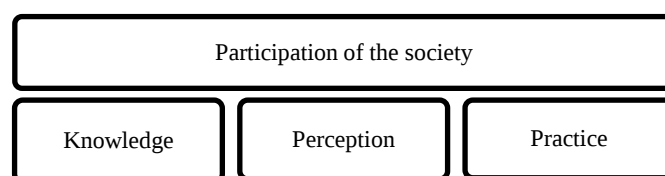


Figure 3: Summary of the aspects analysed for the participation of the society

Knowledge

A significant portion of Malaysia's population comprises members of society. To achieve LCC, a society must have a complete comprehension of the significance of a low-carbon lifestyle. This can be performed by educating society on the

accurate understanding of the LCC initiative, which will sow the correct values of a low-carbon society. Based on the survey findings, 48.20% of the respondents chose the best-fit definition of LCC, as presented in Figure 4.

Choose the best definition of Low-carbon City (LCC)

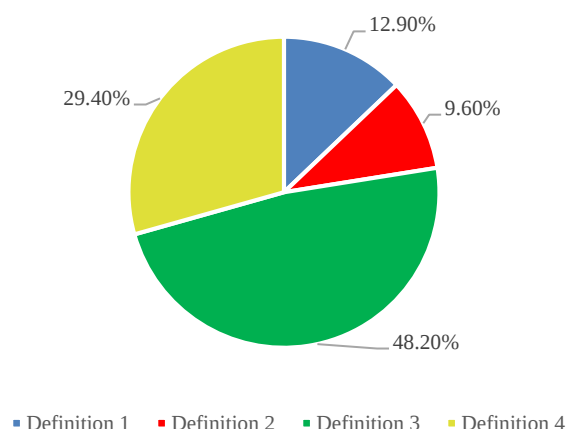


Figure 4: Percentages of respondents on the best definition of LCC

The best-fit definition from the survey is a city that implements low-carbon strategies to meet its environmental, social, and economic

needs by measuring, managing, and mitigating GHG emissions to reduce its effects on climate change. This definition of LCC involves

balancing the quality of the environment of the city, the health of the society, and maintaining sustainable economic growth. The survey findings in Figure 3 suggest that less than half of the society in the MPKj area understands the various aspects of the LCC initiative.

Furthermore, establishing a sustainable economy is a vital factor in achieving LCC. The analysis of the economic development correlates with the carbon emission levels of a city (Shen *et al.*, 2018). Notably, sustainable living practices by society can contribute to the reduction of

resource usage, which in turn can benefit the economy of a city. Another aspect that LCC addresses is improving and maintaining the good health of society, as demonstrated through various health impact studies that provide quantitative data (Nieuwenhuijsen, 2020). This is due to changes in an urban environment lasting over extended periods. Hence, more green spaces should be implemented in urban cities to mitigate the detrimental effects of carbon emissions on physical and mental health, as well as daily living for all age groups (Gouldson *et al.*, 2018).

I understand the LCC goal for MPKj to reduce 45% of city carbon emissions by the year 2035

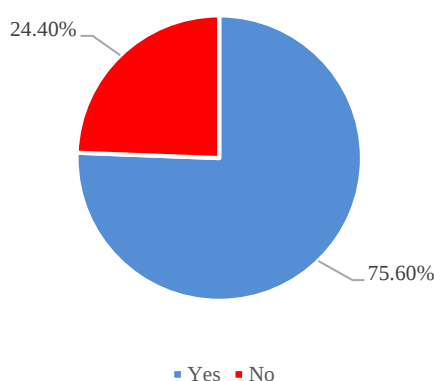


Figure 5: Percentage of respondents who understand the LCC goal for MPKj

Based on Figure 5 from the survey, 75.6% of respondents have heard of the LCC goal in the MPKj area. A majority of respondents have heard of the LCC goal, yet fewer than half could properly define the initiative. This indicates a lack of in-depth education for the public regarding the various aspects that the LCC encompasses, including environmental, societal, and economic considerations that can be developed through the implementation of sustainable urban transport, infrastructure, buildings, and environmental practices.

Perception

City areas are responsible for more than three-quarters of the GHG emissions and global energy consumption. Despite this, cities have the

necessary tools and resources to develop into LCC while mitigating the impacts of climate change on coastal or riverside areas (Mi *et al.*, 2019). Meanwhile, non-urban cities face the most negative effects from climate change, particularly in terms of infrastructure, environment, transport, and buildings. Various studies have been conducted using focus groups and citizens' juries to assess the public perception towards initiatives similar to LCC. The studies revealed that their society requested more diverse energy options, utilising low-carbon technologies to better address environmental and safety concerns (Wong *et al.*, 2022). When transitioning a society to adopt an initiative, it is imperative that it be undertaken thoughtfully by cultivating a detailed action plan

and an itemised list of targets with the acceptance of the society. This is to avoid any adverse social or economic effects on society and to divert attention from the primary goal of combating climate change. A research questionnaire that employed both informed and uninformed questionnaires in the Netherlands reported that respondents were more open to accepting and supporting the use of low-carbon technologies when they were properly informed about the issue of global warming compared to those who were uninformed through the survey (Wong *et al.*, 2022).

From the survey, questions for all the above, except Figure 9, were negatively connotative questions. Figures 6 and 7 display that 44.9% and 47.9% of the respondents highly agreed that electric or hybrid vehicles and commercial solar panels are expensive. Meanwhile, Figures 8 and 10 illustrate that 31% and 45.2% of respondents highly agreed that separating waste and bringing reusable bags when going out shopping is not difficult to do. Figure 9 presents that 71.9% of respondents highly agreed that recycling centres should be more accessible to housing areas.

Electric or hybrid vehicles are more expensive compared to motor vehicles that use fossil fuel

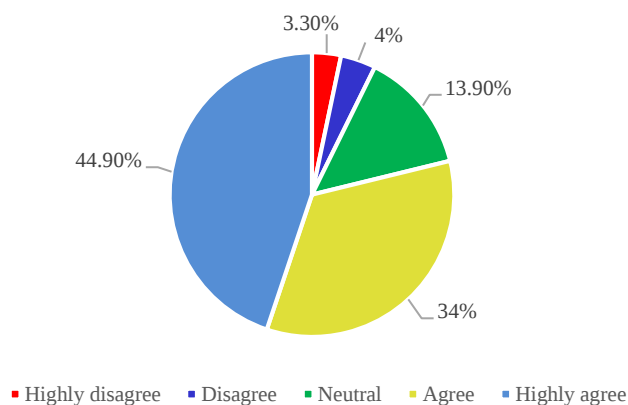


Figure 6: Survey findings on expensive electric or hybrid vehicles

Commercial solar panels in Malaysia are not sold at an affordable price

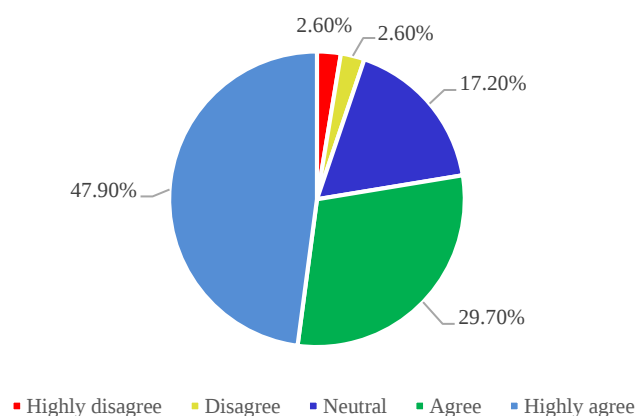


Figure 7: Survey findings on the affordability of commercial solar panels

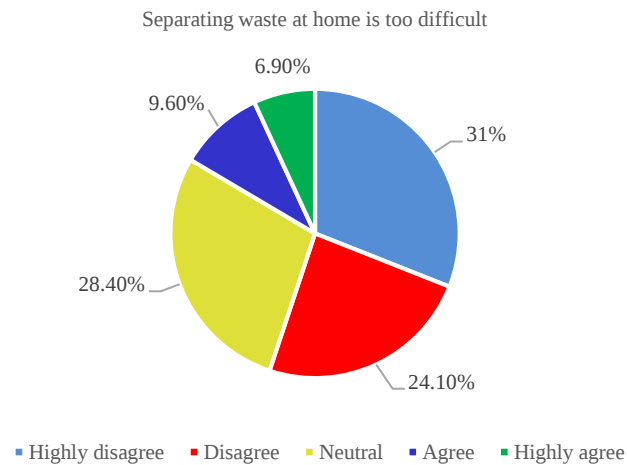


Figure 8: Survey findings on difficulty separating waste at home

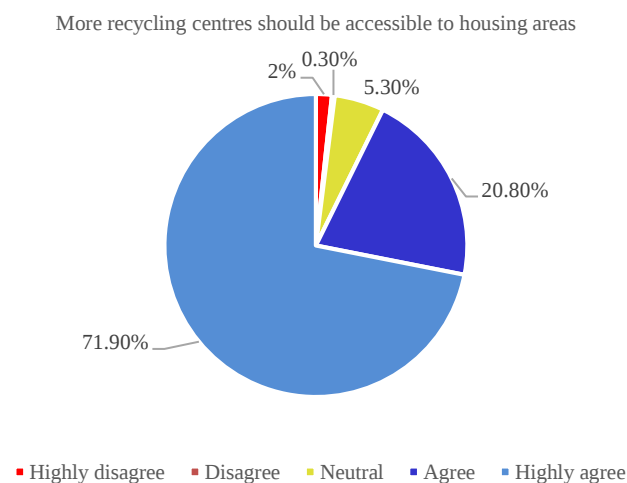


Figure 9: Survey findings on making recycling centres more accessible to housing areas

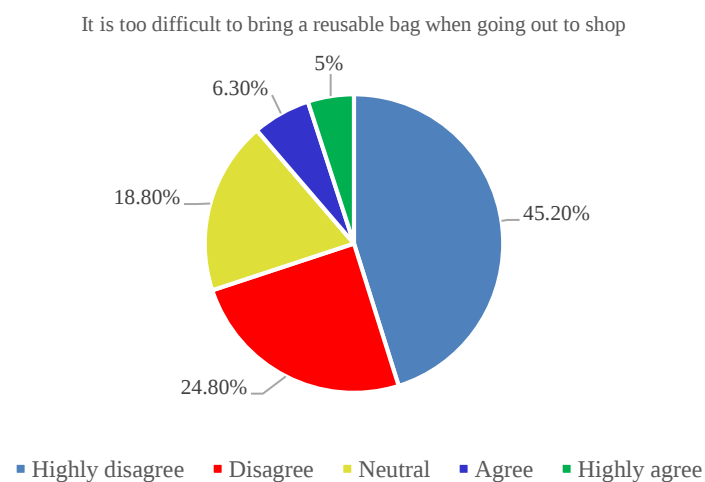


Figure 10: Survey findings on the difficulty of bringing a reusable bag when shopping

The use of electric or hybrid vehicles is still considered by society in the MPKj area as an expensive investment. This is largely attributed to the fact that consumers do not decide to buy Hybrid Electric Vehicles (HEVs) or Electric Vehicles (EVs) based on altruistic values or environmental betterment. The increase in HEV usage among Malaysians requires the political decisiveness from the government to remove non-tariff barriers and implement appropriate incentives that encourage society to be more accepting of the long-term benefits of owning HEVs instead of vehicles that use fossil fuels (Leng *et al.*, 2020).

However, it should be noted that for countries with developing economies, HEVs are more suitable compared to EVs. Notably, the hybrid aspect does not require the same drastic demands in terms of infrastructure setup as those required for a society to run on electric-powered vehicles. Furthermore, EVs have a higher total cost of ownership compared to HEVs due to the lack of electric charging stations throughout Malaysia (Hamzah *et al.*, 2022). Hence, HEVs should be considered as the smarter option compared to fossil fuel vehicles and full EVs when working to reduce society's carbon footprint.

Commercial solar panels are increasingly being utilised as a source of renewable energy. Nevertheless, the use of these solar panels in urban housing areas has yet to become commonplace in the MPKj area. This is primarily due to the cost of purchasing commercial solar panels, as well as the expenses associated with acquiring a solar energy battery and installing the energy collection system. Malaysian society has been observed to lack proper knowledge and awareness regarding solar PV systems and government incentives for adopting solar energy, especially in housing areas. Based on the conducted survey, these findings align with the results of other studies, confirming that society hesitates to fully accept the use of renewable energy as it is perceived as more costly and due to the fear of change (Florez & Ghazali, 2020).

Regarding waste separation, more than half of the respondents highly disagreed or disagreed that waste separation was challenging. Most respondents also agreed that there should be more recycling centres accessible to housing areas. This suggests that a majority of the sample population mentioned that they could adopt waste separation into their lifestyle, yet lacked the convenience of proper waste separation facilities. Referring to the previous section of the study, recycling centres are available in the MPKj area. Despite this, it appears that there is a lack of publicity regarding such facilities, as well as a lack of convenience due to the distance of the recycling centres from housing areas. A portion of GHGs is composed of methane, which originates from decomposing waste and is the second most significant GHG due to its more potent ability to warm the climate (Marmier & Schosger, 2020). The increase in the concentration of this GHG is attributed to inadequate waste management. Globally, waste production has increased from 635 million tonnes in 1965 to 1,999 million tonnes in 2015, with estimates suggesting that it will triple the amount by 2050 if current trends continue (BİLGİ, 2022).

Lastly, in terms of the perception of using reusable bags when shopping, it was noted to have a positive response, as more than half of the respondents did not find it to be a problematic practice. In 2019, Malaysia introduced a fine of RM0.20 per plastic bag to encourage the use of reusable bags and discourage the use of single-use plastic bags when shopping (Coco Chin, 2023). The methods for implementing policies vary between stores. Some stores require customers to pay for single-use plastic bags, while others offer the option of buying reusable bags. Conversely, other stores simply no longer provide single-use plastic bags. Initially, the ban on single-use plastics was ineffective. However, after identifying the causes, which included a lack of awareness, suitable alternatives, and participation, a more effective approach was proposed.

Practice

In general, a low-carbon lifestyle is introduced from the LCC initiative to shift the consumption and daily habits of society towards reducing carbon emissions while promoting economic growth (Rahman, 2020). By adopting more sustainable daily habits, such as using public transportation, separating waste, avoiding the use of single-use plastic bags, and practicing energy-saving appliance use, a society benefits from the skill of reducing resource usage. The saved resources can then be utilised over a more extended period or to enhance other societal needs. The findings on the practice of the society from the survey are displayed in Figures 11 to 18.

Based on the figures from the survey, 24.1%, 46.9%, 56.4%, 64.4%, 20.5%, 8.6%, 6.6%, and 31.3% of respondents use the public transport daily, separates waste at home, uses

single-use plastic bags, use energy saving appliances, participate in low-carbon emission activities, use solar panels, use electric or hybrid cars, and agree to never hearing about the LCC initiative, respectively. Figure 11 displays that fewer than a quarter of respondents use public transport daily, and Figure 12 illustrates that fewer than half of the respondents practice waste separation at home. Meanwhile, Figures 13 and 14 indicate that more than half of respondents use single-use plastic bags and use energy-saving appliances at home. In Figures 15 and 18, fewer than a quarter of respondents participate in low-carbon activities and have previously never heard of the LCC initiative. Moreover, the lowest participation is presented in Figures 16 and 17, as less than 10% of respondents use solar panels and/or hybrid or electric cars in their daily life.

I practice using public facilities/transport in my daily life

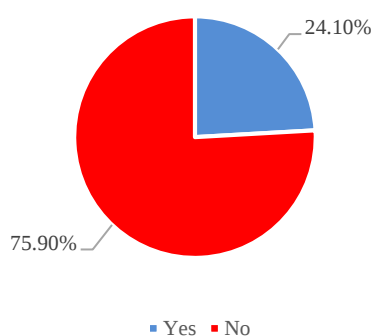


Figure 11: Survey findings on the practice of using public facilities/transport daily

I practice waste separation at home.

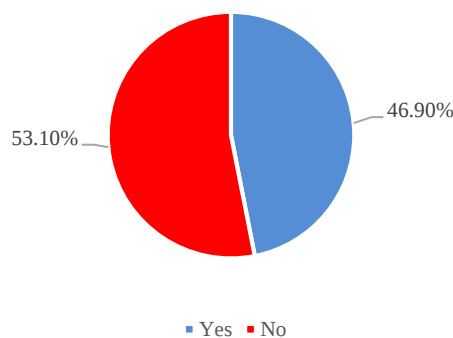


Figure 12: Survey findings on the practice of waste separation at home

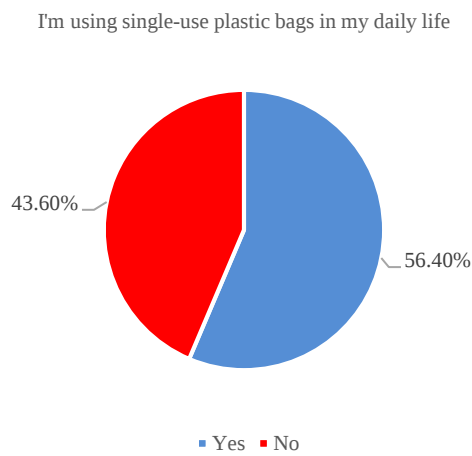


Figure 13: Survey findings on the practice of single-use plastic bags

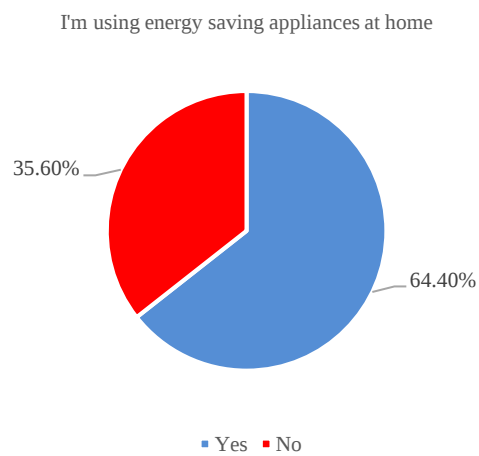


Figure 14: Survey findings on the practice of using energy-saving appliances

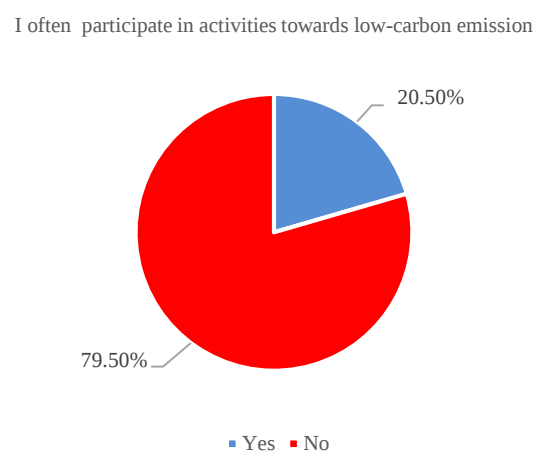


Figure 15: Survey findings on the practice of participating in activities towards low-carbon emission

I use solar panels at home as a source of electricity

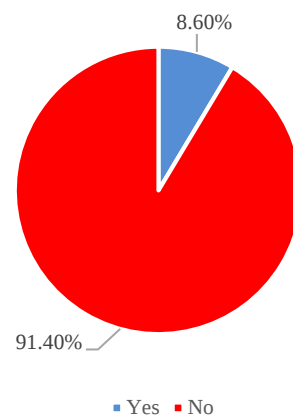


Figure 16: Survey findings on the practice of using solar panels at home

I use an electric or hybrid car in my daily life

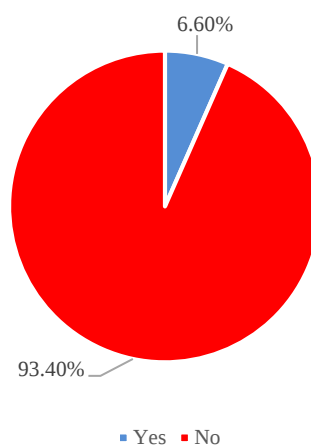


Figure 17: Survey findings on the practice of using an electric or hybrid car daily

I have never heard of the Low-carbon City (LCC) initiative

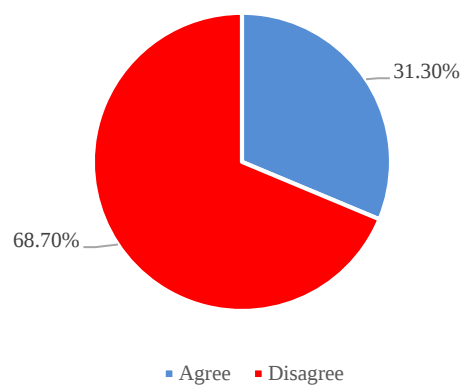


Figure 18: Survey findings on awareness of the LCC initiative

The results from Figure 12 contradict those from Figure 8 in the previous section on perception. This suggests that, despite respondents perceiving waste separation as manageable, it is not commonly practiced. However, this also correlates with the perception that more recycling centres should be provided near housing areas, as it is likely that waste separation cannot be properly practiced without proper facilities being conveniently available. The issue of implementing waste management has long been a challenge for local governments, as it requires increasing the number of street waste collectors to manage both recyclable and non-recyclable waste. This, alongside the lack of public awareness regarding the impact of improper waste management, prevents the practice of waste separation from developing into a societal habit, similar to cities in Japan. Other countries, such as Turkey, which has a developed economy identical to Malaysia, have still not replaced their buy-to-dispose consumer operation method (BILGI, 2022). This method of operation generates a high amount of waste that takes up space in landfills, which resort to burning the excess amount of waste.

Similarly, the results from Figure 13 contradict those from Figure 10 in the previous section on perception. The results from Figure 10 suggest that the majority of respondents strongly disagreed or disagreed with the perspective that bringing reusable bags when shopping is challenging. However, more than half of the respondents do not actually use reusable bags, instead opting for single-use plastic bags in their daily lives. This implies that there is still a lack of understanding regarding the impacts of practicing sustainable habits. A study conducted in Germany discovered that using visual materials to promote the pros and cons of practicing and not practicing a low-carbon lifestyle, and employing simple imagery to convey the significance of a low-carbon society to a large population (Ernst *et al.*, 2017).

There is a discrepancy between the results in Figure 15 and Figure 18, and those in Figure 4 of the knowledge section. This is mainly due to

the results from Figure 4, which only question the surface-level understanding of the LCC initiative, which aimed to reduce 45% of carbon emissions by 2035. Conversely, the results from Figures 15 and 18 suggest a lack of understanding of what needs to be done to achieve the LCC goal. These results also prove the lack of awareness regarding the action plan for society to achieve the initiative. In more recent discussions during the 2022 Conference of the Parties to the UN Framework Convention on Climate Change (COP27) that was held in Sharm El Sheikh, it was agreed among members of the UN on the significance of executing a bottom-up approach in order to effectively tackle climate change (Wu *et al.*, 2023). Hence, to increase awareness and participation among society, more effective promotional methods need to be implemented by the local government. This top-down approach, followed by a bottom-up approach, aims to educate society with accurate knowledge and a plan of action to implement systems that will curb carbon emissions in urban areas for generations.

Lastly, Figures 16 and 17 correlate with the results from Figures 6 and 7 from the perception section. A majority of respondents also use electric or hybrid cars, as well as solar panels, due to the cost. Furthermore, there is a noticeable lack of solar technology companies in Malaysia. The first-ever solar technology company in Malaysia is TS Solartech, which initially began production in 2012. Nonetheless, prior to that, the cost of implementing solar panels was significantly higher, as all solar technology components had to be imported from more developed countries such as Japan (Florez & Ghazali, 2020). Due to this, implementing solar panels at home has since been perceived as a costly investment. Alternative solutions to overcome this issue include further developing Malaysia's solar technology or implementing community solar houses.

Accordingly, advancing the development of solar technology in Malaysia will reduce the costs of implementing commercial solar panels in individual households. However, it will

require time for research and development. Despite this, community solar houses can be shared in terms of cost, as it will benefit society in the long run by providing power to community buildings.

Combining Qualitative and Quantitative Results

Based on both data sets of this study, conclusions regarding the implementation of the LCC initiative in the MPKj area were able to correlate and justify the qualitative data using the quantitative data. In both datasets, a significant lack of public awareness and understanding of the LCC initiative had emerged. In particular, informants [P2] and [P3] emphasised the lack of clear communication from local authorities and the general confusion among residents about the initiative's goals. This aligns with the survey results, where 24.4% of respondents reported being unaware of the LCC goal, and 31.3% had never heard of it. Furthermore, although 75.6% claimed to have heard of the initiative, fewer respondents were able to accurately define or describe its scope.

In line with this, the findings reveal a discrepancy between the actual lifestyle practices and support for sustainability initiatives. For instance, while 71.9% of respondents supported adding recycling centres near housing areas, only 46.9% actually practiced waste separation at home. Similarly, more than half of the respondents continued to use single-use plastic bags, while the majority indicated that it was manageable to bring reusable bags. This discrepancy mirrors the concerns raised by informants [P3] and [P5], who noted that public support often lacks follow-through without accessible facilities and contextually relevant messaging.

Additionally, the interviews and survey findings both highlight the limited options for meaningful public participation in LCC activities. Only 20.5% of respondents reported active involvement in low-carbon initiatives. Informants [P2] and [P3] stressed that bottom-up efforts are insufficient without corresponding top-down

support, emphasising the importance of government-led programmes to create structured opportunities for community engagement. Although informant [P5] mentioned the various LCC programmes implemented by the MPKJ municipal, it appears that most survey respondents are unaware of them, further emphasising the lack of proper LCC initiative promotion.

Lastly, perceptions of cost and affordability emerged as a shared barrier across both data sources. Informants expressed concerns about the financial burden associated with green technologies despite the well-known benefits. Subsequently, 44.9% and 47.9% of survey respondents agreed that EVs and solar panels were expensive, aligning with the very low adoption rates of these technologies. Correspondingly, individuals who used solar panels and electric or hybrid vehicles were both < 10% based on the survey data.

In essence, these overlapping insights highlight the quantitative results that support and contextualise the interview replies, while the qualitative data expands the interpretation of the survey results. The triangulation of both data sources provides a more comprehensive understanding of the practical barriers and behavioural dynamics that influence the implementation of the LCC initiative in the MPKj area.

Conclusions

To conclude, many LCC initiatives are currently being provided by the MPKj government, despite its official launch in 2021. There is an interesting new approach to increasing society's participation utilising the concepts of "good health, good business" and "sustainable living saves money", as this can improve society's quality of life. The government should first enhance the publicity, convenience, and effectiveness of its regulations, as they have proven effective in industrial sectors due to the SDG tax reduction benefits. Moreover, the MPKj society still lacks in-depth education on the

significance of sustainable life habits, especially among the youth and less developed city areas. Additionally, there is a staggering disagreement between society and the local government about which side should increase its level of participation. This leads to the proposal of a top-down approach, followed by a bottom-up approach, in increasing positive results towards LCC.

Nevertheless, there is still a lack of practice in regard to reducing waste and conserving resources, based on the daily habits of society as a whole. Notably, the society in the MPKj area does not find participating in a low-carbon lifestyle to be challenging. However, the challenges lie in shifting generational habits and highlighting the long-term benefits of sustainable living. In addition, the integration of both qualitative and quantitative findings, which consistently revealed common themes across both methodologies, supports the study's conclusions. This mixed-methods approach offers a more comprehensive understanding of the LCC implementation issues in MPKj and supports the validity of the analysis.

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Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts, and declare the absence of conflicting interests with the funders.

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