

Preparing and developing the indexes of sustainable development of transportation in I.R. Iran

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Abstract— The paper is to identify and develop indexes for sustainable development of public transportation in order to plan and evaluate the performance of the transportation section in according to the sustainable development, identify the stabilities and instabilities in developing of public transportation, review the theoretical bases of development indexes in different sections, effects of social, economic and environmental development in this country, provide executive solutions for quantitative assessment of performance in transportation, create balanced access of human with the concept of time and lower cost, safer movement and more comfort on every journey, a more healthy environment, and a better society and economy. Transportation in the past indicates that this section cannot be able to handle the increased demands in the coming years as sustainable. If the necessary facilities to increase performance of the transportation are not provided in the near future, concerning the sustainable development, the transportation problems will be encountered more economic, social and environmental consequences. In this respect, the comparative study of countries is done regarding sustainable development and section indices of Transport, Transport activities in the country, goals and development strategies in the transportation, the principles of sustainable development, the constraints in production and environmental improvement. After identifying the environmental problems and legal obstacles, the study finally determines the evidence-based indexes in 4 groups in the form of society, economy, environment, transportation (supporting of services and transportation infrastructures), and presents the development indexes in four modes of Road, Rail, Air and Marine Transportation.

Finally, it is used the AHP model, as one of the assessment methods in sustainable development of transportation at the national level. In fact, after reaching a general logic and result in sustainable development indexes and policies, AHP was used for statistical analysis of sustainable development in transportation issue at the national level. This model is based on cause and effect relationships among transportation, economy, society and environment. The model intends to show how the sustainable development occurs in transportation at any moment in regard to statistics and the indexes.

Keywords—Railway transport; sustainable development; indexes; measuring sustainability; environment

I. INTRODUCTION

In viewpoint of Union International Transportation Public (UITP) and due to its statement with title of "better mobility for all [people]", transportation with sustainable transferring has emphasized as an important and fundamental part of sustainable development; that is to say that in addition to being environmentally compatible, clear transportation has strong socioeconomic justification and also is one of the important factors to reach sustainable development.

Sustainable transport not only meets today needs but also mainly helps to protect and maintain livable environment and climate in future cities. What was mentioned in UN's Agenda₂₁ program under global goals title about third millennium goals is not accessible without sustainable mobility.

With regards to above topics, it can be said that at present need to access to new concepts, definitions, and guidelines to produce and consume all goods and services, that transportation is one of its elements, is globally accepted. Global demand for mobility and access facilities is growing increasingly. Population throughout world and especially people of cities and residents of their vicinity expect that transport facilities rapidly become more easy, cheap, and accessible for their use. These global expectations have created a big challenge against governments, decision-makers, policy-makers, beneficiaries of transportation systems, and entire transportation industry.

In addition and regarding that linking facilities including ground roads, railways, nautical roads, and aerial paths along with peripheral equipments are fundamental factors and infrastructures of development, so this topic is accounted as one of the resuscitative artery in all countries. Thereupon, creation and supplying these infrastructures such as all other institutions relatively has both benefits and useful results and inevitably some environmentally disadvantages. Thus, it is necessary that governments apply policies of transportation sector more accurately and pay more attention to those policies and indices that affect on results of activities. To this end, governors in all local, national and international levels need information and as for complexity and diversity of existent information, it is necessary to specify contents, context, and accessibility of this information. For more advancement it is essential to take broader guidelines and then by identifying and examining sustainable indices of

transport economically and environmentally and so by evaluating the performance of this sector quantitatively, we will be able to move toward sustainable development.

II. PAPER GOALS

Goal of this paper is identifying and arranging indices of sustainable development for transportation systems aimed at planning and assessing performance of transportation sector in the direction of sustainable development, identifying sustainability and non-sustainability of this sector development, investigating about theoretical bases of indices arrangement in different sectors, social-economical-environmental effects of this development inside the country, presenting executive guidelines to evaluate transportation performance inside the country, making balanced human access with less time/cost, more secure departure, more comfort in all journeys, better economic for society, and healthier environment. Past procedure of transportation sector of the country shows that in future years this sector cannot answer to increment of demands for different departures in a sustainable manner. If in upcoming future necessary facilities to increase performance of internally transportation are not presented in the direction of sustainable development then transportation will face with more problems that it will be followed by undesirable economical, social, and environmental events.

Importance of present research can be explained by different aspects. These aspects in fact return to nature of sustainable development, arrangement pattern of sustainable development indices, and study level. Firstly, proceed fundamentally into sustainable development of transportation and perusing effects of transportation on environment and society is vital. Secondly and due to that the topic is new, arrangement of indices to examine sustainability of transportation is important. Finally, chosen level for this research increases its importance because this level has been discussed in other researches less than expectances. Importance of this research and similar ones is caused by important effect of transportation on environment.

III. METHODOLOGY

The common aspect among sustainability literature is presence of an inter-generation equality and simultaneous attention to other societies' aspects such as environment and society alongside economy. Based on above-mentioned topics about concept of sustainable development, assessment criterion in this section is compatibility and coordination between different aspects and transportation sector.

Based on figure 1, in this research, after comparative study of countries concerning sustainable development and transportation of the country the following items have been discussed: activities of transportation sector inside the country, goals and strategies about development of transportation sector in Iran, principles of sustainable development in transportation sector, limitations of transportation sector to produce and improve environmental situation. Consequently, after determining environmental problems and legal barriers in different sectors the following

items have been determined: the index in format of four social, economic, environmental, and transportation groups.

Some sets of the valid sustainable transportation indices in international level are Green Society checklist – USA's organization of environment protection, environmental performance assessment – USA's roads ministry, performance indices of sustainable transportation – sustainable transportation centre, environmentalist sustainable transportation – European organization of economical and developmental cooperation, sustainable transportation indices of global trade assembly – sustainable transportation project, environment and transportation reporting mechanism – European Union, actions and assessment of sustainable transportation – SUMMA project – European Commission, sustainable transportation indices – institute of transportation policy-making in Australia; results of perusing these indices showed that most of the indices have been arranged for national levels. Their difference between different countries (such as size, level of industrial being and so on) and existent non-homogeneities between countries (particularly big countries) usually is very deep and extensive and causes serious troubles for applying same indices at national levels in all countries. [13, 22, 19, 16]

Many experts and governors severely encourage developing indices of sub-national levels (That is, defining local or native indices in levels lower than national level). In some sectors that have more importance, such as agriculture, forestry, transportation, industry, city building, and energy, a set of indices (which is sometimes very advanced and complete) has been arranged and is being used.

IV. MODEL

Highly used model in pattern making for sustainable development is pressure – situation – response method (P.S.R). In this framework first pressures enter into system and then these pressures combine together and determine situation of system. Thereafter, policy-makers and planners apply suitable response and reaction to reduce these pressures.

This model has been formed by three parts of pressure, situation, and response; in the pressure part those items have been discussed that in a way has effect on some of the sustainability dimensions that in fact form same system or environment. These pressures will change situation of system. In status or situation part, most important dimensions of sustainable development – environmental, economical, and social dimensions – have been represented.

In order to reduce negative entered effects into sustainability dimensions and in the direction of reaching our main goal, that is sustainable development of transportation, some policies have been considered. After applying them, effect of these policies on environment is observable and then improvement level of system is receivable.

This pattern acts dynamically. It means that at any time using present information and statistics we can analyze procedure of sustainable transportation development in the country. Most of used relations in this pattern are linear and have coordination with present statistics.

Required information for indices must provide in cooperation with active organizations and institutes in transportation sector of the country. It must be mentioned that presence of an independent organization with research nature to produce information can be useful but a fundamental question is emerged here: produced information to what extent can cover improvement needs of sustainable development of transportation. Undoubtedly, policy-makers must know much about importance of this subject and its effects due to absence of sufficient information in made decisions.

V. DEDUCTION

Thus, after perusing and comparative studying about countries concerning indices of sustainable development and transportation sector of the country, activities of transportation sector inside the country, development strategies and goals of transportation sector in Iran, principles of sustainable development in transportation sector, presenting effective policies in relation to sustainable development of transportation, examining their effects in different social, economical, and environmental dimensions, and information collecting that have been provided by global statistics centers concerning sustainable development of transportation in different countries and by using P.S.R method, best options for selecting and grouping indices have been determined. A document has been prepared to introduce each index and in these documents the following items have been represented: the index introduction, its application, present situation in view of computability or un-computability, collecting method, and index computation.

❖ *Related indices into supporting services and infrastructures of transportation*

High emphasis is applied on efficiency of transportation infrastructure because more efficient infrastructure results in less infrastructure level and instead will has lowest environmental effect.

- Length of asphalted roads: efficiency of using roads is examined
- Length of sustainable infrastructure: increment of using more clear models of transportation (such as rapid electric transportation)
- Seat – Kilometer per capita in transportation: transportation supporting is discussed.
- Aggregation index: by decreasing vehicle with only one passenger and increasing public transportation, the aggregation must be decreased.

❖ *Related indices into transportation activities*

- All trips of people by using personal car: proportion of done trips by personal cars against all done trips by all models of transportation
- Synthetic transportation of load: transportation between models, using standard containers that transfer load

between two models (such as nautical – railway, railway – truck, truck – aerial). By transferring from one model to another model, this model allows every model to do those parts of whole movement that are suitable for that work.

- All load movements/transfers by vehicles: does the trends point to growth of transferring goods by truck against other transportation models such as railway, nautically, aerially or not?
- Number of without car trips inside civil zones: key goal of sustainable development is increment of using without car transportation modes including walking, cycling, and other similar ones.
- Proportion of those trips that did not performed by public ground transportation: Proportion of those trips that are not done by ground vehicles of public transportation (urban and intercity traffic by bus, train, and school bus).
- Number of registered vehicles: ownership of vehicle is a key factor in use of vehicle and so it is a prominent index of transportation activity.
- Transferring level by light passenger vehicles: movement of passenger-carrier vehicles is cause of many transportation effects such as gas propagation inside city, noise making, ground consuming (), slow traffic, interferences, and accidents. Many of these effects have been achieved by other indices.
- Efficiency of passenger vehicles: increment of passenger vehicles efficiency (such as increasing passenger rate in them) is an effective method to decrease vehicle – kilometer rate of trips and so improving sustainability.

❖ *Related indices into economical considerations of transportation*

Economical indices of sustainable transportation must display costs and benefits of using vehicles.

- Costs caused by transportation: related costs to transportation of each family, cost of fuel consumption level, rent cost, cost of car ownership, cost caused by accidents, cost for public transportation, external costs to utilize transportation
- Revenues caused by transportation: carried ton – kilometer demand, traversed passenger – kilometer demand, proportion of transportation's added value in GNP

❖ *Related indices into social and cultural considerations of transportation*

Safety: number of annually accidents, number of human victims;
 Health: effects of transportation on human health;
 Cultural and educational activities;
 Social justice: income level, car ownership per capita, index of poorest and richest person's proportion from energy subsidy;
 Social participation: job creation of transportation sector

❖ *Related indices into environmental considerations of transportation sector*

Resources consumption: level of using fossil fuels, energy intensity, proportion of natural gas in transportation sector, ratio of energy consumption per capita and population, productivity of energy

Level of land using to generate and develop infrastructures, proximity of infrastructures to sensitive zones and conserved zones of environment, transportation effects on environment health

Pollutions: level of sonic pollution, level of water pollution, level of air pollution, propagation of air pollutants caused by transportation, level of greenhouse gas propagation caused by transportation, level of soil pollution.

VI. PRESENTING INDICES OF SUSTAINABLE DEVELOPMENT OF TRANSPORTATION IN FOUR ROAD, RAILWAY, AERIAL, AND NAUTICAL MODES

At the end of this part, indices of sustainable development of transportation in four road, railway, aerial, and nautical modes have been represented with regard to importance of sustainable development indices.

Performed conclusion in this part showed that implementing sustainable transportation indices in national level is beyond-sector action with management and guidance of transportation sector. Since indices are diverse and even sometimes outside of transportation sector including educational or environmental centers, so their cooperation and partnership plus to all beneficiaries in implementation of sustainable transportation indices/criteria is necessary. It should be mentioned that in present conditions of Iran, statistics and information about some indices of sustainable transportation exist but some of these information are raw and so must be processed. Additionally, we need more study, examination, and even research to measure some indices. Decision-maker must access to an applicative domain of effective indices about transportation system in order to act correctly in response to question of minimum or maximum acceptability of considered indices. Hence, existent references and experts' comments must be used to access proper and suitable domains.

VII. SUGGESTIONS AND RESULTS

- Examining and studying goals, programs, strategies, and policies of government, road-and-transportation ministry, and national committee of sustainable development to arrange and adjust environmental policies and transportation sustainable development.

- Preparing, arranging, and completing priorities, criteria, and indices of transportation sustainable development and environmental evaluation patterns in different sub-parts of transportation sector
- Designing and establishing monitoring system, assessing environmental indices, supporting and directing to execute it in different sub-parts of transportation sector
- Monitoring to make sure about good execution of approved environmental standards in different sub-parts of road-and-transportation ministry to reach sustainable development
- Collecting related statistics and information about transportation sustainable development and environmental considerations and contribution to found related database in the direction of environmental cultural development and informing and use of them in plans and programs of transportation sector
- Making presented instructions executive to evaluate sustainable development of transportation in the direction of more accurate analysis and considering more aspects of sustainability
- Presenting arranged indices for Statistics Center to incorporate it into annually census in a formalized manner to examine annual procedure of sustainable development in transportation sector
- Incorporating more indices in suggested pattern to access to more accurate results in each sub-part

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TABLE I. PRESENTED INDICES IN EACH SECTOR

Sum	Environmental	Social-Cultural	Economic	Transportation	Index type
					Transportation mode
65	31	10	12	12	Road
43	25	6	10	2	Railway
33	22	7	3	1	Nautical
35	19	6	9	1	Aerial

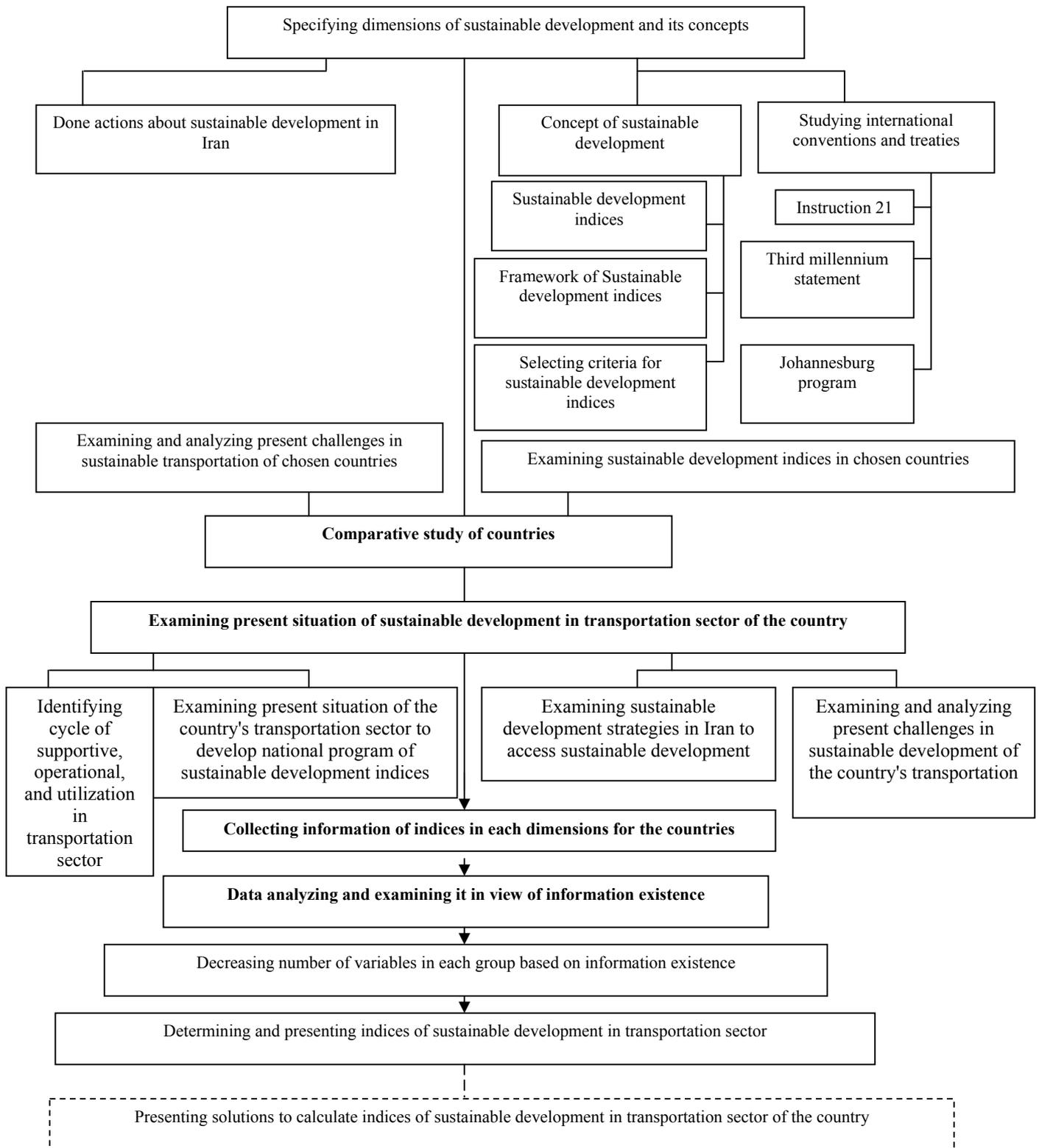


Figure 1. Methodology of providing indices of sustainable development in transportation sector