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Original Paper

Greening the Urban Transport System towards Achieving Sustainability

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Abstract

The transport system comes along with a broad range of sustainability issues, including environmental, social and economic stability of the transportation. As we are going through a new development paradigm with the Sustainable Development Goals (SDGs), therefore, our urban transport system should now be "green", that requires an alignment with the core purposes of several stakeholder groups. The study explores the stand point of the situation in the context of rapid urbanization and addresses the components of our urban transport systems. The study follows a qualitative approach to find out the possible answer considering the daily transport experiences of city dwellers. Urban transport system is considered as the study experimental unit and a sample of four Focused Group Discussions (FGDs) conducted within four groups of urban citizens-adult male, female, older and younger. Finally, the study experiences illustrate with many technical and non-technical strategic solutions, which might be implemented in the context of poor road infrastructure, technology, people's desires, capital intensive nature and the overall the good governing system. With different approaches towards greening the transport system, research concludes that the non-technical review is more important and quicker solution than the technical solutions for Dhaka city.

Keywords

green transport, sustainability, sustainable development, FSSD, Bangladesh, urban transport, developing countries

1. Introduction

Transportation is an integral part in our daily lives irrespective of the age, gender and classes (White, 2016). The importance of greening the transport system is a very crucial in the present developmental

aspects. Moreover, the woes of the conventional transportation system are a very vibrant issue for the developing countries, especially for a rapidly growing city like Dhaka. Rapid urbanization is closely related to the demand of dynamic transportation that ultimately seeks for the rapid enhancement of modern transport facilitation (Zhang & Fei, 2011). The system comes along with a broad range of sustainability issues, including environmental sustainability (global warming, degradation, fossil fuel burning and emissions); social sustainability (human satisfaction, road safety and health-physical, mental, emotional, spiritual); and economic stability (cost and benefit over environmental and social violations). In fact, the transport sector is responsible for 14% of the global greenhouse gas emission with over 95% of all road transportation depending on fossil fuel (The US EPA). Therefore, road transportation holds up a lion share in contributing to the total greenhouse gas emissions. The projection of this trend is to be increased in the future if we aren't enough conscious about our policies and strategies on the green initiatives towards sustainable transportation.

There are different modes of transport facilities in a modern city. Public transport system is mainly operated to serve city dwellers. Apart of this service, some other modes of services are available in many cities like private transport, ride sharing, official transport, etc. However, public transport system includes different types of vehicles, which are accessible to the public irrespective of age, gender and race. In the system, ownership of vehicles differs from different types and mode of vehicle services. Sometimes, private car, taxis, school bus or like any other small vehicles may exist in the system beyond a large portion of vehicles like buses, trains, boats, etc. (White, 2016). In a sustainable manner, the "green transport" is characterized by the low carbon vehicles as means of most popular concept worldwide (Yu et al., 2011). In this regard, non-motorized vehicles are designated as the most prioritized concern in the safety issue of sustainable transport (Makarova et al., 2017).

An effective public transport is measured with its various operations of a whole system, which includes most likely ticket, price, purchase and easy access on riding any chosen vehicles whatever the distance of respective route. In reality, the function of these non-technical components is not systematic in developing countries in most cases if compared to the developed countries (Zhenqi & Weichi, 2017). As a non-technical issue of the green transportation, cycling and walking are mainly considered, but some other factors are also investigated in the system in developing countries like China (Ye, 2014). The systematic process includes three intelligent services in establishing sustainable transportation targeted with (1) energy saving and emissions reducing vehicles, (2) context specific demand in greening transportation, and (3) consequence estimation of green transportation adaption. The ambition of these measures may applicable in the same direction to other developing countries. Therefore, the minimization of pollution level is a prime agenda, which has been considered as a technical solution of the vehicles. It is suggested that the hybrid vehicles could be solution on the roads globally (Panday & Bansal, 2014). Already different governments have taken initiatives in lucent manner of these challenges.

Physical infrastructure is a matter of transformation toward green development, where infrastructural

change should be adjusted with the country's economic growth alongside the ecological restoration (Feng, 2013). The recent rapid transportation has a huge concern due to its influential impact on economic value of environmental resources. Road construction may protect our economic losses by improving our environment as well as urban trafficking. The three aspects of legal, planning and management issues can solve the environmental protection during making green transportation (Xu & Zhao, 2014).

However, there are many indicators that we had found to support environment friendly transportation, but decision making support is still missing in literatures towards achieving sustainable transport system. Environment friendly transport does not mean always sustainable transport. But environment friendly system may ensure the greening process of our transport system that ultimately develop a flexible platform towards ensuring sustainability. Here all types of stakeholders are very important to be engaged in the process of sustainability integration in urban transport system. Because the system require different level of satisfaction of all people characterized by wide unique socioeconomic demand. So, the system deserves localized perception of the convenient transport system in making constructive planning (Jones et al., 2015). Regarding transformation process, almost all people of Dhaka city are highly dissatisfied about the existing urban transport system (Munira & San, 2017). There is no minimum standard in regard to measure the sustainability performance of the city's transport system. In general, the tope most priority issues are identified up to date in the area of road safety, travel time and women accessibility to public transportation in Dhaka city.

Objective of the study: Stakeholder pressure over high densely cities like Dhaka is a considerable factor where the specific needs configure the existing logistic resources to be used in designing sustainable transportation (Palsson & Kovacs, 2014; Zhao, 2012). Therefore, the study targets variations of stakeholder demand and their perception in taking actions to develop strategy in the sustainable ways. To execute the greening scope of the transport, the broad objective is to understand the current gap of the present urban transport systems under a set of stakeholder perceptions in line with the recognized sustainability framework.

Research Questions: Based on the study objective, the research questions might be as follows-

1) How can the sustainability framework be integrated in the urban transport system for a better decision making support?

2) Which local level measurements of technical and non-technical strategies are perceived by the stakeholders?

Conceptual model: Over the research questions, the conceptual model of the study can be drawn as follows.

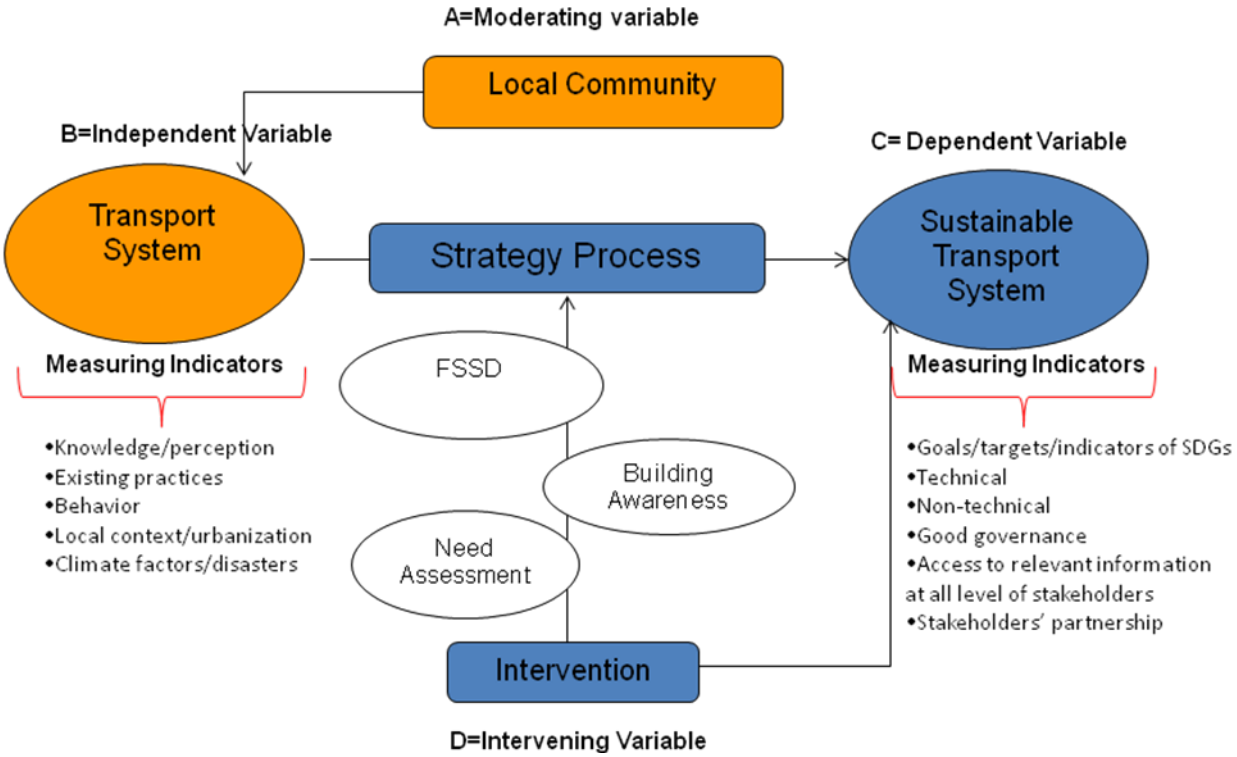

Figure 1. Conceptual Model of the Study

2. Methods

The study follows a qualitative approach to find out the possible answer considering the daily transport experiences of city dwellers. Urban transport system of Dhaka city is considered as the study experimental unit and a sample of four Focused Group Discussions (FGDs) conducted with four groups of urban citizens-adult male, female, older and younger. Representatives of these groups of stakeholders are total of forty members were selected for the FGDs. Secondary sources of data such as official websites and different relevant articles were also used to validate the research objective.

Considering the research context, the data analysis was conducted through a robust and analytical sustainability framework—the Framework for Strategic Sustainable Development (FSSD). The FSSD was designed for strategic sustainability planning in a complex situation through its five sequential elements—"system, success, strategy, actions and monitoring tools" (Broman & Robert, 2017). The existing transport difficulties and the planned success of the urban transport system had been considered as a case analysis under the framework. The qualitative data were gathered within the stakeholders' operational movement and analyzed for planning towards a sustainable transport system in Bangladesh.

An analysis of the current reality of the transport sector was planned through the FSSD approach where the "backcasting from sustainability principles" is incorporated in defining the success (Robert, 2000; Saha & Seal, 2011). The designated of these four sustainability principles for the FSSD were as

follows:

In a sustainable society nature is not subject to systematically increasing

1) *Concentrations of substances extracted from the Earth's crust,*
2) *concentrations of substances produced by society,*
3) *degradation by physical means and, in that society,*
4) *people are not subject to conditions that systematically undermine their capacity to meet their needs.*

These non-overlapping principles were created for a common understanding of social and ecological systems and their interdependence. The principles provided a concrete process of decision making with a shared vision model in the system (transport system) when working for a sustainable society (Ny et al., 2006; Robert et al., 2001; Saha & Seal, 2011).

3. Result

The perception over the study findings are analyzed through five components of the FSSD in order to draw the concrete strategic directions, which ultimately explores these two dimensions of transport development-technical and non-technical in the greening process.

System: The system level described all about the functional components of a transport system. It was important to understand the relevant transport components and it's inter-relationship in the present context. The relevant matters of the transport system within the biosphere found out our knowledge and experiences on resource, availability and flows of stocks, existing practices, biogeochemical cycles, resource integration capacity, biodiversity, climate regulation capacity, resilience, trust between each of us, social institutions, and governance. The overall functions of these elements and their impacts could be recognized in the social and ecological system. The stakeholder approaches had been networked in this specific context and it described how it was nested in the relevant sustainability impacts of the transport system. In this level, the impacts of existing practices connected with regional or global value chains of the system. The stakeholder perceptions of greening the transport system was forwarded to the subsequent analytical parts of the FSSD.

Success: This was a visionary approach for defining a "success" of the green transportation under the FSSD. The vision of the green transportation was framed by the basic sustainability principles designated in this stage. The core purpose of the study was valued in the process of greening transportation for the future, which could be aspired by any organization working towards sustainability. Basically, the vision of future transportation was a way forwarded dentition of the "system" analysis of the framework. Unless a systematic function was analyzed properly, the desired transportation could not be defined in the success level. There were some major areas of the transportation system that had been identified to make strategies for sustainable development under the four sustainability principles to define success of the transportation. The trajectory pathways of this specific development sector were given in the following Table 1.

Table 1. Systematic Violations of the Sustainability Principles in Transport System

Sustainability Principles (SPs)	Violations of SPs by present transport system	Planning Area to Minimize Violations
SP 1: ...concentrations of substances extracted from the Earth's crust.	• More dependency on fossil fuel oriented transportation. • Use of non-renewable energy sources to charge battery for lightening, air-cooling, etc.	• Energy consumption pattern and sources.
SP2: ...concentrations of substances produced by society.	• Supply chain of vehicle raw materials, public services and maintenance were not controlled and/or monitored properly. • Increase of dumping vehicle wastage, packaging materials, sewerage, etc.	• Raw materials production. • Dematerialization and substitution of the raw materials. • Vehicle fitness. • Vehicle loading. • Dumping site development.
SP3: ...degradation by physical means.	• Extensive use of road by heavy loaded vehicle. • Road infrastructure is collapsed by illegal markets, shops and other establishments. • Water pollution by washing of vehicles. • Road lane and dividers are not properly used.	• Conservation of land, water body and other natural resources. • Restriction of loading vehicles, road use, vehicle maintenance, road infrastructure.
SP4: ...people are not subject to conditions that systematically undermine their abilities to meet their needs.	• Dissatisfaction between transport services and passengers' choices. • Cultural clashes. • Destroying ethical practices in services. • Various crime and drug addiction. • Traffic congestion and loss of working hours.	• Ethical practices. • Respect to others. • Controls of sharing. • Security, control and check.

Strategy: The "strategy" level of the FSSD generated some guidelines for how to move forward with the principle-framed transport system strategically. With the FSSD, the market needs or desires of transport were identified and made a connection between strategic objectives and its implementation at the stakeholders' stage as shown in the Table 2.

Table 2. Strategic Objectives of Sustainable Transport and Its Conduction to Implementation Stages

Strategic Objectives	Implementation Stages
• Establishing a platform for continuous dialogue process among all relevant transport stakeholders. • Making opportunity to receive the support from other players of sustainable development. • Receiving support from the key stakeholders for the specific projects and activities, e.g., technical and non-technical solutions for road infrastructure, pollution control, traffic management, etc. • Increasing awareness of sustainability among all stakeholders including law enforcement and monitoring partners.	• Cooperation and coordination of the stakeholders. • Identification of stakeholders' demand in a mutual and agreed way and integrate it at the final stage of policy reformation of the government. • Agreed action plan between traffic management and other relevant stakeholders. • Prioritizing the strategy based transport development for short, medium and long term perspectives. • Cross checking of strategic ideas with others, who were working for sustainability management into their products.

Actions: The required actions for transforming the transport system had been prioritized in this "Actions" level of the FSSD. Considering the specific needs, any relevant organization would have a strategic plan by using the strategic pathways generated from the previous level and systematically guided by the vision to encourage, inform, and analyze the possible actions. The stakeholder perceptions had been analyzed in the sustainability context of existing transportation system and included strategic actions under sustainability education of stakeholders, incorporating certain substances, renewable energy sources, procurement practices, value chain, and governance importantly. The strategic plan could be re-assessed repeatedly in the specific context, demand and the required investment.

Stakeholders' misconceptions about the integration of sustainability in the transport system were identified, which was as the ultimate destination of green transportation. It was identified over the stakeholder discussion, where the community based solutions could solve the created transport problem.

The best practices in the strategic actions are to comply with the success (four sustainability principles);

develop more sub-principles in line with the main principles into the corporate policy, and manage the monitoring impacts of all actions in the transport system.

Tools: The tools of the FSSD were usually used in any desired system considering the nature of the problem. Among many other tools, the study found the lack of using a transport specific tool for the stakeholders except some of the users to EMS in Bangladesh. On the other hand, the operators should use, which one—a vital question to them depending on the purpose and circumstances of the tool. In the competitive market, this problem certainly hindered the process to achieve sustainability in the sector. But the specific nature of the transport destination could explore many answers to this question.

First, it is needed to assess all existing tools considering the transport destination and then choice for the best. The main purpose of the tools is to minimize the violations of sustainability principles through continuous monitoring and manage of the transport impacts.

4. Discussions

The guiding framework "FSSD" shows that the assessment of sustainable transportation depends on many indicators and strategies, which might be sorted in the context of core urban studies. Indicators are developed in specific urbanization nature and culture of Bangladeshi citizens. In different studies, many authors used different indicators to assess the sustainable transportation, while a recent study analyzed all of these relevant studies and decided about a total 535 variables for the sustainable transportation (Buzasi & Csete, 2015). Even some of these indicators were overlapped, but most of these are unique approach to evaluate the transportation system sustainably. However, the concrete indicators of sustainable transportation are still an emerging issue due to the insufficient information regarding availability of specific indicators for the developing countries.

Therefore, a justification of urban transportation is become an important issue to transform of the current transport systems like favoring motorized, non-motorized transport, or other factors on road. The prioritized vehicle considers significant social and environmental burdens, which violates the forms of sustainable transportation rather than other mode of traffic participants on the road. Literature conceptualizes "urban transport justice" through appearing three dimensions such as exposure to pollutants and traffic risks; allocation of space; and assessment of transport time (Gossling, 2016). Among all of these, we find road infrastructure, which is a vital issue in the context of Bangladesh to make the transportation system sustainably. Urban traffic congestion is a common problem in high densely cities like Dhaka, or Chittagong, where the poor road infrastructure leads traffic congestions and make air pollution to destroy city's fresh breathing space as well. This problem might be overcome by following some steps as suggested in literature like short term, mid-term and long term changes of creating more breathing space, infrastructure and resource use efficiency respectively (Colvile et al., 2004). Here the following concrete pathways are obviously considered as potential indicators for sustainable transport system in the existing urban structure of Bangladesh, or many other developing countries.

Non-technical review: Behavioral or attitudinal changes must be characterized by increasing walking space, cycling and the preferred transit mood. Behavioral change is a non-technical intervention that could decrease emissions by changing people's motivation towards sustainable transport system (Linton et al., 2014; Taylor & Philp, 2013). It is recognized that this is as the excess capacity to reduce transport pollution. For environment friendly cities, these are the vital issues that contribute to the composites of a green transport system. The methodological approaches to work for a green travel style is to incorporate the mood of walking, cycling and transit which make up four strategies mainly: changing the pattern of land use in promoting the space for walking and cycling, giving priority to the public transport, restricting car buying and using, and implementing rules and regulations through good governance. It is true that we have seen already some good policies and strategies on these reviews, but more investigation can be highlighted to assess our limitations and solve the problem by setting up priorities. Some policy making themes can be drawn to the restriction of private cars to carry out students/teachers to their academic institutions, facilitating group transport facilities for schools/institutions, family restrictions to own more than one car, parking management in order to reduce car use frequently, facilitating public transport and availability to all classes of citizens, scheduling public transport considering school or institutional opening and ending time, promoting dynamic road infrastructure including all modern facilities, etc. An example in the following the issue is, Vienna, Austria reduced car share of trips between 1993 and 2014, from 40% to 27% (Buehler et al., 2017), where we are foolishly increasing our dependency on the cars. Another glowing example is Vancouver in Canada, when the city decreased vehicle kilometer driven per person from 2007 level of 27% as they are increased their awareness and practices in walking, cycling and public transit (City of Vancouver, 2017). The key to the success of has been a harmonized package of common understanding in reinforcing land-use policies and public transport issues that have made the car use slower, less convenient and more costly.

Land pattern is also a non-technical part to measure the green transportation. Even, land use planning is mostly administered by the central government, but the local government agencies may provide proper orientation to the relevant designers and owners of vehicles to develop green transportation infrastructure (Kong et al., 2010; Li & Lo, 2013). The road infrastructure is also a part of innovative land utilization process, where environment friendly route plan is suggested to travelers for changing their travel mood to drive (Bothos et al., 2012). Some models are developed by using social network among electric vehicles, accumulating information, monitoring and evaluation, assisting driving and traffic management. According to the literature, the enabled social network supports both individual and company transportation system towards green (Shu et al., 2013).

However, the Transport Demand Management (TDM) is an overall review of non-technical solution that might be considered in planning sustainable urban transport system. The concept helps urban planner to design urban transport based on three indicators—smarter choices, mobility and travel management (Black & Schreffler, 2010). Ensuring green logistics can be a process of the TDM, where

a joint action between logistics, enterprises, government and customers that could stimulate the sustainable process in a system (Guirong et al., 2012). Toll design is another concern in the green logistics of public transport system, where it is suggested to consider in the pricing of travel cost and traffic congestion (Wang & Liu, 2012).

Technical review: For the recent years, environmental friendly public transit relies on a green transportation system, e.g., green buses, bikes, taxies, trains, etc. However, new green technologies are being successful in operations in the developed countries, rather than the developing countries. Green transportation reduces people's dependency on conventional fuel use in their vehicles and ultimately decreases in pollution level in terms of greenhouse gas emissions, but it deserves most modern technologies for manufacturing several types of vehicles. After all, buses and taxies release the same exhaust gases as other vehicles, so they are still being considered towards the innovation of green technologies. However, in the idea of green technologies, public transportation should get more priority for further extension in innovations. The increased use of public transportation must get a proper direction on the road to create less air and noise pollution. But we still have lots of things that can be done. Here some forms of public transportation that may go green and become environmentally friendly technologies in our urbanization context include—1) electric vehicles, such as electric trains, bikes, buses can be promoted (but the electricity must come from renewable resources), 2) introducing multiple occupant vehicles, 3) introducing hybrid bus, taxies, commuter vehicles, etc., 4) developing road infrastructure including bus bay, footpath, underpass, overpass, etc., 5) introducing large capacity of public transport (big buses, metro, double Decker, etc.), 6) introducing auto traffic signals and central monitoring systems for maintaining traffic rules and regulations, 7) steam engine may be tested over diesel engine, which has large consequences of environmental benefits and enhance the green transportation system in life cycle perspectives (Frenger, 2013), and 8) reducing traffic congestions through different initiatives (shifting or restructuring of political rallies, events, exhibition, VIP offices, VIP movements and VIP protocol, etc.). For example, the location of Bangladesh Prime Minister's office often makes huge traffic congestions almost every day in a week and as consequences, the situation causes sufferings to millions and wastes their precious time and efforts. In fact, such experiences evoke the sustainability violations underlying mental and environmental hazard importantly.

Figure 2. Violating Traffic Rules by Common People and as Consequences of This Is a Traffic Jam in Dhaka City

5. Conclusions

Considering both technical and non-technical parts of transportation, sustainable transportation can be ensured where the greening of transportation can act as leverage in the present sustainability transition period. The "Green" vigorously drives for accelerating the policy making and implementation of a sustainable transport system. We have indeed many challenges to achieve this, but for the improvement we should take our positions in a coordinated way to a wide range of politicians, stakeholder groups, researchers and transport planners. To summarize the issue, we definitely need to restructure and prioritize our transport network that includes walking, cycling, and public transport facilities. Every single step can push us unanimously to identify the improvement of our present situation within a multi-staged and long term process requiring political deals, compromises and coalition-building among multi stakeholder groups.

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