Key factors of low carbon development strategy for sustainable transport

K Thaveewatanaseth\textsuperscript{1} and S Limjirakan\textsuperscript{2}

\textsuperscript{1} The Environment, Development and Sustainability Program, Graduate School, Chulalongkorn University, Phayathai Road, Phatumwan, Bangkok, 10330, Thailand
\textsuperscript{2} The Environmental Research Institute, Chulalongkorn University, Phayathai Road, Phatumwan, Bangkok, 10330, Thailand

*sangchan.l@chula.ac.th

Abstract. Cities become more vulnerable to climate change impacts causing by urbanization, economic growth, increasing of energy consumption and carbon dioxide (CO\textsubscript{2}) emissions. People who live in the cities have already been affected from the impacts in terms of socio-economic and environmental aspects. Sustainable transport plays the key role in CO\textsubscript{2} mitigation and contributes positive impacts on sustainable development for the cities. Several studies in megacities both in developed and developing countries support that mass transit system is an important transportation mode in CO\textsubscript{2} mitigation and sustainable transport development. This paper aims to study key factors of low carbon development strategy for sustainable transport. The Bangkok Mass Rapid Transit System (MRT) located in Bangkok was the study area. Data collection was using semi-structured in-depth interview protocol with thirty respondents consisting of six groups i.e. governmental agencies, the MRT operators, consulting companies, international organizations, non-profit organizations, and experts. The research findings highlighted the major factors and supplemental elements composing of institution and technical capacity, institutional framework, policy setting and process, and plan of implementation that would support more effective strategic process for low carbon development strategy (LCDS) for sustainable transport. The study would highly recommend on readiness of institution and technical capacities, stakeholder mapping, high-level decision-makers participation, and a clear direction of the governmental policies that are strongly needed in achieving the sustainable transport.

1. Introduction
Cities are the first priority areas to concentrate in economic development, social activities, extensive infrastructures and governmental operations. They have a great potential for improving people’s lives, economic, infrastructure, and accessibility in healthcare and education. However, urbanization process can cause several negative impacts on quality of life, natural resource, and environment. Consequently, this causes the changing of climate. Socio-economic development in many cities in Asia has been growing very rapidly such as economic growth, urbanization, production and consumption, urban employment, and motorization. As results of these developments, this region has the fastest producing greenhouse gas (GHG) emissions in the world that would generate GHG emissions up to 40-54 percent of global CO\textsubscript{2} emissions as of business-as-usual (BAU) scenario in 2050 [1]. Such GHG emissions, leading temperatures increasing, urban climate variable, and extreme
events have already affected people who living in the cities in terms of socio-economic and environmental aspects leading unsustainable city. The Intergovernmental Panel on Climate Change (IPCC) reported that countries in Asia region had high vulnerable to the impacts of global climate change [2]. Sustainable transport has been raised up into the mainstreaming of low carbon development and sustainable city frameworks since first recognized at the United Nations Conference on Environment and Development (UNCED), in the outcome document namely the Agenda 21 [3]. Nowadays, sustainable transport is one of the major approaches for the mega cities to achieving Sustainable Development Goals (SDGs) as the 2030 Agenda for Sustainable Development [4]. Bangkok is one of the cities in Asia where become more vulnerable areas to climate change impacts and unsustainable city patterns [5]. As results from inefficient public transport system, lack of land-use planning as well as lack of mobility management, Bangkok has more environmental, social and economic problems. Mass rapid transit system is presently considered as the key transportation mode to support sustainable transport and low carbon city with regard to CO$_2$ mitigation, air quality improvement, energy saving and quality of life improvement. In Thailand, the mass rapid transit master plans have been developed as the key role in developing Bangkok toward low carbon and sustainable city, but there still lack of sustainable transport concept applied in such plans. The research aims to study key factors of low carbon development strategy for sustainable transport.

2. Literature review

2.1. City, urban development, and climate change

The United Nations Department of Economic and Social Affairs (UN DESA) reported that South-Eastern Asia countries have gradually increased in the proportions of urban population since 1950 and it is projected to increase to 65 per cent of the total region population by 2050 [6]. In addition, Institute of Southeast Asian Studies (ISEAS) noted that small cities and lack of urban management capacity lead to difficulty in improving the local economy and develop infrastructure [7]. Regarding to cities and environment, the effects of urbanization create unprecedented negative impacts upon quality of life, social stability, economic, and environment. Furthermore, global cities are critical areas in mitigate climate change [8]. The United Nations Human Settlements Programme (UN HABITAT) also noted that there is the interrelationship between climate change and urban development [9]. While economic development under BAU scenario leads to higher GHG emissions leading climate change impacts. In order to facing of climate change, urban areas must improve planning and building capacities for adaptation and mitigation. There has been become more and more cities in developed and developing countries doing climate change mitigation policy and implementation [8, 10].

2.2. Low carbon development concepts

Low carbon development is a development paradigm that contributes to addressing the challenges in economic development and environmental sustainability by keeping GHG emissions low without intervention. Low carbon development is at the intersection of development and mitigation by harmonizing the two imperatives of economic growth and environmental sustainability [11]. According to changing in a development model from treating environmental protection as an economic burden to a driver for global and national economic development, green low carbon growth concept has changed as essential for long-term economic and environmental sustainability [12]. Additionally, Tilburg et al. [11] reported that the development of low carbon development planning needs six elements including (1) readiness refers to available in data of the current situation, experts, and awareness of stakeholders, (2) building blocks refer to assessing the current situation in data and capacity; and identification of policy aims, actions, and interventions, (3) technical and political refer to technical assessments and national political process and decision-makers, (4) continuous process refers to planning, analysis and design, implementation, and evaluation, (5) purpose and (6) outcomes.
2.3. Sustainable transport
Sustainable transport has been concerned in many international agreements. Sustainable transport was firstly considered in the Agenda 21 [3]. In addition, the Future We Want, the outcome document from the United Nations General Assembly (UNGA) in 2012 or Rio+20, mentioned sustainable transport as the central to sustainable development [13]. Nowadays, sustainable transport is one of the major approaches for the mega cities to achieving Sustainable Development Goals (SDGs) on climate actions and sustainable cities [4, 14]. Several studies in megacities both in developed and developing countries support that public transportation in mass transit system plays the key role in CO2 mitigation, efficient energy use and quality of life improvement through sustainable transport [15-17]. Moreover, sustainable transport could contribute to enhancing the three pillars of sustainable development including environment, economic, and social aspects as well as climate change mitigation and adaptation to the city [18].

3. Research methodology
Bangkok is located in the central part of Thailand which has high density in the inner city areas locating by official places and commercial business areas. In terms of motorization, Bangkok had number of registered cars about 7.5 million at an increasing rate of 27 percent between 2008 and 2012 while the road capacity available was only for 1.6 million cars [19]. The transportation system study selected is the Bangkok Mass Rapid Transit System. Regarding the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region or M-Map proposed by the Office of Transport and Traffic Policy and Planning (OTP) is the current master plan to develop an urban rail transit network system serving in Bangkok [20]. It was designated eight primary routes and four feeder lines and plan to be constructed within a development period of twenty years (2010–2029).

The nature of this research was designed as exploratory and descriptive researches. A qualitative research method was used in the study. Purposive sampling method was used in order to select the key respondents who play the major roles and responsibilities in the policies and plans. Source triangulation was used to increase the conformability of the result findings. In this study, various sources of data and information were integrated in order to build a coherent for themes and to confirm the validity. The instruments of data collection consisted of two approaches: (1) desk study - literature reviews based on low carbon development strategy and sustainable transport including secondary relevant document assessments such as policies and plans in order to understand the current situations according to the existing problems, their consequent effects, and management. (2) the in-depth interview applied semi-structured interview and the interview protocol was open-ended and descriptive.

Total numbers of thirty respondents are from various organizations with different levels of operation and multi-fields of expertise consisting of six groups including 40% are governmental agencies, 17% are the MRT operators, 13% are consulting companies, another 13% are international organizations, 10% are non-profit organizations, and 7% are experts.

4. Results and discussions
4.1. Factors and elements of low carbon development strategy (LCDS)
The research findings indicate factors and elements for the LCDS as follows:
- Readiness - The study found that there are inadequate in data availability and sharing as well as data organized for support sustainable transport and low carbon development plan while data gaps and overlapping are also mentioned. Additionally, readiness in experts, human resources, and technology in such development plan are inadequate. For process and policy, shifting political priorities has influence on policy processes and unpredictably changing in politics could result in different policy priority setting and discontinuity in transport policy implementation. In addition, the study further found that lack of stakeholders’ awareness, engagement, and ownership to the development plan is still exists leading to less their buy-in
for the strategy and its implementation. Furthermore, high-level decision-makers participation is required in an important role.

- Building blocks – For capacity assessment, the capacity to analyze the data is needed due to insufficiency of stakeholders’ knowledge, skills, and technology. Such capacity is still limited caused by budgeting supports and the government support policies. In terms of stakeholder mapping, unclear roles and responsibilities of stakeholders are still exist in the cross-sectoral strategies implementation. This could result in lacking of their awareness, engagement, and ownership to the development plan leading to less stakeholders’ coordination and communication. The study further found that there is inter-ministerial committee which set up with key sector ministries, departments and agencies for the sustainable transport; however, high-level decision-makers and inter-ministerial participation are inadequate. In long-term vision, targets and actions of the policy, Thailand policies have long-term vision in transportation development; nevertheless, concrete targets and actions are lacked to achieving the long-term goals. Additionally, financial sources and private sector investment supports are needed in developing the sustainable transport. Moreover, the research findings indicate that government supporting policies and effective relevant regulations enforcement are the supplemental elements for institutional and technical capacity of sustainable transport development.

- Technical and political process - The LCDS should ensure to align with technical and policy process for confirming that the strategy could be implemented properly. In terms of technical assessments, the findings indicated lack of data availability, reliability, and analysis due to less data sharing, data disorganized, data gaps and overlapping. In addition, the numbers of experts, human resources and technology are inadequate for technical capacity. For national political process and decision-makers, the study found that shifting political priorities has influence on policy processes.

- Continuous process - The research findings from secondary data assessments show that the plans and strategies have policy development process include planning, analysis and design, implementation, and evaluation. However, the study found that continuous and effective implementation plans of stakeholder groups are inefficient.

- Purpose – Although, the LCDS has different purposes depending on the stakeholders and apply the strategy to their different purposes. However, the study found that there are different transport policies and plans in Thailand context which proposed by different stakeholders but such policies and plans have common purposes in reducing traffic congestion and improving transportation mobility.

- Outcomes - Based on the secondary data assessments, the study found that Thailand policies and plans have been adjusted regarding changes of condition and circumstance. For example, Thailand’s Transport Development Strategy: 20 years plan proposed by the OTP has developed the strategic plans in order to achieving the 20-year National Strategic Plan goals by recognizing the importance of the current transport infrastructure development. This strategic plan has three operational periods: critical issue, medium, and long-term periods to ensure the optimization of implementations and outcomes [21].

The study findings are consistent with Tilburg et al. [11]. Additionally, the study further found more important factors with relevant elements that would make more effective low carbon development planning.

4.2. The LCDS factors to achieve sustainable transport
Table 1, six factors of the LCDS elements include an inter-ministerial participation and stakeholders coordination and communication as (F1), integration and consistency of policies and plans as (F2), budget and financial support as (F3), clarification of role, responsibility and awareness of stakeholders as (F4), readiness of knowledge, skills, and technology of stakeholders as (F5) and readiness of data availability, reliability, and analytical data as (F6).
Table 1. The LCDS factors to achieve sustainable transport.

| LCDS factors | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|--------------|-----------------------|---------------|----------------------|-----------------------------|---------|------------------------|---------|
| F1           | 88%                   | 76%           | 80%                  | 80%                         | 100%    | 93%                    | 86%     |
| F2           | 90%                   | 76%           | 80%                  | 80%                         | 90%     | 80%                    | 83%     |
| F3           | 92%                   | 88%           | 95%                  | 65%                         | 70%     | 67%                    | 79%     |
| F4           | 83%                   | 32%           | 70%                  | 70%                         | 100%    | 93%                    | 75%     |
| F5           | 75%                   | 56%           | 65%                  | 70%                         | 90%     | 80%                    | 73%     |
| F6           | 77%                   | 32%           | 70%                  | 70%                         | 80%     | 87%                    | 69%     |

To achieve sustainable transport, all respondent groups strongly agreed in two major factors including inter-ministerial participation and stakeholders’ coordination and communication (86%) and integration and consistency of policies and plans (83%). However, it is obviously noticed that the MRT operators did not emphasized on the factors including readiness of knowledge, skills, and technology of stakeholders (56%); clarification of role, responsibility and awareness of stakeholders (32%); and readiness of data availability, reliability, and analytical data (32%).

5. Conclusion and recommendations

According to the research findings to achieve sustainable transport, key LCDS factors compose of institution and technical capacity, institutional framework, policy setting and process, and plan of implementation as shown in figure 1.

In terms of institution and technical capacity, readiness of data availability, quality, and reliability is required to provide input data of the current situation and related information to the policy maker and decision as well as relevant stakeholders to analyzing and assessing for setting their policies and actions. Readiness of experts, human resources, and technology is also needed to increasing capacity in generating knowledge, skills, and technology for develop and implement filling information gaps of the countries in developing the low carbon strategic plan. In addition, sources of finance are essential for high investment in transport infrastructure and budget allocation to key ministries sectors, departments, and agencies. Finally, awareness and engagement of stakeholders are important elements to make their involvement and buy-in to the process. Therefore, institution and technical capacity is a prerequisite in the LCDS process.

Institutional framework is the second factor of the LCDS process which calls for high-level attention and participation to develop a stronger awareness and buy-in among decision-makers and a participatory process of high-level political support from the start could provide strong high-level leadership within the government. The framework needs inter-ministerial committee setting up effectively coordinates with key sector ministries, departments and agencies. Shifting political priorities has influence on policy processes resulting in different policy priority setting and discontinuity in transport policy implementation. Therefore, consistency of political and policy are important for institutional framework. Additionally, regulations and government intervention could support governmental agencies in good management and control on the traffic and transportation as well as the city planning. Not only sources of finance is mentioned as a requirement to ensure the institutional and technical capacity, but also budget allocation and financial support are required in institutional framework for the LCDS. In terms of stakeholder mapping, clear roles and responsibilities of them are necessary in setting the institutional framework for the cross-sectoral development strategic plans. Such unclear roles and responsibilities could result in lacking of their awareness, engagement, and ownership to the development plans.

For policy setting and process, based on institutional framework part, this could lead to support policy setting and process for the LCDS. With high-level and inter-ministerial participation, these could lead long-term concrete plan and strategy as well as policy integration and inclusive plan.
Consistency of political and policy leads to policy and strategic orientation. Additionally, stakeholder mapping and clear roles and responsibilities are major elements to create stakeholders involvement and buy-in in the policy setting and process.

In plan of implementation, effective regulations enforcement and administration supports are needed to promote efficiency and concrete action and implementation. Iterative process and continuity in implementing plan would provide more effective in such strategic process. In addition, stakeholder collaboration and communication are demanded for supporting in the cross-sectoral strategic implementation.

**Figure 1.** Key factors of low carbon development strategy for sustainable transport.

Based on the findings on key factors to support effective strategic process for the LCDS on sustainable transport, the further recommendations are as follows: (1) the governmental agencies and relevant stakeholders such as the MRT operators should have readiness of institution and technical capacities as a prerequisite component of achieving the LCDS process, (2) the governmental agencies should have stakeholder mapping and clarification of their roles and responsibilities to enable the strategy to be successfully implemented plan, (3) high-level decision-makers would have participation and consistency of political and policy process to ensure concrete long-term vision and supportive intervention, and (4) those decision-makers would have a clear direction of the governmental policies that would be strongly support in achieving the LCDS on sustainable transport.

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