

**DEVELOPMENT OF AN IMPROVED CRITERIA TO
EVALUATE ACCESSIBILITY TO PUBLIC BUS
TRANSPORT SYSTEMS IN A SUSTAINABLE
PERSPECTIVE**

Thisaiveerasingam Thilakshan

198066D

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa

Sri Lanka

May 2021

**DEVELOPMENT OF AN IMPROVED CRITERIA TO
EVALUATE ACCESSIBILITY TO PUBLIC BUS
TRANSPORT SYSTEMS IN A SUSTAINABLE
PERSPECTIVE**

Thisaiveerasingam Thilakshan

198066D

Thesis submitted in partial fulfillment of the requirements for the degree
Master of Science

Department of Civil Engineering

University of Moratuwa

Sri Lanka

May 2021

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, in whole or part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as article or books).


Signature: 

Date: 28.05.2021

T. Thilakshan

The above candidate has carried out research for the Master's thesis under my supervision.

Name of the supervisor: Prof. J.M.S.J. Bandara


Signature of the supervisor:

Date: 28th May 2021

ABSTRACT

Sustainability is a universal concept applied in all industries and services to instigate a base of responsibility in an individual and collective manner. The need to promote the concept and hold stakeholders responsible and answerable is the current core in terms of incorporation of sustainable practices.

The concepts of sustainability in transportation especially with respect to accessibility is evaluated using available tools that are more biased towards qualitative measures and comparisons between routes, transit systems or cities and regions are difficult or biased towards opinion. The study deals with the relationships in relation to the SDGs and more precisely the 169 targets which elaborate the SDGs in a focused manner. The analysis provides rise to relationship/links directly and indirectly in identifying targets related to sustainable transportation and linking the targets more precisely with the five dimensions of sustainable transportation as stated by the United Nations for better understanding and relationship establishments.

The need for a better measure for the context of understanding accessibility levels to transportation mainly in the context of public transit (bus) services in cities in an urban environment was identified and this study evaluates the factors that needs to be concerned in affecting the concept of ‘ease of access’ in a sustainable platform. The evaluation of the available sustainable transportation measures, models and tools give a comprehensive understanding of the avenues that had been considered and the quantitative and qualitative disparity that exists among the existing indicators. Thus, the need for a more representative and quantifiable measure of accessibility to public transit services in the urban context is identified. The research study presents a critical review in existing literature and identifying research gaps in paving the path in achieving a quantitatively enriched index with qualitative support.

Sustainable Urban Transit Accessibility Scorecard (SUTAS) is proposed considering all available parallels in developing a more effective measure for policymakers and researchers to identify the accessibility quotient to public transit systems available while improving the measure further to accommodate different regions, cities, routes into respective levels of comparison. The incorporation of the indicators was done in line with highlighting the accessibility quotient and striking a fine balance with giving a fair space with the other dimensions of sustainable transportation. This inclusiveness has facilitated further strengthening the scope of the improved criteria to be with strong quantitative outcomes. A number of majorly qualitative indicators are also incorporated which enhance the scope of the improved criterion. The indicators have been set to provide a single SUTAS value for analysis. The study in detail further elaborates on how every indicator can be improved to increase the validity of their individual score in highlighting their parameters. Thus the developed SUTAS is able

to assess the accessibility quotient to public transit (buses) in an urban context both in terms of individual city assessment through a timeline and in comparison amongst cities.

The pilot phase of the scorecard has been carried out using case studies and the outcomes have been informative and hence applicable. The scorecard is further refined along with real case applications to introduce a comprehensive procedure that will be a standard method in terms of evaluating accessibility to public transit systems in the urban scenario. Thus, the purpose of SUTAS is to support urban zones to improve sustainable transportation and its related challenges through proper analysis and understanding in a platform where cities of different context can be compared and contrasted to support each other.

Keywords: Sustainable Transportation, Accessibility, SDGs, Scorecard, Indicators

DEDICATION

I dedicate this dissertation to **Prof. J.M.S.J. Bandara**, my research supervisor and mentor who gave me this opportunity and guided me throughout the research study until completion.

T. Thilakshan

Department of Civil Engineering,

University of Moratuwa.

28.05.2021

ACKNOWLEDGEMENT

I would like to acknowledge many people who supported me to complete the research successfully.

I am especially in debt for life to **Prof. J.M.S.J. Bandara**, Senior Professor of the Department of Civil Engineering, University of Moratuwa, who supervised and guided me throughout the entire research study.

I wish to thank the support given by the Department of Civil Engineering, University of Moratuwa and its academic and non-academic staff members. Special mention to **Prof. S.A.S. Kulathilaka**, the current Head of Civil Engineering Department in providing all administrative support when required.

I would also like to thank all the lecturers in Transportation Engineering Group in addition to my supervisor, including **Prof. W.K. Mampearachchi, Dr. H.R. Pasindu, Dr. G.L.D. de Silva** and **Dr. Loshaka Perera** who helped me both academically and otherwise during my time as a researcher.

Further I would like to express my gratitude to my research progress committee members including **Dr. A.G.T. Sugathapala** (Chairman of the panel) for his extensive comments and guidance on my research and **Dr. J.C.P.H. Gamage** (Research coordinator), for her guidance to improve my research findings. I would like to provide a special mention to the postgraduate course coordinator, **Mrs. Melani Jayakody** for her continuous administrative support and my **fellow research assistants** in Transportation Engineering Group during the period of 2019/2020 for their constant help and guidance throughout the research period.

Finally, I must thank my parents who were supportive and had helped throughout the period of the study.

T. Thilakshan

Department of Civil Engineering,

University of Moratuwa.

28.05.2021

TABLE OF CONTENTS

| | |
|--|------|
| DECLARATION | iii |
| ABSTRACT | iv |
| DEDICATION | vi |
| ACKNOWLEDGEMENT | vii |
| TABLE OF CONTENTS | viii |
| LIST OF TABLES | x |
| LIST OF FIGURES | x |
| LIST OF ABBREVIATIONS | xi |
| 1 INTRODUCTION | 12 |
| 1.1 Background..... | 12 |
| 1.2 Initial Definitions..... | 15 |
| 1.3 Scope of Study..... | 15 |
| 1.4 Objectives..... | 16 |
| 1.5 Outcomes..... | 16 |
| 1.6 Arrangement of the Dissertation..... | 16 |
| 2 LITERATURE REVIEW | 18 |
| 2.1 Sustainability and Sustainable Development Goals (SDGs)..... | 18 |
| 2.2 Sustainable Transportation: Concept, Measures, Models and Indicators..... | 22 |
| 2.3 Accessibility, Public Transit and Further Analysis..... | 32 |
| 2.4 Summary of the Chapter..... | 43 |
| 3 IDENTIFICATION OF RELEVANT SUSTAINABLE TRANSPORTATION LINKS TO SDGs | 44 |
| 3.1 SDG Targets and Sustainable Transportation..... | 44 |
| 3.2 Identification on links for a conceptual study..... | 46 |
| 3.3 Summary of the Chapter..... | 55 |
| 4 AN IMPROVED CRITERION..... | 56 |
| 4.1 SUTAS - ‘Sustainable Urban Transit Accessibility Scorecard’ | 56 |
| 4.2 Normalization..... | 71 |

| | | |
|-----|---|----|
| 4.3 | Summary of the Chapter..... | 72 |
| 5 | SUTAS ANALYSIS & RESULTS..... | 73 |
| 5.1 | The SUTAS Comparative Outcomes – SUTAS 10..... | 73 |
| 5.2 | Study 02 – CASE STUDY (Application of the developed indicator in a Real Case Comparative analysis of five towns)..... | 78 |
| 5.3 | Summary of the Chapter..... | 91 |
| 6 | CONCLUSIONS AND RECOMMENDATIONS | 93 |
| | REFERENCES..... | 95 |

LIST OF TABLES

- Table 01 – Sustainable Transportation Indicators
- Table 02 – Comparison of Sustainable Transportation Indicator: SUTI & STPI
- Table 03 – List of UN SDGs along with their number of targets
- Table 04 – Identified Links of SDG targets with sustainable transportation factors
- Table 05 – No. of targets linked to individual targets (analyzed from Table 01)
- Table 06 – Side by side comparison of SUTI, STPI and SUTAS (and SUTAS 10)
- Table 07 – SUTAS 10 Indicators and Corresponding Parameters (Individual City)
- Table 08 – SUTAS 10: In City Comparisons using Hypothetical Values
- Table 09 – SUTAS Values based City Rankings on Access to Public Bus Transport
- Table 10 – Summarized Description of the five towns
- Table 11 – RCI (Road Connectivity Index) Values
- Table 12 – PTCI (Public Transport Connectivity Index) Values
- Table 13 - Network - Transit Service Ratio
- Table 14 – Service Accessibility Ratio
- Table 15 – Disadvantaged User Access Rating
- Table 16 – Total Access Time
- Table 17 – SUTAS outcome from the case study

LIST OF FIGURES

- Figure 01 – Millennium Development Goals
- Figure 02 – Sustainable Development Goals
- Figure 03 – Sustainable Development – The 5Ps
- Figure 04 – 5 Is and 5 Cs (UN -Mobilizing Sustainable Transport for Development)
- Figure 05 – Number of targets and percentage of impact of every dimension to SDGs

Figure 06 – Spider Chart of Individual SUTAS Indicators Depiction

Figure 07 – Spider Chart of Comparison Depiction of SUTAS Index value (4 Cities)

LIST OF ABBREVIATIONS

MDGs – Millennium Development Goals

SDGs – Sustainable Development Goals

SUTI – Sustainable Urban Transport Index

STPI – Sustainable Transport Performance Index

SUTAS – Sustainable Urban Transport Accessibility Scorecard