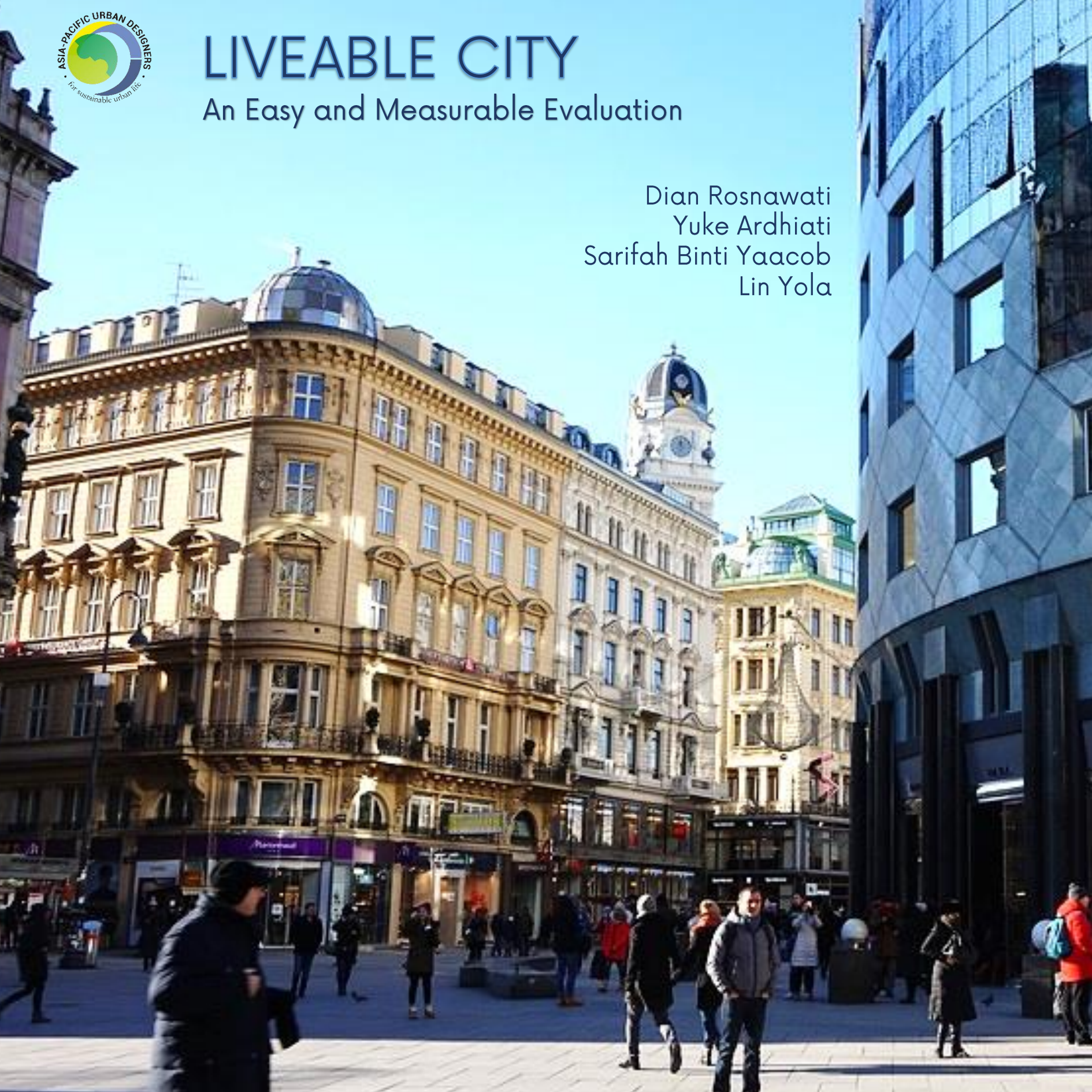
LIVEABLE CITY

An Easy and Measurable Evaluation

Dian Rosnawati
Yuke Ardhiati
Sarifah Binti Yaacob
Lin Yola



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Dr. Lin Yola is a Senior Lecturer at the School of Strategic and Global Studies, Universitas Indonesia. She currently holds the Head of Center for Spatial Data and Analysis, which mainly focuses on the simulation model and integrated Eco-Spatial study and technologies. She has years of experience in an Academic and Administrative Position in some international university programs, and also highly active as Publication Editor and Reviewer, Curriculum Developer, International Event Chairman, and Community Services. Dr. Lin Yola has a strong academic and professional background in urban, energy, and technology innovation. She is best known for her model of 'Climatically Responsive Urban Configuration'. Besides the significant cross-discipline studies, her projects and publications impose technology innovation as the strategic methodology in addressing global development, social and environmental issues.

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Yuke Ardhiati, an author and professional architect. Graduated of two different doctoral scientific fields; History (2005) and Architecture (2013). Then, to be the author of books and articles related to Soekarno's architectural ideas, such as; (a) Soekarno the Architect: the Artistic Study of Architectural Works, Urban Spatial Planning, Interiors, Crafts, Symbols, Fashion Fand Speech Texts 1926-1965 (2005), (b) Soekarno in the "Indonesian Stage" (2013), (c) The Three Reliefs of Three Artists: The Indonesian Narrative in the VIP Room of the Ex-Kemayoran Airport in Jakarta (2019), The Two Reliefs at the Sarinah Building (2021). She also author of several architecture theory books and published her articles in several international journals. She also a member of the technical assessment team for government assistance at the Creative Economy Agency, Ministry of Creative Economy and Tourism and a member of the study team for the establishment of several museums at the Indonesian Ministry of Education and Culture.

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Sarifah Bt Yaacob is a Senior Environmental Consultant at AM PM International Sdn Bhd based in Kuala Lumpur, Malaysia. She is also the Chairman of Eco Women Association(EKOWI), an NGO promoting and educating environmental awareness to the public. She received her Degree in BSc Civil Engineering from University of Louisiana, USA and MSc Environmental Engineering from University of Technology Malaysia. She has more than 30 years experience in environmental fields including Environmental Impact assessment(EIA), Solid Waste Management Plans and Strategies, Waste Research and Field survey, Green Technology, Waste Training Module Development and conducted trainings on waste management. She has been appointed as the Subject Matter Expert on waste management projects for several government and private agencies.

5. DIAN ROSNAWATI

Dian Rosnawati is a representative for Rigid 1 Projects, a funding company headquartered in USA and Egypt. She is also a business advisor for Lab Moneta, a Fintech company in Singapore. She earned her degrees in architecture and urban design from Institut Teknologi Bandung (ITB), Indonesia. She is experienced as pasca-mining Spatial Planner for Adaro, and as infrastructure Planner and Project Manager for Ministry of Public Works and Housing of Indonesia. Following her leadership as Chairman of Association of Urban Design Alumnae of ITB (Alumni Rancang Kota ITB (ARKI)), She and her colleagues expanded their concerns on urban environment in Asia-Pacific region by creating Asia-Pacific Urban Designers (APUD) in which she has been the Founder and President. She is also an Adjunct Senior Lecturer of Taylor's University. Together with APUD, Rigid 1 Projects, Lab Moneta, and Taylor's University, she continues her legacy in contributing to the urban planning, design, and development, not only in building the people's capacity, making plan, designing, and digitizing urban needs, but also in funding the efforts in the most sustainable terms across Asia-Pacific.

PREFACE

The concepts of liveable and sustainable city are widely recognized by major urban stakeholders around the world. There is hardly any debate among the experts about them.

The challenges, in making the concepts of liveable and sustainable cities come true, are their implementation in various countries, especially in countries that are considered late in developing or redeveloping their cities, with comprehensive urban development approaches. If we look closely, the burdens borne by each city, are quite heavy, especially in countries or regions that are late in carrying out comprehensive urban development actions. Central and local governments in these countries must take different steps from other countries.

There are many references about conceptual to technical guidelines, that countries or local governments, who want to make breakthroughs, could refer to. Detailed indicators for a city that we consider liveable and sustainable, are completely provided from the works of the experts.

Each chapter on this book gives real and useful contribution as a reference for the implementation. In this book, we can get feasible parameters and quality standards of housing, water supply, waste, environment, public space, and other urban design elements, to be adopted. While providing conceptual thinking, all chapters on this book also offering benchmarking materials from the experiences and built designs of several cities which are considered close to the standard of liveable cities.

Central and regional governments, who are considered late in making their cities liveable and sustainable, have to overcome certain non-physical criteria, before they can make the desired physical criteria come true. They are: regulation, governance system, supporting fiscal policy, the ease of land provision, proper division of roles between government and private sector, and policy to control migration and population mobility.

Urbanization flow has been rapidly going on. If it is not controlled, it will greatly affect on the increasing of the demand of land in cities, for various functions needed by their inhabitants. The provision of all the functions must be anticipated and be the base of urban planning, including one function that is always left behind: cemetery.

Andrinof Akhir Chaniago
Honorary Member
Asia-Pacific Urban Designers

HOW TO USE THIS BOOK

This book is made by Asia-Pacific Urban Designers (APUD), a professional association of urban designers in Asia-Pacific region, by the expertises of our members and the best referenced literatures. This book consists of several relate deditions. This one you are reading is the first edition.

This book presents a perspective method of city system performance in experiencing the quality of city life through the enrichment and implementation of resilience and sustainability concepts. With the livability index, the ability of each city to offer city dwellers as the main concern could be presented. After reading this book, you will know about the liveable cities matters in depth, and measure the city you live in using the criteria and indicators, objectively and quantitatively.

This book can be used for the cities within the Asia Pacific region. The context of social demography, governance, environment, climate, and the ability of cities to innovate in the Asia Pacific, particularly Indonesia, were mainly adapted in defining the gap between the city livability index. Though the scientific methodology of measuring the city's livability through the quantitative measurement index as a whole, the strong objective of each criterion and indicator within the index defines the context of the city in defining its livability. You can choose and take any criteria that are suitable for your city but still have fair score although you exclude certain criteria that do not belong to your city. The important thing is the validity of data. Use only the latest-valid data.

The mapping of the indexes, criteria and indicators in this book were set for a basic measurement framework, at least for responding to the current cities' development and trends in the Asia Pacific and Indonesia. The criteria and indicators, are open for improvement, adaptable to future needs, issues, and paradigms.

The book is made up of four distinctive chapters clearly having its purpose towards the reader to know how to create a liveable city. Chapter One discusses about what is the meaning of a liveable city. Chapter Two proposes what attributes are needed for a city to be liveable. Chapter Three shows the how to measure a city's liveability through the various indicators indices, by simulation of calculations on 3 (three) dummy cities. Chapter Four explores the various examples of built environments in cities that are liveable by design related to the indexes simulated in this book.

CHAPTER I

Understanding of A Liveable City

"A liveable city is a city that is available, accessible, affordable, and has all necessities needed by its citizens, both physically and physiologically for their better lives now and in the future." (Yuke Ardhiati, 2022)

"Liveable city aims to provide a holistic urban system that offers experience of 'quality of life' of the livelihood and the ecological urban space environment by the city dwellers, through the enrichment and implementation of resilience and sustainability concept. The liveable city concept priorities the well-being of people as the focus of its' development and decision-making, however, it adopts environmentally sustainable and resilient concepts in targeting the good city dwellers' welfare." (Lin Yola, 2022)

"A liveable city is a city where people could live and earn sustainable income peacefully for comfortable living and children education, affordable cost of living, availability of various range of property cost for various level of community, safe and feel secured wherever in the city, healthy environment (clean air, clean river and drains, free from litters, efficient waste management), offers varieties of activities/facilities for elderly/retired citizen, good and fast accessibility for work/business, education, shopping, recreation and well connected virtually with outside world." (Sarifah binti Yaacob, 2022)

"Liveable city is an area/region inwhich all tangible and intangible needs of the residents, inhabitants, and visitors, are fulfilled in decent, humane, and sustainable ways, both for human and environment, while being resilient, through integrated urban system, design, and activities." (Dian Rosnawati, 2022)

CHAPTER II

Criteria of Liveable City

This chapter contains all the criteria, which are the indexes need to be measured and is open for improvement. The whole indexes are classified as below, and shared on several editions of this book. We are sharing the 6 green-highlighted indexes below in this first edition, which are explained in the next chapter in this book.

1. Physical Indexes
   a. Population Density Index
   b. Healthcare Index
   c. Natural Disaster Mitigation Index

2. Green Indexes
   a. Green Coverage Plot Ratio
   b. Environmental Comfort Index
   c. Natural Preservation Index
   d. Development Independence Index

3. Infrastructure Indexes
   a. Energy Index
   b. Food Security Index
   c. Housing Index (in Chapter III of this first edition, by Yuke Ardhiati)
   d. Public Transportation Index (in Chapter III of this first edition, by Lin Yola)
   e. Waste Management Index (in Chapter III of this first edition, by Sarifah bint Yaacob)
   f. Water Infrastructures Index (in Chapter III of this first edition, by Dian Rosnawati)
   g. Information and Communication Technology (ICT) Index

4. Social & Cultural Indexes
   a. Cultural Sustainability Index (in Chapter III of this first edition, by Yuke Ardhiati)
   b. Public Facility Provision Index

c. Education Index
d. Public Participation Index
e. Neighbourhood Plot Ratio Index

5. Economic & Political Indexes
   a. Economic Stability Index
   b. Political Stability Index
   c. Public Security Index (in Chapter III of this first edition, by Yuke Ardhiati)

CHAPTER III

City's Liveability Indexes Part I

The 6 (six) city's indexes of liveability that are measured in this book are:

1. Housing Index by Yuke Ardhiati
2. Public Transportation Index by Lin Yola
3. Waste Management Index by Sarifah binti Yaacob
4. Water Infrastructures Index by Dian Rosnawati
5. Cultural Sustainability Index by Yuke Ardhiati
6. Public Security Index by Yuke Ardhiati

3. 1. Housing Index by Yuke Ardhiati

3.1.1 Definition

The Housing Index in this book is defined as many types of physical facilities to shelter or stay. Both the new and the ancient within their conditions and indicators that have (a) availability, (b) accessibility, (c) affordability and (d) proximity of all necessities of the fundamental citizen's need to their physiological needs related for better lives and a better future. Physical facilities of housing in many types among others;(a) land houses, (b) tall houses/ apartments, and (c) mixed.

3.1.2 Housing Index on Output Based

The goal of Housing Index output is based on how the city's stakeholder can availability, (b) accessibility, (c) affordability and (d) proximity for all housing facilities that can contribute to citizen's quality of life.

3.1.3 Housing Index Criteria

Naturally, human need the basic needs till their esteem needs. Housing is very close to basic human needs. Abraham Maslow's Theory (Maslow, 2013)[1] shown in Maslow Pyramidal of human

[1] McLeod, Saul (2007). Maslow's Hierarchy of Needs in Simply Psychology. Updated December 29, 2020. Retrieved in March 23, 2022 from https://www.simplypsychology.org/saul- mcleod.html

need. His first theory divided into five. During life, he updated his five theories in 1943 and 1954 to be eight. And then, he divided into two stages named the Deficiency Needs and the Growth Needs or Being Needs.

The first four levels named as Deficiency Needs (D-needs), and the upper levels are named as Growth Needs or Being Needs (B-needs). During the Deficiency Needs (D-needs) arise due to deficiencies and are said to motivate people when they are not met. In this phase the motivation to fulfill those needs will be stronger the longer they are denied. The longer a person doesn't eat, the hungrier they are (Mcleod, 2007)[2]

The Deficiency Needs (D-Needs) phase, divided into; (a) Physiological Need, (a) Security Need, (b) Social Need, and (c) Esteem needs, which arise due to deprivation. Examples of Deficiency Needs (D-needs) Phase:

a. Physiological Needs means need for food, water, shelter, warmth, sleep, clothing, comfort, rest or sleep, reproduction or procreation. Physical facility or building type related is private housing styles among others;(a) land houses, (b) tall houses/ apartment, and (c) mixed.

   Safety Needs is needs: safety, shelter, security, law and order, employment, health, stability etc.

b. Belonging and Love Needs or Social Needs mean need for love and to be part of a group family group, peer group, friendship group. Social Needs mean need for belongingness, love, affection, intimacy, family, friend, relationship etc. To safety from dangerous physical and social situations. Therefore, physical facilities or building types related to them are; (a) Security/Police Station, (b) Law Office, (c) Hospital. Physical facilities or building types related to them are;(a) Place of Worship/ Sacred Place, (b) Place of Cultural Tradition, (c) Family House (Long House of Traditional Architecture), is the limited edition in cities

c. Esteem and Prestige Needs or Ego Needs is the mean need for self-worth in order the public opinion about themself and the value of their place on themselves citizens need to their respect, status, recognition, reputation, admiration, and strong confidence. Physical building

[2] https://www.simplypsychology.org/saul-mcleod.html

types related to them are; (a) prestigious housing, (b) private office, (c) government office, (d) informal office/ creative hub

Refers to Maslow, Housing is quite related to the basic needs as a Physiological Needs. So, the Housing Index will are reflected to the real condition of a liveable city to portray the citizen's happiness. If, the basic needs are covered may reflected the citizen's happiness are shown.

United Nation Habitat also had concerned about housing and they had report to 2030 that; (a) housing demand for 96,000 new affordable and accessible housing units every day, (b) 100 million people worldwide are homeless and (c) one in four people live in harmful conditions that to their health, safety and prosperity (UN, 2012). [3]Housing roles more to the opportunity for better lives and a better future, especially to the disable people and COVID-19 pandemic protocol's standard.

3.1.4 Criteria and Indicator of Housing Index

Quality of life related Housing Index are; availability, accessibility, affordability and proximity of all necessities of citizen or physical facilities both the new and the ancient within their conditions, and the indicators are refers to the eight-stage model of the Maslow's Theory in 1943 that added in 1970, among others; (1) Availability, (2) Accessibility, (3) Affordability, and (4) Proximity of function.

1. Availability, mean the housing or building typologies related to:
    a. Housing Style/Shape; among others: (a) land houses, (b) tall houses/ apartment/loft/condominium, (c) mixed houses, (d) compact/ tiny/ small house, (e) mobile houses/ temporary houses.
    b. Quality of Housing Façade; (a) singular roof, (b) coupling house, (c) mixed.
    c. Quality of Housing Structure Material; (a) heavy duty material (brick/ concrete), (b) light material (wooded), (c) temporary material.
    d. Housing Dimension (minimum 8 m2/person); (a) family standard with 2 bed rooms or more than 36 m2, (a) minimum lot size (minimum 36 m2), (c) minimum space (21 m2 for the lower class), (d) studio living (18 m2), (e) lessthan 18 m2.

[3] United Nation Human Settlement Program 2012-2022

e. Design Principles of Environment, (a) water resources, (b) solar access, (c) road network, (d) vehicular access, (e) parking lot, (f) landscaping, (g) servicing and drainage, (h) providing environmental controls, (i) providing internet access, (j) providing to pandemic Covid-19 safety distance.

2. Accessibility, mean the housing accessible for facilities related to:
   a. Accessible to physical facilities; (a) plain/ landed, (b) hills/ mountains/ canyons, (c) rivers/ lakes, (d) near the sea, (e) mobile house/ caravan/ tend, (f) somewhere (gypsy, nomaden).
   b. Accessible to primary facilities; (a) providing water access, (b) providing electricity access, (c) providing garbage access, (d) providing telephone access, (e) providing Internet access.
   c. Affordability, mean the housing ownership related to:
      - Housing Provider; (a) private housing, (b) official resident, (c) subsidiary government (housing backlog), (d) house seller/ private developer, (e) inheritance house, (f) NGO grant/ Aid.
      - Housing ownership, (a) by buying their self (cash/ credit), (b) by renting house (monthly, annually), (c) by lending, (d) NGO grant/ Aid
      - Speciality Housing, (a) Housing for disabilities, (b) Housing for elderly, (c) Monastery housing, (d) Priest housing, (e) Moslem Housing/ *pesantren*)

   d. Proximity, mean the housing or building in the neighbourhood type related to:
      - Neighbour relationship; (a) quantities of the spatial/ configuration, (b) mixed use area/ superblock area, (c) service apartment, (d) cluster, (e) general residential, (f) residential near to or at Transit-Oriented Development (TOD).
      - Quality of life impact, (a) design principles of building and environment, (b) design principles of building, (c) psychological impact (noisy, safety,crowded)

3.1.5 Indicator of Housing Index

Many housings area revealed occupied the ancient city, colonial city or the new city. To score the housing index, need minimum mount 4 (four) in each criteria. And, all facilities need indicator among others;

a. Availability. If the building typologies related their building performance around (i) intact form/ original, score is best/ excellent, (ii) mixed form, score is moderate, (iii) change from original, score is worse.
b. Accessibility. If distance for facilities around (i) 1-5 km by walk, score is best/ excellent, (ii) 6-10 km by vehicle is moderate, and (iii) more 10 km by vehicle is bad
c. Affordability. If the ownership around (i) Housing Providerand (ii) Speciality Housing
d. Proximity. If distance for neighbour relation around. (i) 50 m by walk, score is best/excellent, (ii) 25 m is moderate, and (iii) more than 10 m is bad.

Therefore, the scoring can be classified as follows:

1. Lowest score is 0 - 11
2. Moderate Score is 12-18
3. Highest score is more than > 18

3.1.6 Housing Index

Housing Index is a summary of calculation of all the Housing Index by comparing suitable content with the four criteria.

The Formula of Calculating the Housing Index score of a city. Housing Index list is an optional criterias. It means, a city who does not have a Housing Index, can out-put or exclude or does not need to count the criteria. A city may purely be created as a new city, so it does not find the Speciality Housing among others; (a) Housing for disabilities, (b) Housing for elderly, (c) Monastery housing, (d) Priest housing, (e) Moslem Housing/ *pesantren*). So, all are optional criteria. It means, a city who does not have/ can out or exclude or does not need to count the criteria.

To sum all the scores, therefore, the scoring can be classified as follows:

1. Each of the index must be assessed as 1 (one) unit of index. Any amountof or more exceeding the written index above will result in 0 (zero) score.
2. Summary all the scores
3. Quantity interpretation of each index into score:
   (a) Beginner score: 1, (b) intermediate score: 2, (c) advance score: 3
4. Sum all score of indexes
   (a) Maximum score: 27, (b) Minimum score: 4
5. Final interpretation from the total score using these ranges
   (a) Beginner; 4-11, (b) intermediate: 12-18, (c) advance : 19-27

3.1.7 Calculation of All Indexes

Table 1 . Housing Index Table Form Sheet

No.	Housing	Criteria	Indicators	Score
1.	Availability	Housing Style/ Shape	Land houses	3
			Tall houses/ apartment/ loft/ condominium,	2
			Mixed houses	2
			Compact / tiny/ small house,	1
			Mobile house / temporary houses.	0
		Quality of Housing Facade	Singular roof	3
			Coupling house	2
			Mixed houses	1
			others	0
		Quality of Housing Material	Heavy material (brick/ concrete),	3
			Light material (wooded),	2
			Temporary material	1
		Housing Dimension	More than 36 m2 (2 BR)	3
			Minimum 36 m2	2
			21 m2 for the lower class	1
			Studio living < 18 m2),	0
		Design of Environment	Water ,solar, electricity, road, landscaping,internet	3
			Water, solar, electricity, road,	2
			Water, solar,	1
			Without water, solar, road, electricity,landscaping, internet	0
2.	Accessibility	To physical facilities	Plain / landed	3
			Near river, sea or lake	2
			Hill / mountains/ canyons	1
			Not accessible	0
3.	Affordability	Housing Provider	Private housing	3
			official resident	3
			subsidiary government (housing backlog),	2
			inheritance house	2
			NGO grant/ aid	1
		Speciality Housing	Housing for disabilities	3
			Housing for Elderly	3
			Monastery Housing	2
			Priest Housing	2
			Moslem Housing/ *Pesantren*	2
4.	Proximity	Neighbour relationship	Mixed use area/ superblock area	3
			Service apartment/ cluster	3
			General residential	2
			Near TOD	2
			Housing villa	1
			Without neighbourhood	0

Table 2 . Housing Indexes Calculation of Sunny City

No.	Housing	Criteria	Indicators	Score
1.	Availability	Housing Style/ Shape	Land houses	
			Tall houses/ apartment/ loft/condominium,	
			Mixed houses	
			Compact/tiny/ small house,	1
			Mobile houses/ temporary houses.	
		Quality of Housing Facade	Singular roof	
			Coupling house	
			Mixed houses	1
			Others	
		Quality of Housing Material	Heavy material (brick/ concrete),	
			Light material (wooded),	
			Temporary material	1
		Housing Dimension	More than 36 m2 (2 BR)	
			Minimum 36 m2	
			21 m2 for the lower class	1
			Studio living < 18 m2),	
		Design of Environment	Water, solar, electricity, road,landscaping, internet	
			Water, solar, electricity, road,	
			Water, solar,	1
			Without water, solar, road, electricity, landscaping, internet	
2.	Accessibility	To physical facilities	Plain/ landed	
			Near river, sea or lake	
			Hill/ mountains/ canyons	1
			Not accessible	
3	Affordability	Housing Provider	Private housing	
			Official resident	3
			Subsidiary government (housingbacklog),	
			Inheritance house	
			NGO grant/ Aid	1
		Speciality Housing	Housing for disabilities	
			Housing for Elderly	
			Monastery housing	
			Priest housing	
			Moslem housing/ *pesantren*	
4.	Proximity	Neighbour relationship	Mixed use area/ superblock area	
			Service apartment/ cluster	
			General residential	
			Near to TOD	
			Housing villa	1
			Without neighbourhood	
Total Score				**11**

Table 3 . Housing Indexes Calculation of Vibrant City

No.	Housing	Criteria	Indicators	Score
1.	Availability	Housing Style/ Shape	Land houses	
			Tall houses/ apartment/ loft/condominium,	2
			Mixed houses	
			Compact/tiny/ small house,	
			Mobile houses/ temporary houses.	
		Quality of Housing Facade	Singular roof	
			Coupling house	2
			Mixed houses	
			Others	
		Quality of Housing Material	Heavy material (brick/ concrete),	
			Light material (wooded),	
			Temporary material	1
		Housing Dimension	More than 36 m2 (2 BR)	
			Minimum 36 m2	2
			21 m2 for the lower class	
			Studio living < 18 m2),	
		Design of Environment	Water, solar, electricity, road,landscaping, internet	
			Water, solar, electricity, road,	2
			Water, solar,	
			Without water, solar, road, electricity, landscaping, internet	
2.	Accessibility	To physical facilities	Plain/ landed	
			Near river, sea or lake	2
			Hill/ mountains/ canyons	
			Not accessible	
3	Affordability	Housing Provider	Private housing	
			Official resident	
			Subsidiary government (housingbacklog),	2
			Inheritance house	
			NGO grant/ Aid	
		Speciality Housing	Housing for disabilities	
			Housing for Elderly	
			Monastery housing	2
			Priest housing	
			Moslem housing/ *pesantren*	
4.	Proximity	Neighbour relationship	Mixed use area/ superblock area	
			Service apartment/ cluster	
			General residential	
			Near to TOD	2
			Housing villa	
			Without neighbourhood	
Total Score				18

Table 4. Housing Indexes Calculation of Wonderful City

No.	Housing	Criteria	Indicators	Score
1.	Availability	Housing Style/ Shape	Land houses	3
			Tall houses/ apartment/ loft/condominium,	
			Mixed houses	
			Compact/tiny/ small house,	
			Mobile houses/ temporary houses.	
		Quality of Housing Facade	Singular roof	3
			Coupling house	
			Mixed houses	
			Others	
		Quality of Housing Material	Heavy material (brick/ concrete),	3
			Light material (wooded),	
			Temporary material	
		Housing Dimension	More than 36 m2 (2 BR)	3
			Minimum 36 m2	
			21 m2 for the lower class	
			Studio living < 18 m2),	
		Design of Environment	Water, solar, electricity, road,landscaping, internet	3
			Water, solar, electricity, road,	
			Water, solar,	
			Without water, solar, road, electricity, landscaping, internet	
2.	Accessibility	To physical facilities	Plain/ landed	3
			Near river, sea or lake	
			Hill/ mountains/ canyons	
			Not accessible	
3	Affordability	Housing Provider	Private housing	3
			Official resident	
			Subsidiary government (housingbacklog),	2
			Inheritance house	
			NGO grant/ Aid	
		Speciality Housing	Housing for disabilities	3
			Housing for Elderly	
			Monastery housing	
			Priest housing	
			Moslem housing/ *pesantren*	
4.	Proximity	Neighbour relationship	Mixed use area/ superblock area	3
			Service apartment/ cluster	
			General residential	
			Near to TOD	
			Housing villa	
			Without neighbourhood	
Total Score				27

From the calculation above, we can say that the interpretations of

1. Sunny City is Beginner
2. Vibrant City is Intermediate
3. Wonderful City is Advance

Radar Chart Assessment

1. Radar Chart of Housing Index of Sunny City

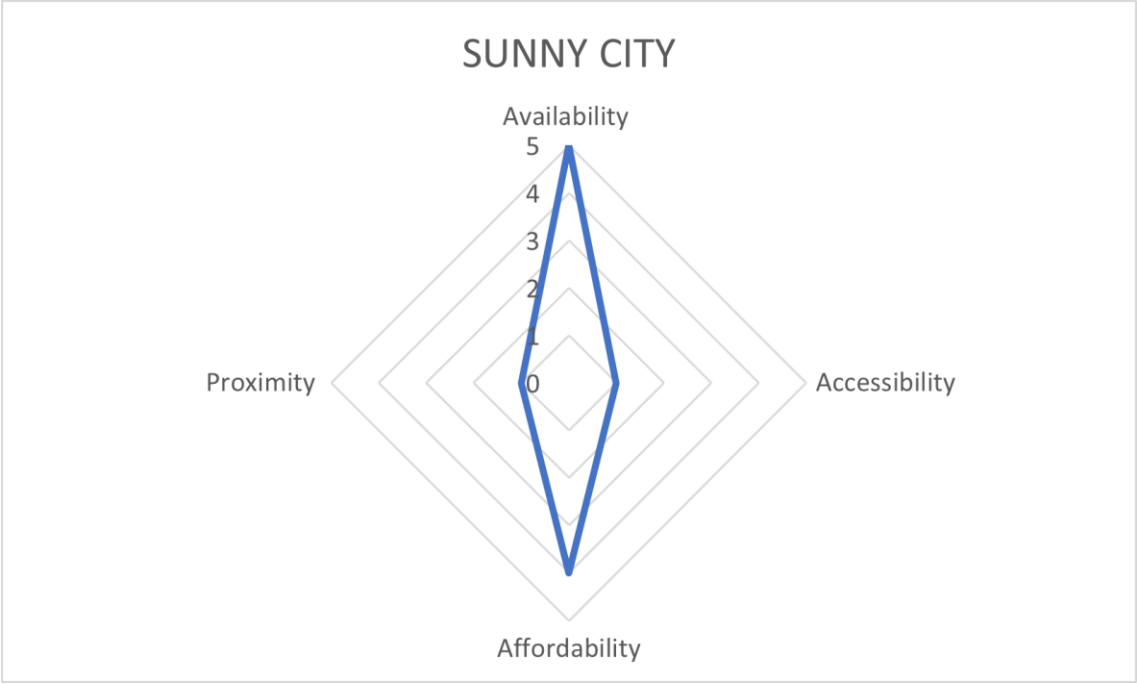

Diagram 1. Radar Chart of Housing Index of Sunny City

2. Radar Chart of Housing Index of Vibrant City

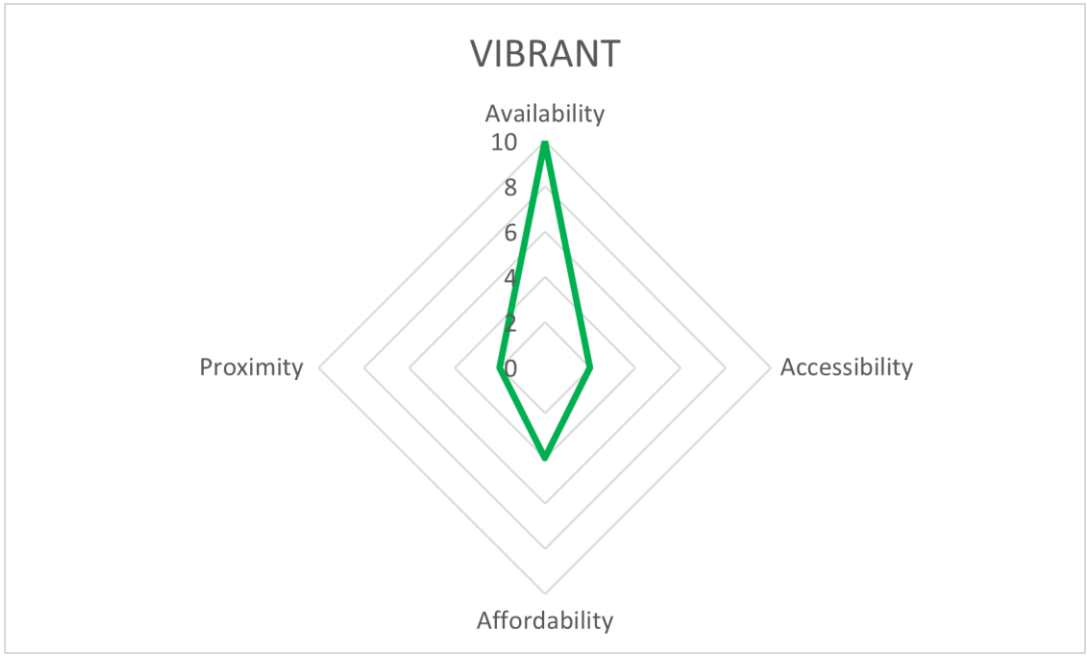

Diagram 2.. Radar Chart of Housing Index of Vibrant City

3. Radar Chart of Housing Index of Wonderful City

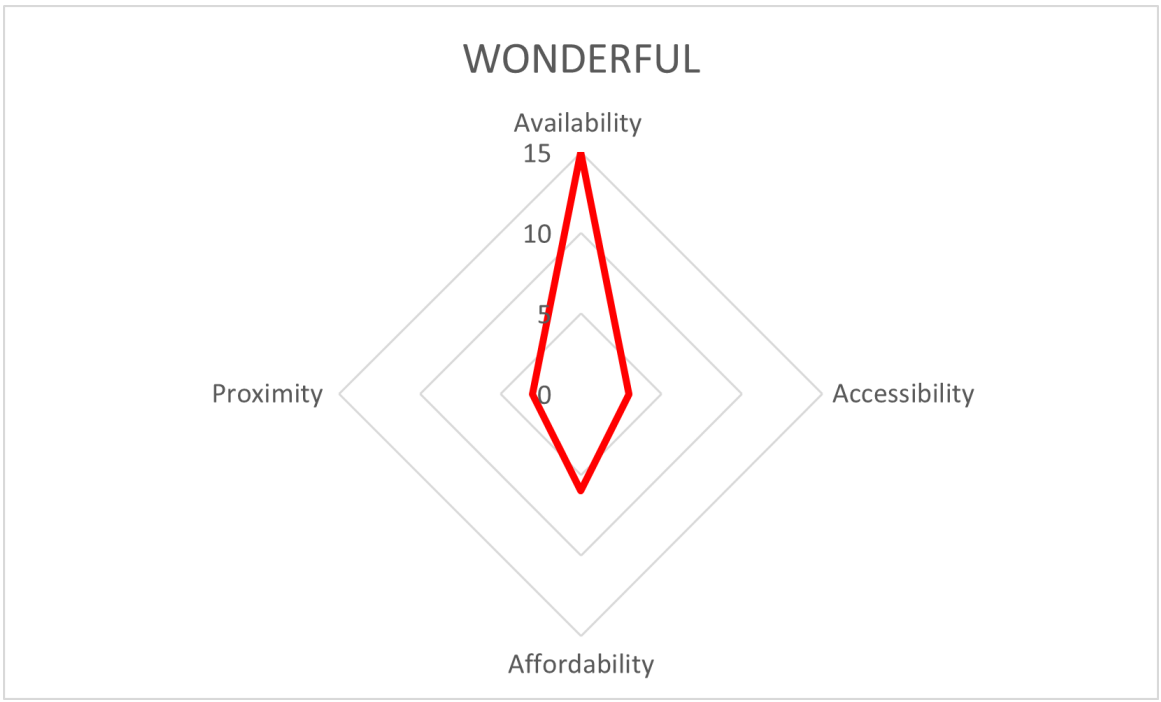

Diagram 3. Radar Chart of Housing Index of Wonderful City

4. Comparison of All City Index

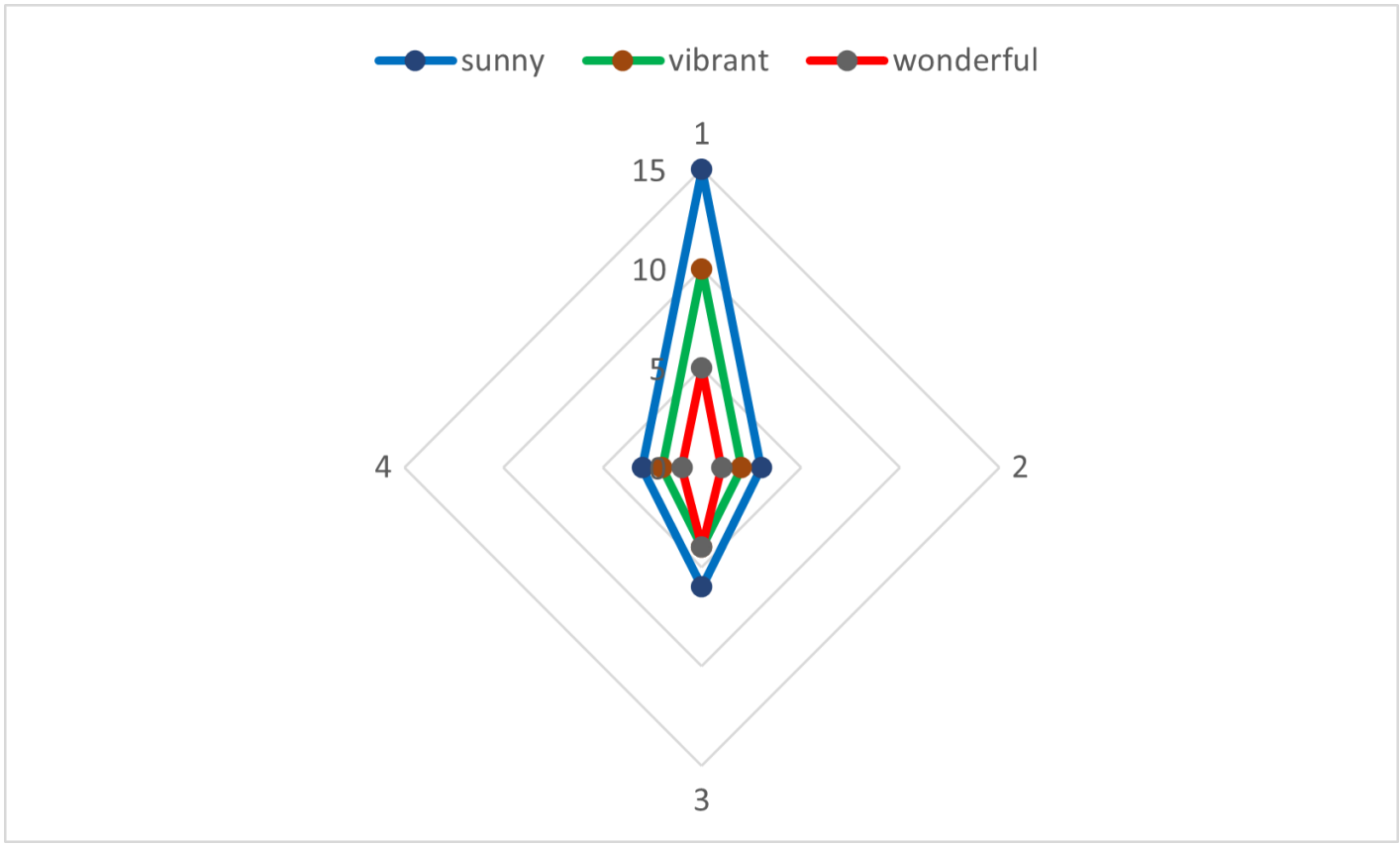

Diagram 4. Radar Chart Collage of Housing Index of 3 Cities : Sunny City, Vibrant City, and Wonderful City

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3.2 Public Transportation Index by Lin Yola

Concept of Public Transportation in Livable City Context

City is a living organism. In planning and designing a livable city, it requires a holistic urban system of equity, participation and accessibility. Technically, the city dwellers need to experience the quality of life through the access to infrastructures and amenities, as well as their participation on the decision making. Among the critical infrastructure is transportation. A livable city serves a comfortable, safe, inclusive and accessible transportation system. The increase of city population's mobility causes massive city issues such as traffic congestion, pollution, poor public health, low productivity and high energy demand. This issue calls for an urgent strategic solution for an effective transportation management system especially public transportation services to encourage the livability of the city. Good plan of public transport systems is a crucial to livability of a city, and the holistic approach integrates the public transportation system into the planning of the livable city.

3.2.1 Criteria and Indicator of Livable City

Public Transportation Index

Urban transportation consists of private, for-hire and public transportation. Public transportation or mass transportation services is a solution to the city issues of private vehicle dependence, imbalance of road infrastructures and traffic volumes, environmental degradation and relocation or far distances of commercial and service land use to residence area. In achieving livable city, public transportation requires a good service to the needs of city dwellers on city mobility. The followings are the criteria and indicators of public transportation index in a livablecity.

1. Criteria and Measurement System
   a. Transit System

      Urban Transit Systems are needed to make high-density of diverse urban activities, such as housings, commercials, working places, social service facilities, recreational, etc. The transit system includes (each carries onescore)

      - Street Transit; includes buses, trolleybuses and street cars
      - Semi Rapid Transit; includes Light Rail Transit (LRT) and Bus
      - Rapid Transit; includes Rail Rapid Transit (RRT), Metro systems; Rubber-Tired Rapid Transit (RTRT), Light Rail Rapid Transit (LRRT), Automated Guided Transit (AGT) and Monorails.

b. Interconnected and Accessible System
   Connectivity and accessibility are the key to an effective public transport. They present the possibility of interaction of transportation nodes and network. Connectivity and accessibility from origin to destination among different urban land uses through different transportation modes by all layers of urban dwellers are the target in this index. In average, the dense city center requires access to a public transport stop within 500 metres walking distance.
c. Public Transport Frequencies
   The number of trips in dense cities indicates the demand and management of public transportation in city area. In average, half of the population could access to at least 50 departures an hour of weekdays and office hours.
d. Vehicle speed
   The information of the vehicle speed is required for estimation of the scheduled trip. The average bus speed in the average population is around 14.5 km/h, while for sub-urban rail at 52.7 km/h and contributing 1.0 vkm/inhabitant.
e. Trip Duration
   The trip duration from all origins to destinations in the urban centre defines the effective public transport management. A 45-minute journey for a distance of 11.25 km is realistic for a trip in large city.
f. Scheduling System
   The good public transportation system provides clear, informative, and transparent schedules. The good pubic transportation system provides a well-managed schedules for passengers, particularly on the transit waiting time. The appropriate transit waiting time is around ≤ 10 minutes, while ≥ 20 minutes considered as in effective transit waiting time.

2. Walkability
   The good public transportation system provides options for pedestrians, either for passengers without vehicles or passengers who walk from parking area or walking from one node to other nodes of transportation nodes.
   a. Comfortability
      The public transportation provides facilities for pedestrians to walk from one node to another nodes. The facilities serve the pedestrians to walk comfortably such as resting

or stopping area, pedestrian signages, recreational facilities, zebra cross or pedestrian bridge, greening area, information center, etc.

b. Safety
Providing facilities for protection from weather, barriers of walking area with vehicle lanes, surveillance services, good lightings, emergency alert facilities, security facilities, etc for pedestrians.

c. Accessibility
The public transportation system should be able to provide accessibility to pedestrians from the connected pathways, transit, bus stops, or one node to other nodes

d. Inclusivity
The considerations to accommodates pedestrians, cyclists, and special needs (kids, elderly, disable pedestrians and pedestrians on wheels). This consideration includes the proper zone division, facilities etc.

3. Technology Applications
Technology applications and digital solutions plays major role in achieving urban smart mobility, effective and efficient transportation management,and better passenger services.

a. Intelliegent Transport Services
Real-time data collection using smart technologies to provide real-time network performance big data and offers information on traffic, public transport status, parking availability, etc. The ITS provides informative database for transport managers and passengers

b. Security System
The public transportation provides full safety and security to all staffs and passengers through the installations of advanced surveillance andoperation systems.

c. Digital Ticketing and Face System
Implementation of digital information on tickets and machinery or online payment systems in public transportation that allow for prepayment and faster boarding. The digital ticketing and fare system offers convenience, effectivity and efficiency of travel. This system also creates better and effective publictransport management.

d. Traffic Modeling and Simulation
The big data information of urban transportation could be more advance and effective if the passengers are welcome to get involve in contributing to the traffic data, such us traffic accident, traffic congestion, faulty infrastructure, etc. Social media could also be platform of implementing this purpose.

4. Environmental Consideration
   a. Sustainable Energy Consumption
      Public transportation system should priorities the energy efficiency, renewable energy, and technology application for low energy demand vehicles. The fuel efficiency standard is ≥ 25.4 (km/L)
   b. Low Carbon Emission
      The vehicle should also generate low carbon emission for reducing the pollution, environmental degradation, and better urban public health. The standard is NOx≤ 4.5 g/kWh, PM ≤ 0.25 g/kWh), CO_2 ≤ 95g per km for cars.
5. Partnership and Participatory Approach
   a. Promoting the Partnership among cross stakeholders in planning and implementation stages is crucial for forming resilience and sustainablepublic transportation. Partnership includes;
      - Public sector; federal, state, city, and regional authorities.
      - Institutional parties; such as universities and hospitals
      - Private sector; businesses players.
      - Community; residents and neighborhood organizations.
   b. Participatory approach, involving feedbacks from users or passengers on the public transport performance. This process would contribute the significant improvement of the services during the evaluation process

6. Planning, Management, and Policies
   a. Incorporating transport planning into urban planning process
      The livability vision and mission of transport into the urban planning process can help define projection of a transportation need or problem. Furthermore, collaborated and holistic planning stage could also support local authorities to plan for a high quality and long-term public transportation planning and policies to foster the local economic development, as the urban mobility is one of the important keys to the economic and physical development forces.
   b. Facilities Maintenance
      The well managed facilities maintenance plays major role in a sustainable transportation system, resilience public transportation planning, and good authority's maintenance on the public amenities.

c. Traffic Policies

Traffic policies is important in managing the traffic issues, encouragement to use public transportation, city mobility, and effective transportation management. The policies basically focus on the Restraints on car access to the CBD, which include Public Transport Pricing, and Parking Fees. A good traffic policy offers fare-free public transport (FFPT) however USD2 for the price of a single ticket for public transport for a trip of around 10 kilometers distance. For the parking rate, averagely charges USD10 per day.

3.2.2 City Livability Indexes Infrastructure Indexes

Public Transportation Index is mapped as follow;

Table 5. Public Transportation Index Table Form Sheet

Public Transportation	Criteria	Indicators	Score
System	Transit System	Availability of Street Transit	1
		Unavailability of buses	0
		Availability of Semi Transit	1
		Unavailability of LRT	0
		Availability of Rapid Transit	1
		Unavailability of RRT or monorail	0
	Interconnected and AccessibleSystem	< 500 meters walking distanceto find public transport stop	2
		500 meters walking distance to find public transport stop	1
		> 1000 meters walkingdistance to find public transport stop	0
	Public Transport Frequencies	half of the population couldaccess more than 50 departures an hour of weekdays and office hours	2
		half of the population could access to 50-25 departures an hour of weekdays and office hours	1

Public Transportation	Criteria	Indicators	Score
		half of the population couldaccess to less than 25 departures an hour of weekdays and office hours	0
	Vehicle Speed	bus speed > 14.5 km/h, sub- urban rail at > 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inhabitant	2
		bus speed at least 14.5 km/h,sub-urban rail at at least 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inhabitant	1
		bus speed < 14.5 km/h, sub- urban rail at < 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inhabitant	0
	Trip Duration	A ≤ 30-minute journey for a distance of ≤ 11.25 km	2
		A 45-minute journey for a distance of 11.25 km	1
		A ≥ 1 hour journey for a distance of ≥ 11.25 km	0
	Scheduling System	Availability of clear and informative schedule	2
		Schedule available but not well managed	1
		≤ 10 minutes transit waiting time	2
		15 minutes transit waiting time	1
		≥ 20 minutes transit waiting time	0
Walkability	Comfortability	≥ 80%	2
		80% - 40%	1
		≤ 40%	0
	Safety	Providing facilities for	1

Public Transportation	Criteria	Indicators	Score
		protection	
		No facilities for protection provided	0
	Accessibility	≥ 80%	2
		80% - 40%	1
		≤ 40%	0
	Inclusivity	≥ 80%	2
		80% - 40%	1
		≤ 40%	0
Technology Application	Intelligent Transportation System	≥ 80%	1
		≤ 80%	0
	Security System	Installation of surveillance system radius 10m	1
		Installation of surveillance system radius ≥ 10m	0
	Digital Ticketing and Fare System	Availability of Digital Ticketing and Fare System	2
		Ticketing and Fare Available but in Non-Digital System	1
	Traffic Modelingand Simulation	Digital traffic information contributed by both managers and passengers	2
		Digital traffic information contributed by managers only	1
Environmental Consideration	Sustainable energy consumption	Fuel efficiency ≥ 25.4 (km/L)	1
		Fuel efficiency ≤ 25.4 (km/L)	0
	Low Carbon Emission	NOx ≤ 4.5 g/kWh, PM ≤ 0.25 g/kWh), CO2 ≤ 95g per km	1
		NOx ≥ 4.5 g/kWh, PM ≥ 0.25 g/kWh), CO2 ≥ 95g per km	0
Partnership and	Promoting Partnerships	Partnership with Public sectorand Institutional parties	1

Public Transportation	Criteria	Indicators	Score
Participatory Approach		No partnership with public sector and Institutional parties	0
		Partnership with Private sector	1
		No partnership with Private sector	0
		Partnership with Community	1
		No partnership with Community	0
	Participatory Approach	Availability of Passengers' feedback for evaluation	1
		Unavailability of Passengers' feedback for evaluation	0
Planning, Management, and Policies	Incorporating transport planning into urban planning process	Available	1
		Not available	0
	Facilities Maintenance	Regular (daily)	2
		Not well maintained (weekly or more)	1
		Irregular	0
	Traffic Policies	fare-free public transport (FFPT)	2
		Public Transport Pricing of ≤ USD2	1
		Public Transport Pricing of ≥ USD2	0
		Parking Fees of USD ≥ USD10 fixed rate per day	2
		Parking Fees of USD 8-10 fixed rate per day	1
		Parking Fees of ≤ USD 8 fixed rate per day	0

7. Quantify interpretation of each index into score:

a. Beginner Score: 0
b. Intermediate score: 1
c. Advance score: 2

8. Sum all scores of indexes
   a. Minimum Score: 41
   b. Maximum Score: 0
9. Final interpretation from the total score using these ranges:
   a. Beginner: 0-21
   b. Intermediate: 22-31
   c. Advance: 32- 41

Calculation of Public Transportation Indexes 3 Case Study Cities

1. Sunny City

Table 6 Public Transportation Indexes Calculation of Sunny City

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
System	Transit System	Availability of Street Transit	Street transit Available	1
		Unavailability of Buses		0
		Availability of Semi Transit	Semi transit Available	1
		Unavailability of LRT		0
		Availability of Rapid Transit	Rapid transit Available	1
		Unavailability of RRT or monorail		0

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
	Interconnected and Accessible System	< 500 meters walking distanceto find public Transport stop	400 meters walking distance to find public Transport stop	2
		500 meters walking distanceto find public Transport stop		0
		> 1000 meters walking distanceto find public Transport stop		0
	Public Transport Frequencies	Half of the population could access more than 50 departures an hour of weekdays And office hours	Half of the population could access to 60 departures an hour of weekdays And office hours	2
		Half of the population could access to 50-25 departures an hour of weekdays And office hours		0
		Half of the Population could		0
		Access to less than 25 departures an hour of weekdays And office hours		

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
	Vehicle Speed	Bus speed > 14.5 km/h, sub-urban rail at > 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha Bitant	Bus speed 20 km/h, sub-urban rail at > 60 km/h and contributing 1.0 vkm (vehicle kilometres)/inha bitant	2
		Bus speed at least 14.5 km/h,sub-urban rail atat least 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha Bitant		0
		Bus speed < 14.5 km/h, sub-urban rail at < 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha Bitant		0
	Trip Duration	A ≤ 30-minute journey for a distance of ≤1 1.25 km	25-minute journey for a distance of ≤ 10 Km	2
		A 45-minute journey for a distance of 11.25 Km		0
		A ≥ 1 hour journey for adistance of ≥		0

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
		11.25 km		
	Scheduling System	Availability of clear and informative Schedule	Clear and informative schedule Available	2
		Schedule available but not Well managed		0
		≤ 10 minutes Transit waitingtime	6 minutes transit waiting time	2
		15 minutes transit waiting Time		0
		≥ 20 minutes Transit waiting time		0
Walkability	Comfortability	≥ 80%	90%	2
		79% - 40%		0
		≤ 39%		0
	Safety	Facilities for Protection ≥ 80%	80%	1
		Facilities for Protection ≤ 79%		0
	Accessibility	≥ 80%	90%	2
		79% - 40%		0
		≤ 39%		0
	Inclusivity	≥ 80%	90%	2
		79% - 40%		0
		≤ 39%		0
Technology	Intelligent	≥ 80%		1

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
Application	Transportation System	≤ 79%		0
	Security System	Installation of surveillance system radius 10m	Radius 8 m	1
		Installation of surveillance system radius 10m		0
	Digital Ticketing and Fare System	Availability of Digital Ticketing And Fare System	Digital Ticketing and Fare System Available	2
		Ticketing and Fare Available but in Non-Digital System		0
	Traffic Modelingand Simulation	Digital traffic information contributed by both managers And passengers	Digital traffic information contributed by both managers And passengers	2
		Digital traffic information contributed by Managers only		0
Environmental Consideration	Sustainable energy consumption	Fuel efficiency ≥ 25.4 (km/L)	26 (km/L)	1
		Fuel efficiency ≤ 25 (km/L)		0
	Low Carbon Emission	NOx ≤ 4.5 g/kwh, PM ≤ 0.25g/kwh), CO2 ≤ 95g per km	NOx 4 g/kwh, PM 0.20 g/kwh), CO2 90g per km	1

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
		NOx ≥ 4.5 g/kwh, PM ≥ 0.25g/kwh), CO_2 ≥ 95g per km		0
Partnership and Participatory Approach	Promoting Partnerships	Partnership with Public sector and Institutional parties	Partnership available	1
		No partnershipwith public sector and Institutional Parties		0
		Partnership with Private sector	Partnership Available	1
		No partnershipwith Private Sector		0
		Partnership with Community	Partnership Available	1
		No partnership With Community		0
	Participatory Approach	Availability of Passengers' feedback for Evaluation	Feedback available	1
		Unavailability of Passengers' feedback for Evaluation		0
Planning, Management, and Policies	Incorporating transport planning into urban planning process	Incorporating planning	Incorporated	1
		Discorporate Planning		0

Public Transportation	Criteria	Indicators	Sample Measurement	Sunny Score
	Facilities Maintenance	Regular (daily)	Daily	2
		Not well maintained (weekly or more)		0
		Irregular		0
	Traffic Policies	Fare-free public Transport (ffpt)		0
		Public transport Pricing of ≤ usd2	Usd2	1
		Public transport Pricing of ≥ usd2		0
		Parking Fees of USD ≥ USD10 Fixed rate perday		0
		Parking Fees of USD 8-10 fixed Rate per day	USD9 fixed rate per day	1
		Parking Fees of ≤ USD 8 fixed rate per day		0
Total				39

2. Vibrant City

Table 7. Public Transportation Indexes Calculation of Vibrant City

Public Transportation	Criteria	Indicators	Sample Measurement	Vibrant Score
System	Transit System	Availability of Street Transit	Street Transit Available	1
		Unavailability of Buses		0
		Availability of Semi Transit	Semi Transit Available	1
		Unavailability of LRT		0
		Availability of Rapid Transit	Rapid Transit Available	1
		Unavailability of RRT or monorail		0
	Interconnected and Accessible System	< 500 meters walking distanceto find public transport stop		0
		500 meters walking distanceto find public transport stop	500 meters walking distanceto find public Transport stop	1
		> 1000 meters walking distance to find public transport stop		0

Public Transportation	Criteria	Indicators	Sample Measurement	Vibrant Score
	Public Transport Frequencies	Half of the population could access more than 50 departures an hour of weekdays And office hours		0
		Half of the population could access to 50-25 departures an hour of weekdays and office hours	Half of the population could access to 45 departures an hour of weekdays and office hours	1
		Half of the population could access to less than 25 departures an hour of weekdays And office hours		0
	Vehicle Speed	Bus speed > 14.5 km/h, sub-urban rail at > 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha Bitant		0
		Bus speed at least 14.5 km/h,sub-urban rail atat least 52.7 km/h and contributing 1.0 vkm (vehicle	Bus speed 14.5 km/h, sub-urban rail at > 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha	1

Public Transportation	Criteria	Indicators	Sample Measurement	Vibrant Score
		kilometres)/inha Bitant	bitant	
		Bus speed < 14.5 km/h, sub-urban rail at < 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha Bitant		0
	Trip Duration	A ≤ 30-minute journey for a distance of ≤ 11.25km		0
		A 45-minute journey for a distance of 11.25 km	30-minute journey for a distance of ≤ 11 km	1
		A 1 hour journey for a distance of 11.25 km		0
	Scheduling System	Availability ofclear and informative Schedule		0
		Schedule available but not well managed	Not well managed	1
		≤ 10 minutes transit waiting time		0
		15 minutes transit waiting time	15 minutes Transit waiting time	1
		≥ 20 minutes transit waiting time		0

Public Transportation	Criteria	Indicators	Sample Measurement	Vibrant Score
Walkability	Comfortability	≥ 80%		0
		79% - 40%	70%	1
		≤ 39%		0
	Safety	Facilities for protection ≥ 80%	80%	1
		Facilities for Protection ≤ 79%		0
	Accessibility	≥ 80%		0
		79% - 40%	75%	1
		≤ 39%		0
	Inclusivity	≥ 80%		0
		79% - 40%	75%	1
		≤ 39%		0
Technology application	Intelligent transportat on System	≥ 80%		0
		≤ 79%	50%	0
	Security System	Installation of surveillance system radius 10m		0
		Installation of surveillance system radius 10m	Radius 15 m	0
	Digital Ticketing and Fare System	Availability of Digital Ticketing And Fare System		0
		Ticketing and Fare Available but in Non – Digital System	Non-Digital System	1
	Traffic Modelingand Simulation	Digital traffic information contributed byboth	Digital traffic information contributed by	2

Public Transportation	Criteria	Indicators	Sample Measurement	Vibrant Score
		managers And passengers	both managers And passengers	
		Digital traffic information contributed by Managers only		0
Environmental Consideration	Sustainable energy Consumption	Fuel efficiency ≥ 25.4 (km/L)	26 (km/L)	1
		Fuel efficiency ≤ 25 (km/L)		0
	Low Carbon Emission	NOx ≤ 4.5 g/kwh, PM ≤ 0.25g/kwh), CO_2 ≤ 95g per km	NOx 4 g/kwh, PM 0.20 g/kwh),CO_2 90g per km	1
		NOx ≥ 4.5 g/kwh, PM ≥ 0.25g/kwh), CO_2 ≥ 95g per km		0
Partnership and Participatory Approach	Promoting Partnerships	Partnership with Public sector and Institutional parties	Partnership available	1
		No partnership with public sector and Institutional parties		0
		Partnership with Private sector	Partnership Available	1
		No partnership with Privatesector		0
		Partnership with Community		0
		No partnership With Community	No partnership	0
	Participatory Approach	Availability of Passengers'	Feedback available	1

Public Transportation	Criteria	Indicators	Sample Measurement	Vibrant Score
		feedback for Evaluation		
		Unavailability of Passengers' feedback for Evaluation		0
Planning, Management,and Policies	Incorporating transport planning into urban planning Process	Incorporating planning	Incorporating	0
		Discorporate Planning		0
	Facilities Maintenance	Regular (daily)		0
		Not well maintained (weekly or more)	Weekly	1
		Irregular		0
	Traffic Policies	Fare-free public Transport (FFPT)		0
		Public Transport Pricing of ≤ USD2	USD1.5	1
		Public Transport Pricing of ≥ USD2		0
		Parking Fees of USD ≥ USD10		0
		Fixed rate per Day		
		Parking Fees of USD 8-10 fixedrate per day		0
		Parking Fees of ≤ USD 8 fixed rateper day	USD5 fixed rateper day	0
Total				23

3. Wonderful City

Table 8 Public Transportation Indexes Calculation of Wonderful City

Public Transportation	Criteria	Indicators	Sample Measurement	Wonderful Score
System	Transit System	Availability of Street Transit	Street Transit Available	1
		Unavailability of buses		0
		Availability of Semi Transit		0
		Unavailability of LRT	LRT unavailable	0
		Availability of Rapid Transit		0
		Unavailability of RRT or monorail	Monorail unavailable	0
	Interconnected and Accessible System	< 500 meters walking distance to find public transport stop		0
		500 meters walking distance to find public transport stop		0
		> 1000 meters walking distance to find public transport stop	1100 meters walking distance to find public transport stop	0
	Public Transport Frequencies	half of the population could access more than 50 departures an hour of		0

Public Transportation	Criteria	Indicators	Sample Measurement	Wonderful Score
		weekdays and office hours		
		half of the population could access to 50-25 departures an hour of weekdays and office hours		0
		half of the population could access to less than 25 departures an hour of weekdays and office hours	half of the population could access to 22 departures an hour of weekdaysand office hours	0
	Vehicle Speed	bus speed > 14.5km/h, sub-urban rail at > 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha bitant		0
		bus speed at least 14.5 km/h,sub-urban rail atat least 52.7 km/h and contributing 1.0 vkm (vehicle kilometres)/inha bitant	bus speed 14.5 km/h, sub-urban rail at 53 km/h and contributing 1.0 vkm (vehicle kilometres)/inha bitant	1
		bus speed < 14.5km/h, sub-urban rail at < 52.7 km/h and contributing 1.0 vkm (vehicle		0
		kilometres)/inha bitant		
	Trip Duration	A ≤ 30-minutejourney for a distance of ≤ 11.25 km		0
		A 45-minute journey for a distance	30-minute journey	0

Public Transportation	Criteria	Indicators	Sample Measurement	Wonderful Score
		of 11.25km	for a distance of ≤ 11 km	
		A ≥ 1 hour journey for adistance of ≥ 11.25 km	1.1 hour journeyfor a distance of ≥ 11.25 km	0
	SchedulingSystem	Availability ofclear and informative schedule		0
		Schedule available but notwell managed	not well managed	1
		≤ 10 minutes transit waiting time		0
		15 minutes transit waiting time		0
		≥ 20 minutes transit waiting time	20 minutes transit waiting time	0
Walkability	Comfortability	≥ 80%		0
		79% - 40%	70%	1
		≤ 39%		0
	Safety	facilities for protection ≥ 80%		0
		facilities for protection ≤ 79%	70%	0
	Accessibility	≥ 80%		0
		79% - 40%	75%	1
		≤ 39%		0
	Inclusivity	≥ 80%		0
		79% - 40%		0
		≤ 39%	35%	0
TechnologyApplication	Intelligent Transportation System	≥ 80%		0
		≤ 79%	50%	0
	Security System	Installation ofsurveillance system		0

Public Transportation	Criteria	Indicators	Sample Measurement	Wonderful Score
		radius 10m		
		Installation of surveillance system radius ≥ 10m	radius 12 m	0
	Digital Ticketing and Fare System	Availability of Digital Ticketingand Fare System		0
		Ticketing and Fare Available but in Non-Digital System	Non-Digital System	1
	Traffic Modeling and Simulation	Digital traffic information contributed byboth managers and passengers		0
		Digital traffic information contributed by managers only	contributed by managers only	1
Environmental Consideration	Sustainable energy consumption	Fuel efficiency ≥ 25.4 (km/L)		0
		Fuel efficiency ≤ 25 (km/L)	20 (km/L)	0
	Low Carbon Emission	NOx ≤ 4.5 g/kWh, PM ≤ 0.25 g/kWh), CO_2 ≤ 95g per km		0
		NOx ≥ 4.5 g/kWh, PM ≥ 0.25 g/kWh), CO_2 ≥ 95g per km	NOx 5 g/kWh, PM 0.30 g/kWh), CO_2 100g per km	0
Partnership and ParticipatoryApproach	Promoting Partnerships	Partnership with Public sector and Institutional parties	Partnershipavailable	1
		No partnershipwith public sector and Institutional parties		0
		Partnership with Private sector	Partnership available	1
		No partnershipwith Private sector		0

Public Transportation	Criteria	Indicators	Sample Measurement	Wonderful Score
		Partnership with Community	Partnership available	1
		No partnership with Community		0
	Participatory Approach	Availability ofPassengers' feedback for evaluation	Feedback available	1
		Unavailability ofPassengers' feedback for evaluation		0
Planning, Management, and Policies	Incorporating transport planning into urban planning process	Incorporatingplanning		0
		discorporate planning	Not available	0
	Facilities Maintenance	Regular (daily)		0
		Not well maintained (weekly or more)		0
		Irregular	seldom	0
	Traffic Policies	fare-free public transport (FFPT)		0
		Public Transport Pricing of ≤ USD2		0
		Public Transport Pricing of ≥ USD2	USD3	0
		Parking Fees of USD ≥ USD10 fixed rate perday		0
		Parking Fees ofUSD 8-10 fixed rate per day		0
		Parking Fees of ≤ USD 8 fixed rateper day	USD5 fixed rateper day	0
Total				11

Final interpretation from the total score using these ranges:

a. Wonderful City: 11 (Beginner)
b. Vibrant City: 23 (Intermediate)
c. Sunny City: 39 (Advance)

Radar Chart

1. Radar Chart of Sunny City

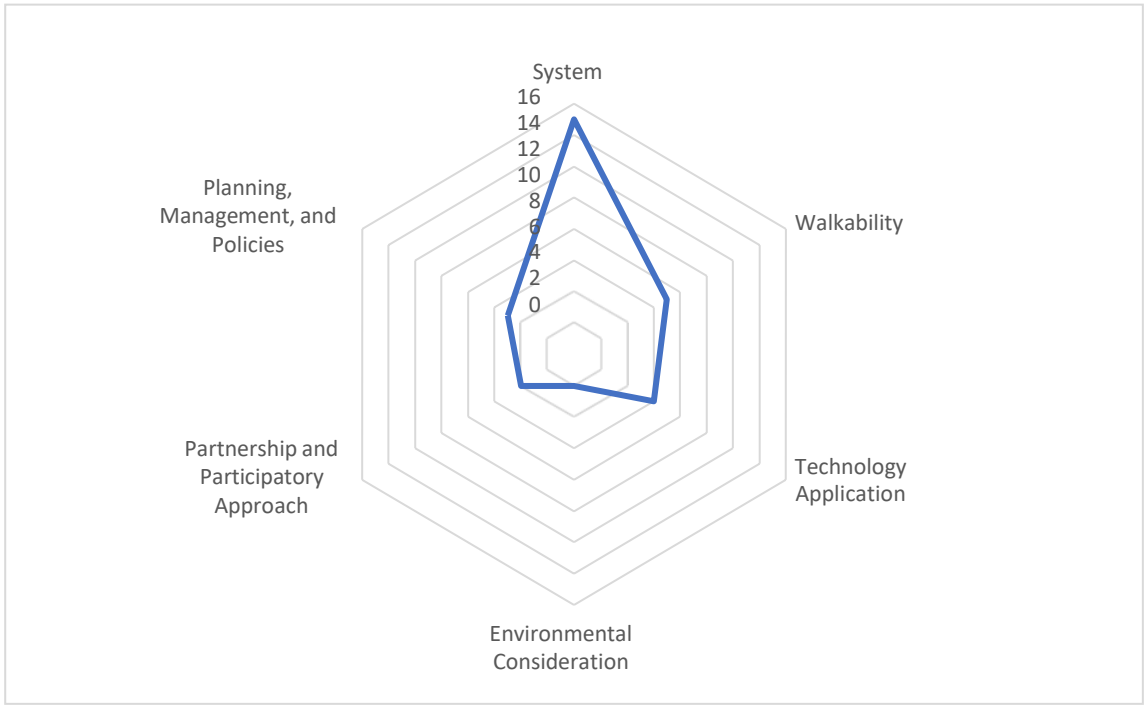

Diagram 5 Public Transportation Indexes in Sunny City

2. Radar Chart of Vibrant City

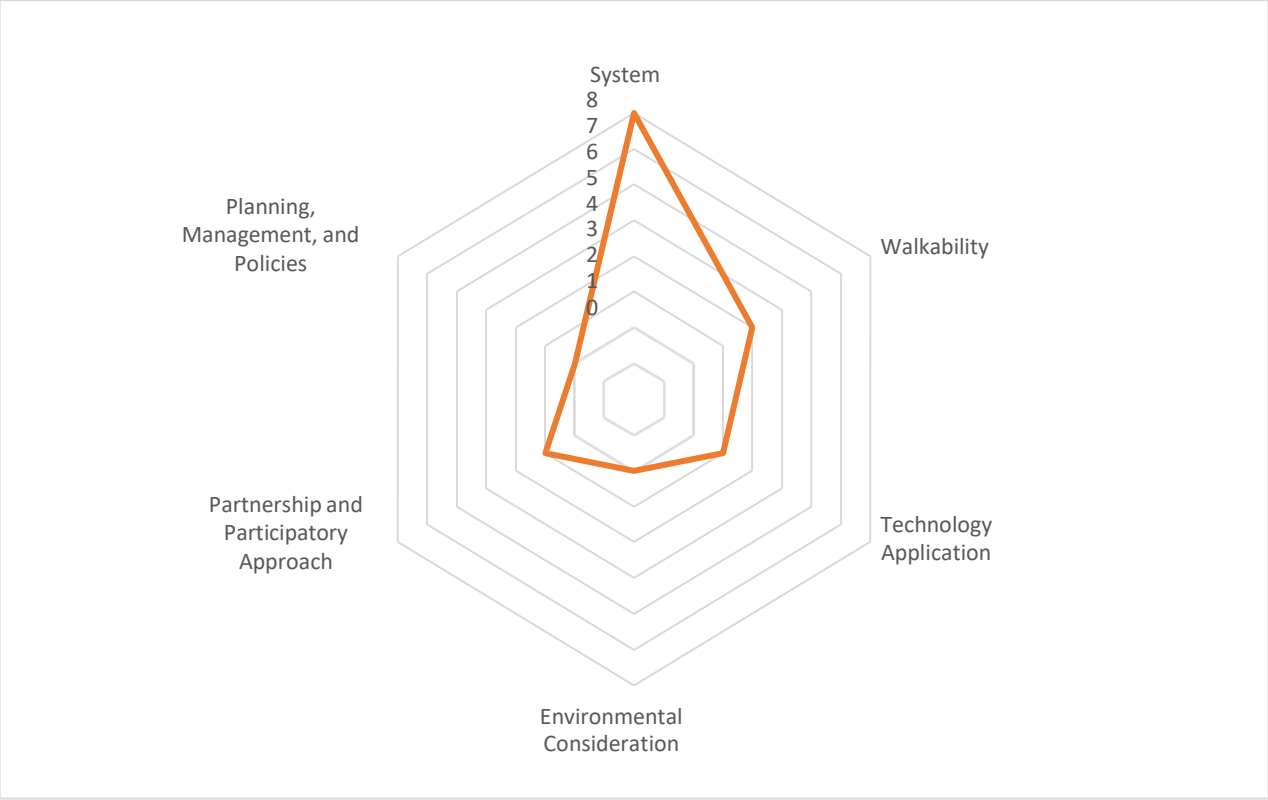

Diagram 6 Public Transportation Indexes in Vibrant City

3. Radar Chart of Woderful City

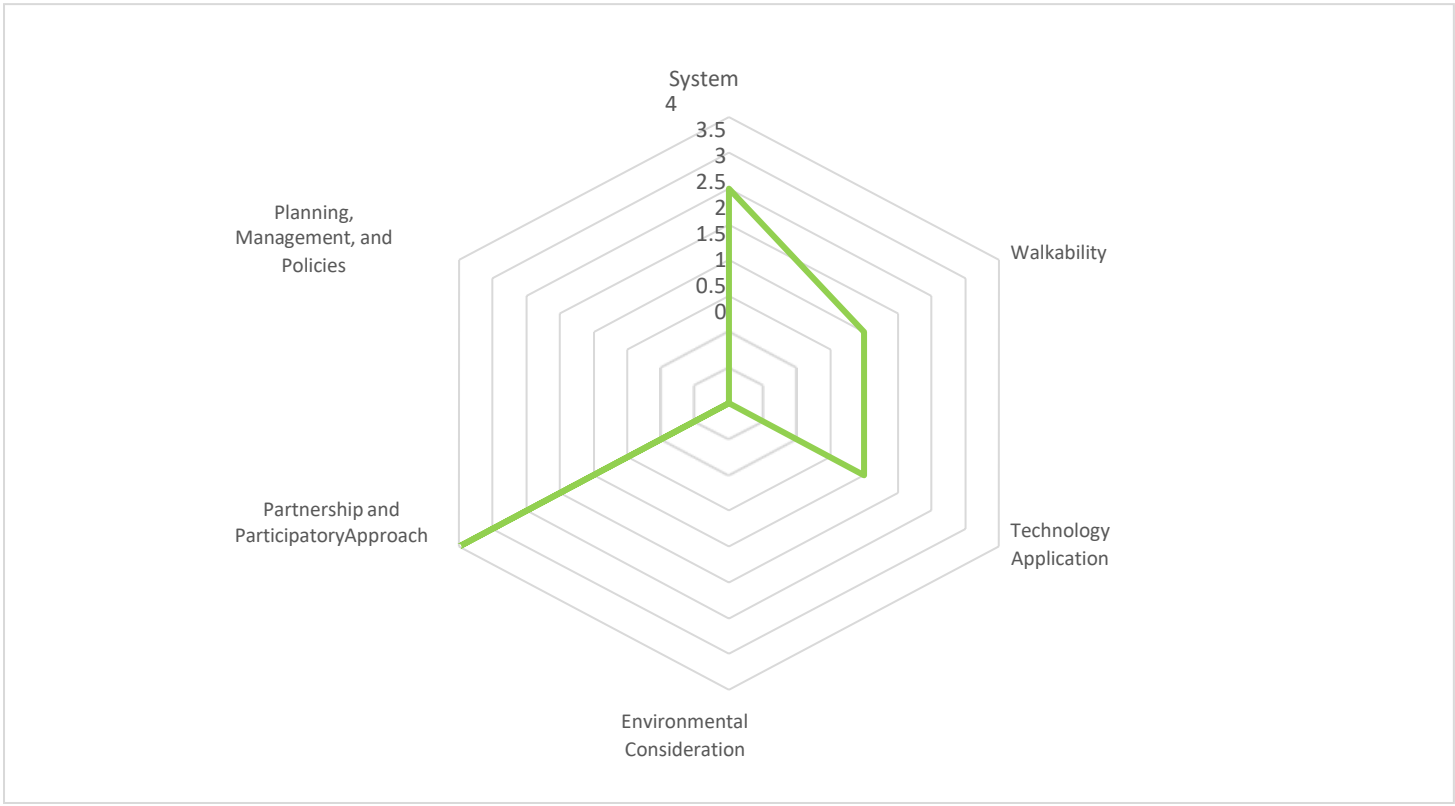

Diagram 7 Public Transportation Indexes in Wonderful City

4. Comparison of All City Indexes

Diagram 8 Public Transportation Index of 3 Cities : Sunny City, Vibrant City, and Wonderful City

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3.3 Waste Management Index by Safirah Binti Yacoob

3.3.1 Definition

Waste is any unwanted or unusable materials which is discarded after primary use, or is worthless, defective and of no use. A by-product by contrast is a joint product of relatively minor economic value. A waste product may become a by-product, joint product or resource through an invention that raises a waste product's value above zero. Examples include municipal solid waste (household trash), landscape waste, construction and demolition(C&D) waste, hazardous waste, wastewater (such as sewage(feces and urine) and waste water from industrial processes), radioactive waste and others.

Waste management Index in this book includes both non-hazardous and hazardous waste in the form of solid and liquid i.e municipal and landscape solid waste, used cooking oil, sewage, hazardous solid and liquid waste and radioactive waste.

3.3.2 Waste Infrastructures based on Output

1. Waste separation at source, Storage and Collection system
2. Materials Recovery Facilities(MRFs)
3. Waste Treatment Facilities
4. Waste Disposal Facilities

3.3.3 Criteria and Indicator of Good Waste Management

1. Waste services and facilities cover all type of waste generation and integrated system
2. Most recyclable materials are separated at source, send to recycling facilities or MRFs and finally send to processing into new products/recycling plant
3. Organic waste is separated and treated (composting, anaerobic digestor, animal feed etc)
4. Minimal public complaints on waste collection and other waste related services
5. Wastes are stored in proper bins prior to collection
6. Waste facilities are sufficient to cater for 100% of waste generated
7. Waste facilities are clean and well maintain and comply to environmental requirements.
8. The effluent/emission discharge and smell from waste facilities do not pollute the surrounding environment.
9. Zero or minimal illegal dumping

Index of Waste Management (Solid Waste and Hazardous Waste)

Table 9 Solid Waste Management Index Table Form Sheet

Solid Waste Management	Criteria	Index	Score
1	Collection service area coverage	100%	3
		80>X<99%	2
		<79%	1
	No collection service		0
2	Waste generation rate per capita (Kg/day/capita)	<1.1 kg/cap/day	3
		1.2<X<2.5 kg/cap/day	2
		>2.6 kg/cap/day	1
3	Recycling rate Percentage of waste being Recycled from total waste generation	>30%	3
		15%<X<29%	2
		<14%	1
	No recycling		0
4	Waste to energy Percentage of waste being treated for energy conversion (WTE, AD or other treatment technology)	>30%	3
		15%<X<29%	2
		<14%	1
	No waste to energy		0
5	Waste dispose at landfill	<20%	3
	Percentage of waste being disposed at landfill	21%<X<40%	2
		>41%	1
	100 % landfill		0
6	Organic waste composting or other treatment (animal feed)	>20%	3
		11%<X<19%	2
		<10%	1
	Zero composting facility		0
7	Illegal dumping	<1%	3
	Percentage of waste being illegally dumped compared to total waste	5%<X<2%	2
	collected	>6%	1

Solid Waste Management	Criteria	Index	Score
8	Registered waste facilities comply To DOE requirements	100% comply	3
		80%<X<99%	2
		<80%	1
	Most waste facilities do not comply to environmental requirements		0
9	Total Public Complaints per day	<10 per day	3
	On waste collection and other	11<X<29 per day	2
	Related to waste services	>30 per day	1
10	Bins provision	100 %	3
	Random pick 10 premises	90%<X<99%	2
	(mixed)	<90%	1

Table 10 Hazardous Waste Management Index Table Form Sheet

Hazardous Waste Management	Criteria	Index	Score
1	Collection service area coverage	100%	3
		70>X<99%	2
		<70%	1
	No collection service		0
2	Recycling rate Percentage of waste being Recycled from total waste generation	>20%	3
		5%<X<20%	2
		<5%	1
	No recycling		0
3	Waste to energy Percentage of waste being treated for energy conversion	>20%	3
		5%<X<20%	2
		<5%	1

Hazardous Waste Management	Criteria	Index	Score
	No waste to energy		0
4	Waste dispose at landfill Percentage of waste being disposed at approved hazardous waste landfill	<20%	3
		21%<X<40%	2
		>41%	1
	100 % landfill / no proper landfill		0
5	Illegal dumping	<1%	3
	Percentage of waste being illegally dumped compared to total waste	5%<X<2%	2
	Collected	>6%	1
6	Registered waste facilities comply to DOE requirements	100% comply	3
		70%<X<99%	2
		<70%	1
	Most waste facilities do not comply to environmental requirements		0

The scoring can be classified as follows:

1. Lowest score is 5 for solid waste and 2 for hazardous waste
2. Highest score is 30 for solid waste and 18 for hazardous waste
3. A city having total score of 5 – 10 for solid waste and 2- 6 for hazardous waste is considered as Beginner
4. A city having total score of 11 – 19 for solid waste and 7-12 for hazardous waste is considered as Intermediate
5. A city having total score of $\geq$ 20 for solid waste and $\geq$ 13 is considered as Advance

3.3.4 Calculation of All Indexes

1. Sum all indexes (solid waste and hazardous waste)

Table 11 City Classification According to Waste Management Index

No.	Score for Solid Waste	Score for Hazardous waste	Total Score	City Classification
1	5-10	2-6	7-16	Beginner Sunny City
2	11-19	7-12	18-32	Intermediate Vibrant City
3	More than or equal to 20	More than or equal to 13	More than or equal to 33	Advance Wonderful

2. A city having score of 7 -16 is considered Beginner
3. A city having score of 18-31 is considered Intermediate
4. A city having score of more than 33 is considered Advance

EXAMPLES OF CALCULATION

Table 12 Examples of Solid Waste Managemet Index Calculation

No	Solid Waste Criteria	Index	Score	Sunny City	Vibrant City	Wonderful City
1	Collection service area coverage	100%	3			3
		80>X<99%	2		2	
		<79%	1	1		
	No collection service		0			
2	Waste generation rate per capita (Kg/capita/day)	<1.1	3			3
		1.2<X<2.5	2		2	
		>2.6	1	1		
3	Recycling rate	>30%	3			3
	Percentage of	15%<X<29%	2		2	

No	Solid Waste Criteria	Index	Score	Sunny City	Vibrant City	Wonderful City
	waste being Recycled from					
	total waste generation	<14%	1	1		
	No recycling		0			
4	Waste to energy	>30%	3			3
	Percentage of waste being treated for energy conversion (WTE, AD or	15%<X<29%	2			
	other treatment technology)	<14%	1		1	
	No waste to energy		0	0		
5	Waste dispose at landfill	<30%	3			3
	Percentage of waste	29%<X<79%	2		2	
	being disposed at landfill	>80%	1			
	100 % landfill		0	0		
6	Organic waste	>20%	3			3
	composting or other	11%<X<19%	2			
	treatment (animal feed)	<10%	1		1	
	Zero composting facility		0	0		
7	Illegal dumping	<1%	3			3
	Percentage of waste being illegally dumped compared to total waste collected	5%<X<2%	2		2	
		>6%	1	1		
	Illegal dumps		0			

No	Solid Waste Criteria	Index	Score	Sunny City	Vibrant City	Wonderful City
	observed at many places along the road side					
8	Registered waste facilities comply	100% comply	3			3
	To DOE requirements	80%<X<99%	2		2	
		<80%	1	1		
	No registered waste facility		0			
9	Total Public Complaints per day	<10 per day	3			3
	On waste collection and other	11<X<29 per day	2		2	
	Related to waste services	>30 per day	1			
	No channel for public complaints		0	0		
10	Bins provision	100 %	3			3
	Random pick 10 premises	90%<X<99%	2		2	
	(mixed)	<90%	1	1		
	Bins are hardly seen		0			
Sub- total 1				**6**	**18**	**30**

Table 13 Examples of Hazardous Waste Managemet Index Calculation

Hazardous Waste Management	Criteria	Index	Score	Sunny City	Vibrant City	Wonderful City
1	Collection service area coverage	100%	3			3
		70>X<99%	2		2	
		<70%	1	1		
	No collection service		0			
2	Recycling rate Percentage of waste being Recycled from total waste generation	>20%	3			3
		5%<X<20%	2		2	
		<5%	1			
	No recycling		0	0		
3	Waste to energy	>20%	3			2
	Percentage of waste being treated for energy conversion	5%<X<20%	2			
		<5%	1	1	1	
	No waste to energy		0			
4	Waste dispose at landfill Percentage of waste being disposed at approved hazardous waste landfill	<20%	3			
		21%<X<40%	2			2
		>41%	1		1	
	100 % landfill / no proper landfill		0	0		
5	Illegal	<1%	3			3

Hazardous Waste Management	Criteria	Index	Score	Sunny City	Vibrant City	Wonderful City
	dumping					
	Percentage of waste being illegally dumped compared to total waste	5%<X<2%	2		2	
	collected	>6%	1	1		
6	Registered waste facilities comply to DOE requirements	100% comply	3			
		70%<X<99%	2		2	2
		<70%	1			
	Most waste facilities do not comply to environmental requirements		0	0		
Sub-total 2				3	10	15
Main Total				9	28	45

Sunny has a score of 9 which falls under Beginner. Vibrant city and Wonderful city, each has a score of 28 and 45 which falls under Intermediate and Advance city, respectively.

1. Radar Chart of Sunny City

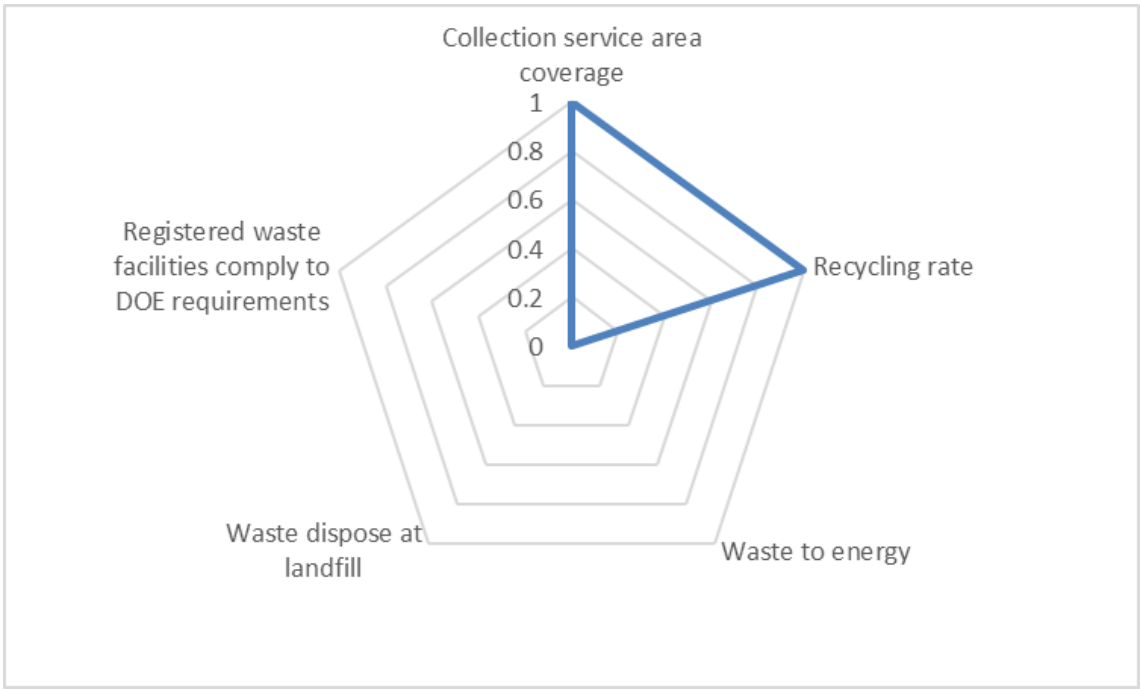

Diagram 9 Radar Chart of Waste Management Index of Sunny City

2. Radar Chart of Vibrant City

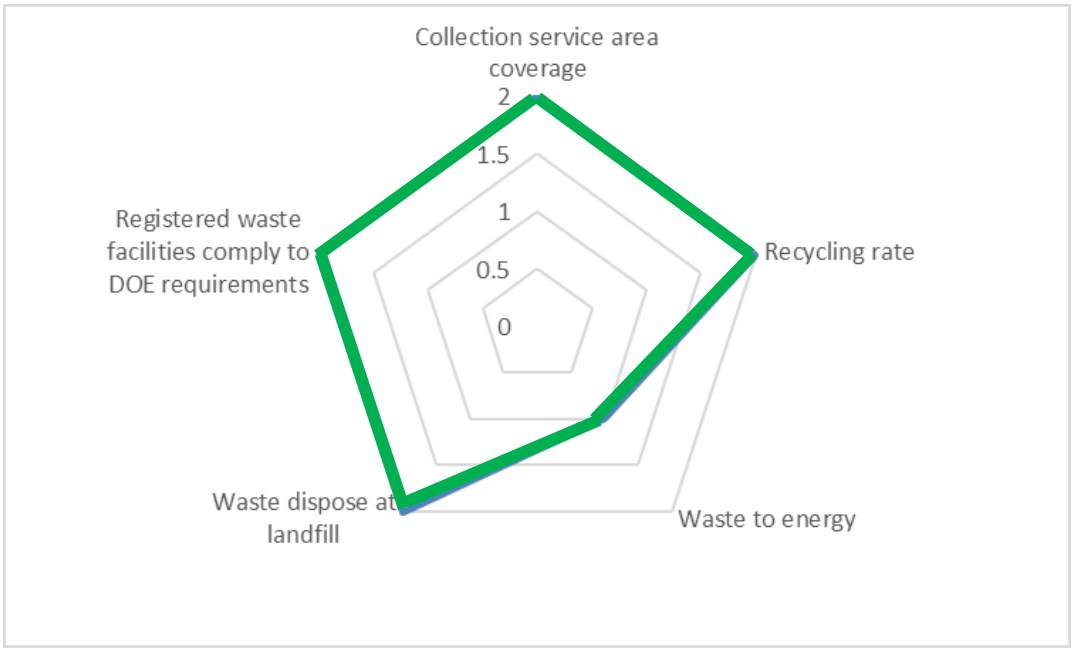

Diagram 10 Radar Chart of Waste Management Index of Vibrant City

3. Radar Chart of Wonderful City

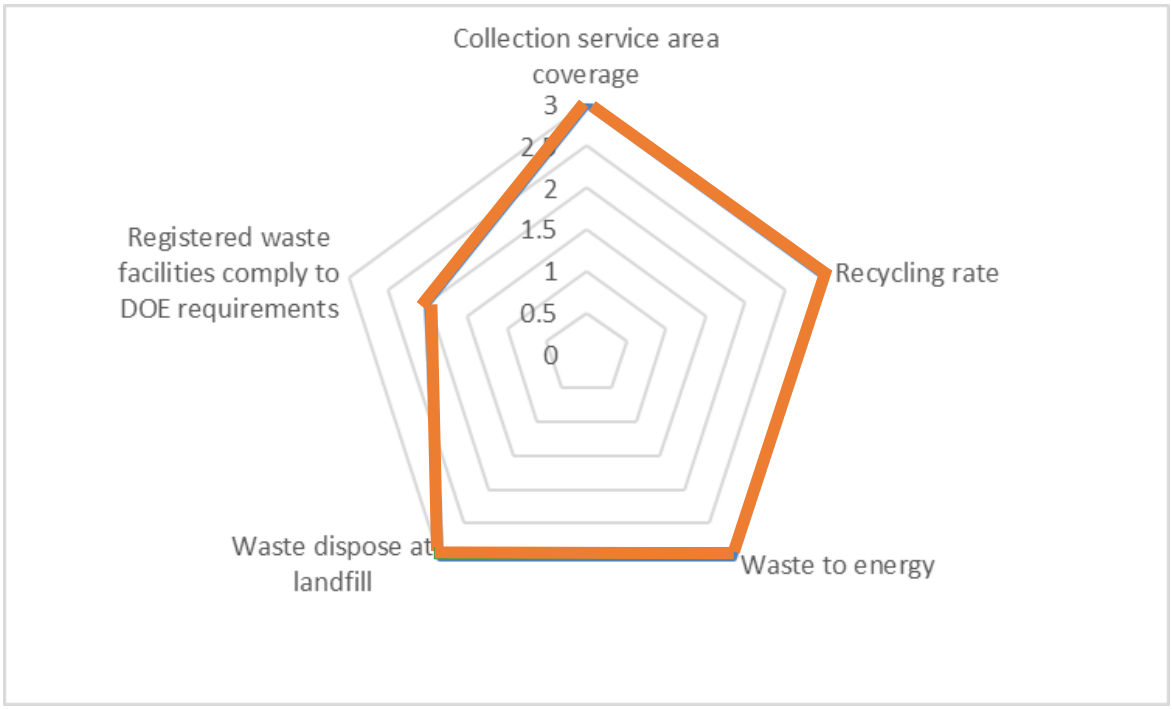

Diagram 11 Radar Chart of Waste Management Index of Wonderful City

4. Comparison of All City Indexes

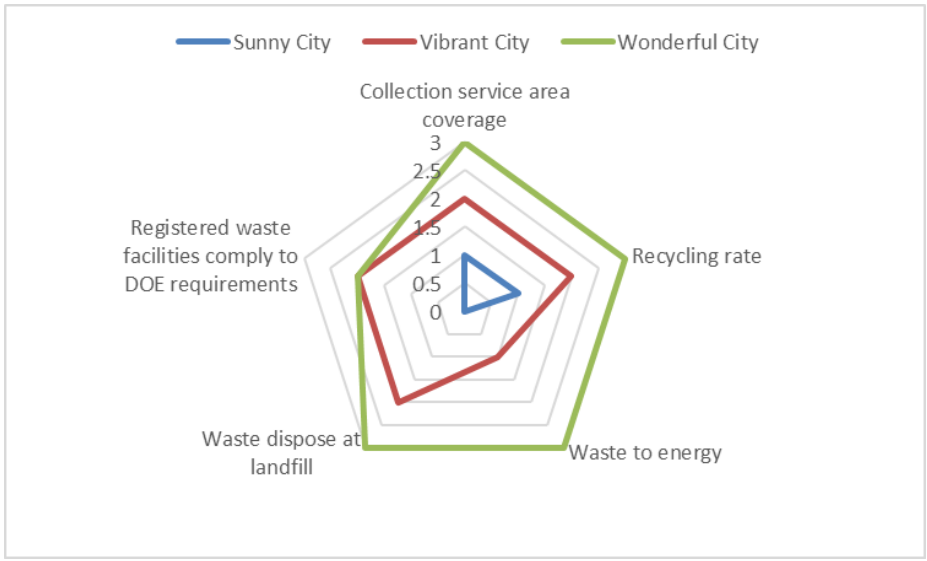

Diagram 12 Radar Chart Collage of Waste Management Index of 3 Cities : Sunny City, Vibrant City, and Wonderful City

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3.4 Water Infrastructures Index by Dian Rosnawati

3.4.1 Definition

Water infrastructure in this book is defined as physical structures and facilities, with their systems, that is needed by inhabitants of an urban or a sub urban environment to fulfill their needs of water, limited to the second section so this index will not overlap with other indexes: Energy index, and Natural Disaster Mitigation index.

3.4.2 Water Infrastracture based on Output

1. Wastewater Treatment: Wastewater treatment plant
2. Drinking Water Treatment: sewage, wastewater plant, aqueduct, dam, weir, cleanwater plant, drinkingwater plant, drinkingwater piping, cistern
3. Flood Protection: dam, weir, storm/rain water drainage, pumping system, deep tunnel, cistern
4. Coastal Erosion Control: seawall, groyne, riverwall
5. Food Security: dam, irrigation, to be discussed in Food Provision Index
6. Lava Control: to be discussed in Natural Disaster Mitigation Index
7. Electricity: to be discussed in Energy Index

3.4.3 Criteria and Indicator of Good Water Infrastructure

1. Wastewater Treatment Criteria

   The indicators used for waste water treatment criteria are of the sample water. Sample of water for measurement is taken from outlet of the treatment plant, or river, and dam, with assumption that all wastewater in the city is processed first in the plant before it is released into river, or dam. Water resulted from this treatment can be used for livestock, agriculture, and washing dishes.

   a. BOD_5 at 20□C: BOD stands for biological oxygen demand. BOD_5 at 20□C is amount of oxygen required during 5 days for biological oxidation of carbon pollution at 20°C. This parameter is very important for determining plant loading and the amount of biodegradable carbon pollution. If sample is allowed to react further, nitrification can occur.
   b. COD: Chemical oxygen demand. It is the quantity of oxygen required for the oxidation of the major part of organic compounds and some inorganic compounds, using a strong oxidant. The COD values are normally higher than BOD. Because the rapidity of the COD test, it is used for preliminary estimation of BOD.

c. Total suspended solids: It refers to the nonfilterable fraction of particles remaining after a glass fiber filtration and drying at 103˚C. The volatile suspended solids represent the remaining fraction after heating to 550˚C.
d. Total nitrogen: Nitrogen occurs in 4 basic forms in wastewater: organic nitrogen, ammonia, nitrite, and nitrate. These forms indicate the level of organic stabilisation. For example, fresh wastewater has higher concentration of organic nitrogen and ammonia, measured as Kjeldahl nitrogen (TKN). Nitrite and nitrate are measured directly and indicate nitrification of activated sludge.
e. Total phosphorus: Phosphorus, as nitrogen, occurs in different forms in wastewater (orthophosphate, polyphosphate and organic phosphate), and is an essential element for biological growth. An excess amount in effluents favours algae blooms and eutrophication.
f. Phenol: Phenol is both a manufactured chemical and a natural substance. It is a colorless-to-white solid when pure. The commercial product is a liquid. Phenol has a distinct odor that is sickeningly sweet and tarry. You can taste and smell phenol at levels lower than those that are associated with harmful effects. Phenol evaporates more slowly than water, and a moderate amount can form a solution with water. Phenol can catch fire. It is corrosive to skin but because of anesthetic qualities will numb rather than burn. Phenol is used primarily in the production of phenolic resins and in the manufacture of nylon and other synthetic fibers. It is also used in slimicides (chemicals that kill bacteria and fungi in slimes), as a disinfectant and antiseptic, and in medicinal preparations such as mouthwash, and sore throat lozenges. It is used to make plastics, adhesives and other chemicals.
g. Sulphide: sulphide is chemical groups containing the covalent sulfur bonds -S-. The sulfur atom can be bound to inorganic or organic moieties. Hydrogen sulfide in water is an aesthetic concern that causes a disagreeable taste and odor to the water. While the gas is poisonous and flammable, the human nose can detect it well before it causes health concerns. Most people can detect hydrogen sulfide levels well below 0.5 mg/L.
h. Oil and grease: Oil and grease includes fats, oils, waxes, and other related constituents found in water, generally wastewater. If these compounds are not removed before discharge of treated wastewater, oil and grease can interfere with biological life in surface waters and create unsightly films.

2. Drinking Water Treatment Criteria
   Sample for measurement is taken from tap water in home, office, hotels, shop, and transportation hub, made by Government.
   a. Level of Bacteria: Detection of bacteria, mainly Campylobacter spp., Clostridium perfringens spores, Escherichia coli, Faecal streptococci/intestinal enterococci, Salmonella spp., Shigella spp.
   b. Level of Viruses: Detection of viruses, mainly Polioviruses,, Rotaviruses, Adenoviruses, Norwalk Viruses, Hepatitis A.
   c. Level of Parasitic Protozoa: Detection of parasitic protozoa, mainly Cryptosporidium parvum oocysts, Entamoeba histolytica, Giardia lambliacysts.
   d. Level of Helminths (ova): Detection of Ascaris spp., Ancylostoma spp., and Necator sp., also Tricuris spp.
   e. Level of pH: Measurement of the alkalinity or acidity of water. A pH of 7 is neutral, below 7 is acidic, and above 7 is basic or alkaline.
   f. Heterotrophic Plate Count (HPC): Used to monitor the efficiency of the water treatment process and undesirable changes in bacterial water quality during storage and distribution. It is a procedure for estimating the number of live heterotrophic bacteria in water. This test can provide useful information about water quality and supporting data on the significance of coliform test results. Heterotrophic plate count levels in potable water should be <500 CFU/mL. These levels may increase on occasion, but counts consistently >500 CFU/mL would indicate a general decrease in water quality. A direct correlation between heterotrophic plate count and biofilm levels has been demonstrated.
   g. Turbidity: a measure of the cloudiness of water and indicates water quality and filtration effectiveness. The cloudiness is caused by suspended chemical and biological particle. It can have both water safety and aesthetic implications for drinking-water supplies.
   h. Electricity conductivity (E.C.) or conductivity: E.C. is a measure of the ability of water to pass an electrical current. E.C. in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees

Celsius (25□C). E.C. is measured in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm).

i. Nitrates and Nitrite: Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle. The nitrate ion (NO_3^-) is the stable form of combined nitrogen for oxygenated systems. Although chemically unreactive, it can be reduced by microbial action. The nitrite ion (NO_2^-) contains nitrogen in a relatively unstable oxidation state. Chemical and biological processes can further reduce nitrite to various compounds or oxidize it to nitrate (ICAIR Life Systems, Inc., 1987).

   Sources of nitrates may include human and animal wastes, industrial pollutants and nonpoint-source runoff from heavily fertilized croplands and lawns. Under certain conditions, high levels of nitrates (10 mg/L or more) in drinking water can be toxic to humans.

   Nitrate is used mainly in inorganic fertilizers. It is also used as an oxidizing agent and in the production of explosives, and purified potassium nitrate is used for glass making. Nitrate is sometimes also added to food to serve as a reservoir for nitrite. Nitrates occur naturally in plants, for which it is a key nutrient. Nitrate and nitrite are also formed endogenously in mammals, including humans.

   Sodium nitrite is used as a food preservative, especially in cured meats. Nitrate is secreted in saliva and then converted to nitrite by oral microflora. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks. Nitrite can also be formed chemically in distribution pipes by Nitrosomonas bacteria during stagnation of nitrate-containing and oxygen-poor drinking-water in galvanized steel pipes or if chloramination is used to provide a residual disinfectant and the process is not sufficiently well controlled.

j. Number of heavy metals: detection of metals, such as iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), arsenic (As), water, or if they accumulate in organisms that are higher in the food chain,and are consumed by humans. Hg, As, Pb, Zn, and Cd

k. Level of Industrial Chemicals: detection of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and Polychlorinated biphenyls (PCBs). PCDDs, PCDFs, and PCBs can be chlorinated to varying degrees. PCBs can have up to 10 chlorine atoms substituting for hydrogen atoms, and PCDDs and PCDFs can have up to 8. The compounds often have similar toxicity profiles and common mechanisms of action and are generally considered together as agroup to set guidelines.
They are two- or three-ring structures that can be chlorinated to varying degrees. PCBs can have up to 10 chlorine atoms substituting for hydrogen atoms, and PCDDs and PCDFs can have up to 8. The compounds often have similar toxicity profiles and common mechanisms of action and are generally considered together as a group to set guidelines. PCDDs and PCDFs concenration unit in drinking water is pg international toxic equivalent quantity (I-TEQ)/L.

PCBs cause a variety of serious health effects on the immune, reproductive, nervous, and endocrine systems. Their toxicity varies depending on the chlorine content in each molecule. Sources of PCBs include industrial and municipal effluent discharges. Dioxins and furans are toxic organochlorine compounds that are found in very small amounts in the environment, including air, water, and soil. Sources of dioxins and furans include the large- scale burning of waste, the production of iron and steel, and the combustion of fuels and wood.

l. Salinity: Concentartions of salt in water
m. Access to drinking water: percentage of citizens/residents who receive drinking water from Government in their homes, compare to total amount ofcitizens/residents.
n. Source of drinking water: ground water, river, sea, rain, spring, snow. Ground water as source of drinking water is less sustainable than other sources.
o. Tap drinking water flow by Government distribution in any function is the debit/how many litre per second the drinking water, distributed by Government, flows from each faucet/tap in any function, such as our home,office, hotel, and hospital.
p. Interruption of tap drinking water flow from Government distribution in any function is the period when drinking water distributed by Government is not flowing in any function, such as our home, office, hotel, and hospital.

3. Flood Protection Infrastructure Criteria
   It is frequency of flood happens in a city. The sample is measured in every part ofthe city.

4. Coastal Erosion Control Infrastructure Criteria
   It is how many meters riverbank and beach line eroded per year. The sample can be measured in every beach/sea shore/riverbank.

Table 14 Water Infrastructure Index Table Form Sheet

Water Infrastructures	Criteria	Indicators	Score
Waste Water Treatment	1. BOD_5 at 20□C	≤ 400 mg/L	1
		> 400 mg/L	0
	2. COD	≤ 1000 mg/L	1
		> 1000 mg/L	0
	3. Total Suspended Solids	≤ 400 mg/L	1
		> 400 mg/L	0
	4. Nitrite (NO_2)	≤ 0 mg/L	1
		> 0 mgN/L	0
	5. Nitrate (NO_3)	≤ 10 mgN/L	1
		> 10 mgN/L	0
	6. Total Phosphorus		
	a. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily average not exceeding 20 mgN/L)	≤ 2 mgP/L	1
		> 2 mgP/L	0
	b. Annual concentration for plantsize from 10,000 to 100,000 p.e. (daily average not exceeding 20 mgN/L)	≤ 1 mgP/L	1
		> 1 mgP/L	0
	7. Temperature	< 45□C	1
		≥45□C	0
	8. pH Value	5 – 9	1
		> 9	0
		< 5	0
	9. Metal	Hg: ≤ 0.1 mg/LCd: ≤ 1 mg/L	1

Water Infrastructures	Criteria	Indicators	Score
		Ch Hexavalent: ≤ 2 mg/L As: ≤ 2 mg/LCy: ≤ 2 mg/LPb: < 2 mg/L CH Trivalent: < 10 mg/L Copper: ≤ 10 mg/L Mn: ≤ 10 mg/L Nickel: ≤ 10 mg/L Tin: ≤ 10 mg/L Zn: ≤ 10 mg/L Fe: ≤ 50 mg/L	
		Hg: > 0.1 mg/L Cd: > 1 mg/L Ch Hexavalent: > 2 mg/L As: > 2 mg/LCy: > 2 mg/LPb: > 2 mg/L CH Trivalent: > 10 mg/L Copper: > 10 mg/LMn: > 10 mg/L Nickel: > 10 mg/L Tin: >10 mg/L Zn: > 10 mg/L Fe: > 50 mg/L	0
	10. Phenol	≤ 5 mg/L	1
		> 5 mg/L	0
	11. Sulphide	≤ 2 mg/L	1
		> 2 mg/L	0
	12. Oil and Grease	≤ 100 mg/L	1
Drinking Water	1. Level of Bacteria	0 CFU per 100mL	1

Water Infrastructures	Criteria	Indicators	Score
Treatment		(Petrifilm)	
		> 0 CFU per 100mL (Petrifilm)	0
	2. Amount of Viruses	0 per 100mL	1
		> 0 per 100mL	0
	3. Level of Parasitic Protozoa	0 per 100mL	1
		> 0 per 100mL	0
	4. Level of Helminths Ova	0 per 100mL	1
		> 0 per 100mL	0
	5. Level of pH	6.5 – 8.5	1
		< 6.5	0
		> 8.5	0
	6. Heterotrophic Plate Count (HPC)	<500 CFU/mL	1
		>500 CFU/mL	0
	7. Turbidity	<1 nephelometric turbidity unit (NTU)	1
		>1 NTU	0
	8. Electricity conductivity	0 µmhos/cm	1
		> 0 µmhos/cm	0
	9. Number of metals	Hg: ≤ 0.001 mg/LAs: ≤ 0.01 mg/L Pb: ≤ 0.01 mg/L Zn: ≤ 3 mg/L Cd: ≤ 0.003 mg/LB: < 0.3 mg/L Fe: < 0.3 mg/L	1
		Hg: > 0.001 mg/LAs: > 0.01 mg/L Pb: > 0.01 mg/L Zn: > 3 mg/L Cd: > 0.003 mg/L	0

Water Infrastructures	Criteria	Indicators	Score
		B: ≥ 0.3 mg/L Fe: ≥ 0.3 mg/L	
	10. Level of Industrial Chemicals	PFOS: ≤ 70 parts pertrillion PFOA: ≤ 70 parts pertrillion PCDDs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCDFs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCBs: ≤ 500 parts pertrillion (ppt) PFOS: > 70 parts pertrillion PFOA: > 70 parts pertrillion PCDDs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L) PCDFs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L) PCBs: > 500 parts pertrillion (ppt)	1
	11. Salinity	< 600 mg/L	1
		≥ 600 mg/L	0
	12. Access to drinking water by Government distribution in anyfunction, e.g.: house, office, hotel, hospital	99% - 100%	3
		90% – 98.99%	2
		80% - 89.99%	1
		< 80%	0
	13. Source of drinking water	Any source except ground water	1

Water Infrastructures	Criteria	Indicators	Score
		Ground water	0
	15. Tap drinking water flow by Government distribution in any function, e.g.: house, office, hotel, hospital	≥ 0.2 m^3/s	1
		< 0.2 m^3/s	0
	16. Interruption of tap drinking water flow from Government distribution in any function, e.g.: house, office, hotel, hospital	0 – 1 hour per year	3
		1 – 12 hours per year	2
		≥12 – 24 hours per year	1
		> 24 hours per year	0
Flood Protection	Puddle or flood happens in a city, minimum 30cm depth in 1Km^2 publicarea for 10 minutes.	0 spot in 1 month	2
		1 – 10 spots in 1 month	1
		>10 spots in 1 month	0
Coastal Erosion Control	1. Riverbank eroded per year	< 2 meters per year	1
		≥ 2 meters per year	0
	2. Beach line eroded per year	< 2 meters per year	1
		≥ 2 meters per year	0

How to calculate the Water Infrastructure Index score of a city:

1. Coastal erosion control infrastructure is an optional criteria. It means, a city who does not have/face river or sea, can opt-out or exclude or does not need to countthe criteria.
2. Each of the indicator of 'Number of Metals' and 'Level of Industrial Chemicals' is a collective index, seen as 1 (one) unit of index. Any amount of one or more metal or industrial chemical (written above) exceeding the written index above will result in0 (zero) score.
3. Sum all the scores

Therefore, the scoring can be classified as follows:

1. Lowest score is 0
2. Highest score is 35
3. A city having total score of 0 – 14 is considered as Beginner
4. A city having total score of 15 – 26 is considered as Intermediate
5. A city having total score of 27 – 36 is considered as Advance

Calculation of All Indexes

3.6.1. Water Infrastructure Index of 3 Cities

Table 15 Water Infrastructure Indexes Calculation of Sunny City

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
Wastewater Treatment. Sample taken from water outlet	1. BOD_5 at 20□C	≤ 400 mg/L	200 mg/L	1
		> 400 mg/L		0
	2. COD	≤ 1000 mg/L	500 mg/L	1
		> 1000 mg/L		0
	3. Total Suspended Solids	≤ 400 mg/L	200 mg/L	1
		> 400 mg/L		0
	4. Nitrite (NO_2)	≤ 0 mg/L		1
		> 0 mgN/L	0.358 mg/L	0
	5. Nitrate (NO_3)	≤ 5 mgN/L	1.82 mgN/L	1
		> 5 mgN/L		0
	6. Total Phosphorus			
	a. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily average not exceeding 20 mgN/L)	≤ 2 mgP/L	1 mgP/L	1
		> 2 mgP/L		0
	b. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily average not exceeding 20 mgN/L)	≤ 1 mgP/L	0.5 mgP/L	1
		> 1 mgP/L		0
	7. Temperature	< 45□C	40□C	1

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		≥ 45□C		
	8. pH Value	5 – 9		
		> 9	10	0
		< 5		
	9. Metal	Hg: ≤ 0.1 mg/L Cd: ≤ 1 mg/L Ch Hexavalent: ≤ 2mg/L As: ≤ 2 mg/LCy: ≤ 2 mg/LPb: < 2 mg/L CH Trivalent: < 10mg/L Copper: ≤ 10 mg/LMn: ≤ 10 mg/L Nickel: ≤ 10 mg/L Tin: ≤ 10 mg/L Zn: ≤ 10 mg/L Fe: ≤ 50 mg/L	Hg: 0.1 mg/L Cd: 1 mg/L Ch Hexavalent: 2 mg/L As: 2 mg/L Cy: 2 mg/L Pb: 1.8 mg/L CH Trivalent:9 mg/L Copper: 9mg/L Mn: 9 mg/L Nickel: 9mg/L Tin: 9 mg/L Zn: 9 mg/L Fe: 10 mg/L	1
		Hg: > 0.1 mg/L Cd: > 1 mg/L Ch Hexavalent: > 2mg/L As: > 2 mg/LCy: > 2 mg/LPb: > 2 mg/L CH Trivalent: > 10mg/L Copper: > 10 mg/L		
		Mn: > 10 mg/L Nickel: > 10 mg/LTin: >10		

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		mg/L Zn: > 10 mg/L Fe: > 50 mg/L		
	10. Phenol	≤ 5 mg/L		
		> 5 mg/L	6 mg/L	0
	11. Sulphide	≤ 2 mg/L	1 mg/L	1
		> 2 mg/L		
	12. Oil and Grease	≤ 100 mg/L		
		> 100 mg/L	105 mg/L	0
Drinking Water Treatment. Sample taken from tap water	1. Level of Bacteria	0 CFU per 100mL (Petrifilm)	0	1
		> 0 CFU per 100mL (Petrifilm)		0
	2. Amount of Viruses	0 per 100mL	0	1
		> 0 per 100mL		0
	3. Amount of Parasitic Protozoa	0 per 100mL	0	1
		> 0 per 100mL		0
	4. Level of Helminths Ova	0 per 100mL	0	1
		> 0 per 100mL		0
	5. Level of pH	6.5 – 8.5		1
		< 6.5	6.45	0
		> 8.5		0
	6. Heterotrophic Plate Count (HPC)	<500 CFU/mL	490 CFU/mL	1
		>500 CFU/mL		0
	7. Turbidity	<1 nephelometric turbidity unit (NTU)	0.53 NTU	1
		>1 NTU		0
	8. Electricity conductivity	0 µmhos/cm	0	1
		> 0 µmhos/cm		0
		>10 mg/L		0

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	9. Number of metals	Hg: ≤ 0.001 mg/LAs: ≤ 0.01 mg/L Pb: ≤ 0.01 mg/L Zn: ≤ 3 mg/L Cd: ≤ 0.003 mg/L B: < 0.3 mg/L Fe: < 0.3 mg/L	Hg: 0.0003 As: 0 Pb: 0 Zn: 0.01 Cd: 0 B: 0.08 Fe: 0.08	1
		Hg: > 0.001 mg/LAs: > 0.01 mg/L Pb: > 0.01 mg/L Zn: > 3 mg/L Cd: > 0.003 mg/L		0
		B: ≥ 0.3 mg/L Fe: ≥ 0.3 mg/L		
	10. Level of Industrial Chemicals	PFOS: ≤ 70 parts pertrillion PFOA: ≤ 70 parts pertrillion PCDDs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCDFs: ≤ 0.64 pg/L,	PFOS: 35 ppt PFOA: 35 ppt PCDDs: 0.32 pg/L PCDFs: 0.32 pg/L PCBs: 250 ppt	1

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		or ≤ 0.021 pg I-TEQ/L) PCBs: ≤ 500 parts pertrillion (ppt)		
		PFOS: > 70 parts pertrillion PFOA: > 70 parts pertrillion PCDDs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L) PCDFs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L) PCBs: > 500 parts pertrillion (ppt)		0
	11. Salinity	< 600 mg/L	100mg/L	1
		≥ 600 mg/L		0
	12. Access to drinkingwater by Government distribution in any function, e.g.:	99% - 100%		3
		90% – 98.99%		2
		80% - 89.99%		1
		< 80%	0	0

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	house, office, hotel, hospital			
	13. Source of drinking water	Any source except ground water		1
		Ground water	Ground water	0
	15. Tap drinking water flow by Government distribution in any function, e.g.: house, office, hotel, hospital	$\geq$ 0.2 m^3/s	0.2 m^3/s	1
		< 0.2 m^3/s		0
	16. Interruption of tap drinking water flow from Government distribution in any function,e.g.: house, office, hotel, hospital	0 – 1 hour per year		3
		1 – 12 hours per year		2
		$\geq$12 – 24 hours per year	24 hours per year	1
		> 24 hours per year		0
Flood Protection. Sample from anopen plaza	Puddle or flood happens in a city, minimum 30cm depthin $1km^2$ public area for 10 minutes.	0 spot in 1 month		1
		1 – 10 spots in 1 month		
		>10 spots in 1 month	100 spots in 1 month	0
Coastal erosion control. Sample from a river and a beach	1. Riverbank eroded per year	< 2 meters per year		1
		$\geq$ 2 meters per year	10 meters per year	0
	2. Beach line eroded	< 2 meters per		1

1. Sunny City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	per year	year		
		≥ 2 meters per year	100 meters per year	0
Total Score of Sunny City: Intermediate City (15 – 26)				**21**

Table 16 Water Infrastructure Indexes Calculation of Vibrant City

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
Water Treatment. Sample taken from water outlet	1. BOD_5 at 20℃	≤ 400 mg/L		1
		> 400 mg/L	500 mg/L	0
	2. COD	≤ 1000 mg/L		1
		> 1000 mg/L	1100 mg/L	0
	3. Total Suspended Solids	≤ 400 mg/L		1
		> 400 mg/L	450 mg/L	0
	4. Nitrite (NO_2)	≤ 0 mg/L		1
		> 0 mgN/L	0.358 mg/L	0
	5. Nitrate (NO_3)	≤ 5 mgN/L		1
		> 5 mgN/L	5.5 mgN/L	0
	6. Total Phosphorus			
	e. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily average not exceeding 20 mgN/L)	≤ 2 mgP/L		1
		> 2 mgP/L	2.5 mgP/L	0
	f. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily averagenot exceeding 20 mgN/L)	≤ 1 mgP/L		1
		> 1 mgP/L	1.5 mgP/L	0
	7. Temperature	< 45℃	25℃	1
		≥ 45℃		
	8. pH Value	5 – 9	6	1
		> 9		
		< 5		
	9. Metal	Hg: ≤ 0.1 mg/L Cd: ≤ 1 mg/L Ch	Hg: 0.1 mg/L Cd: 1 mg/L Ch Hexavalent: 2mg/L	1

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		Hexavalent: ≤ 2 mg/L As: ≤ 2 mg/L Cy: ≤ 2 mg/L Pb: < 2 mg/L CH Trivalent: < 10 mg/L Copper: ≤ 10 mg/L Mn: ≤ 10 mg/L Nickel: ≤ 10 mg/L Tin: ≤ 10 mg/L Zn: ≤ 10 mg/L Fe: ≤ 50 mg/L	As: 2 mg/L Cy: 2 mg/L Pb: 1.5 mg/L CH Trivalent: 9 mg/L Copper: 9 mg/L Mn: 9 mg/L Nickel: 9 mg/L Tin: 9 mg/L Zn: 9 mg/L Fe: 45 mg/L	

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		Hg: > 0.1 mg/L Cd: > 1 mg/L Ch Hexavalent: > 2mg/L As: > 2 mg/L Cy: > 2 mg/L Pb: > 2 mg/L CH Trivalent: > 10mg/L Copper: > 10 mg/L Mn: > 10 mg/L Nickel: > 10 mg/L Tin: >10 mg/L Zn: > 10 mg/L Fe: > 50 mg/L		

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	10. Phenol	≤ 5 mg/L		
		> 5 mg/L	6 mg/L	0
	11. Sulphide	≤ 2 mg/L	1.8 mg/L	1
		> 2 mg/L		
	12. Oil and Grease	≤ 100 mg/L	50 mg/L	1
		> 100 mg/L		
Drinking Water Treatment. Sample taken from tap water	1. Level of Bacteria	0 CFU per 100mL (Petrifilm)	0	1
		> 0 CFU per 100mL (Petrifilm)		0
	2. Amount of Viruses	0 per 100mL	0	1
		> 0 per 100mL		0
	3. Amount of Parasitic Protozoa	0 per 100mL	0	1
		> 0 per 100mL		0
	4. Level of Helminths Ova	0 per 100mL	0	1
		> 0 per 100mL		0
	5. Level of pH	6.5 – 8.5		1
		< 6.5	6.45	0
		> 8.5		0
	6. Heterotrophic Plate Count (HPC)	<500 CFU/mL	490 CFU/mL	1
		>500 CFU/mL		0
	7. Turbidity	<1 nephelometric turbidity unit	0.53 NTU	1

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		(NTU)		
		>1 NTU		0
	8. Electricity conductivity	0 µmhos/cm	0	1
		> 0 µmhos/cm		0
		>10 mg/L		0
	9. Number of metals	Hg: ≤ 0.001 mg/L As: ≤ 0.01 mg/L	Hg: 0.0003 As: 0	1
		Pb: ≤ 0.01 mg/L Zn: ≤ 3 mg/L Cd: ≤ 0.003 mg/LB: < 0.3 mg/L Fe: < 0.3 mg/L	Pb: 0 Zn: 0.01 Cd: 0 B: 0.08 Fe: 0.08	
		Hg: > 0.001 mg/LAs: > 0.01 mg/L Pb: > 0.01 mg/L Zn: > 3 mg/L Cd: > 0.003		0

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		mg/LB: ≥ 0.3 mg/L Fe: ≥ 0.3 mg/L		
	10. Level of Industrial Chemicals	PFOS: ≤ 70 parts per trillion PFOA: ≤ 70 parts per trillion PCDDs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCDFs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCBs: ≤ 500 parts per	PFOS: 35 ppt PFOA: 35 ppt PCDDs: 0.32 pg/L PCDFs: 0.32 pg/L PCBs: 250 ppt	1

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		trillion (ppt)		
		PFOS: > 70 parts per trillion PFOA: > 70 parts per trillion PCDDs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L) PCDFs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L) PCBs: > 500 parts per trillion (ppt)		0
	11. Salinity	< 600 mg/L		1
		≥ 600 mg/L	700mg/L	0

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	12. Access to drinkingwater by Government distribution in anyfunction, e.g.: house, office, hotel, hospital	99% - 100%		3
		90% – 98.99%		2
		80% - 89.99%		1
		< 80%	0	0
	13. Source of drinking water	Any source except ground water		1
		Ground water	Ground water	0
	15. Tap drinking water flow by Government distribution in anyfunction, e.g.: house, office, hotel, hospital	≥ 0.2 m^3/s		1
		< 0.2 m^3/s	0.1 m^3/s	0
	16. Interruption of tap drinking water flow from Government distribution in anyfunction, e.g.: house, office, hotel, hospital	0 – 1 hour per year		3
		1 – 12 hours per year		2
		≥12 – 24 hours per year		
		> 24 hours per year	48 hours per year	0
Flood Protection. Sample from anopen plaza	Puddle or flood happens in a city, minimum 30cm depthin 1Km^2 public area for 10 minutes.	0 spot in 1 month		2
		1 – 10 spots in 1 month		1

2. Vibrant City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		>10 spots in 1 month	100 spots in 1 month	0
Coastal erosion control. Sample from ariver and a beach	1. Riverbank eroded per year	< 2 meters per year		1
		≥ 2 meters per year	25 meters per year	0
	2. Beach line eroded per year	< 2 meters per year		1
		≥ 2 meters per year	100 meters per year	0
Total Score of Vibrant City: Beginner City (0 – 14)				**14**

Table 17 Water Infrastructure Indexes Calculation of Wonderful City

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
Waste Water Treatment. Sample taken from water outlet	1. BOD_5 at 20℃	≤ 400 mg/L	150 mg/L	1
		> 400 mg/L		0
	2. COD	≤ 1000 mg/L	450 mg/L	1
		> 1000 mg/L		0
	3. Total Suspended Solids	≤ 400 mg/L	200 mg/L	1
		> 400 mg/L		0
	4. Nitrite (NO_2)	≤ 0 mg/L		1
		> 0 mgN/L	0.358 mg/L	0
	5. Nitrate (NO_3)	≤ 5 mgN/L	1.82 mgN/L	1
		> 5 mgN/L		0
	6. Total Phosphorus			
	g. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily averagenot exceeding 20 mgN/L)	≤ 2 mgP/L	1 mgP/L	1
		> 2 mgP/L		0
	h. Annual concentration for plant size from 10,000 to 100,000 p.e. (daily averagenot exceeding 20 mgN/L)	≤ 1 mgP/L	0.5 mgP/L	1
		> 1 mgP/L		0
	7. Temperature	< 45℃		
		≥ 45℃	50℃	0
	8. pH Value	5 – 9		
		> 9	10	0
		< 5		

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	9. Metal	Hg: ≤ 0.1 mg/LCd: ≤ 1 mg/L Ch Hexavalent: ≤ 2mg/L As: ≤ 2 mg/L Cy: ≤ 2 mg/L	Hg: 0.1 mg/L Cd: 1 mg/L Ch Hexavalent: 2 mg/L As: 2 mg/L Cy: 2 mg/L	1
		Pb: < 2 mg/L CH Trivalent: < 10 mg/LCopper: ≤ 10 mg/L Mn: ≤ 10 mg/L Nickel: ≤ 10 mg/L Tin: ≤ 10 mg/L Zn: ≤ 10 mg/L Fe: ≤ 50 mg/L	Pb: 1.5 mg/L CH Trivalent: 9 mg/L Copper: 9 mg/L Mn: 9 mg/L Nickel: 9 mg/L Tin: 9 mg/L Zn: 9 mg/L Fe: 45 mg/L	

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		Hg: > 0.1 mg/LCd: > 1 mg/L Ch Hexavalent: > 2mg/L As: > 2 mg/LCy: > 2 mg/LPb: > 2 mg/L CH Trivalent: > 10 mg/LCopper: > 10 mg/L Mn: > 10 mg/L Nickel: > 10 mg/LTin: >10 mg/L Zn: > 10 mg/L Fe: > 50 mg/L		0
	10. Phenol	≤ 5 mg/L	4 mg/L	1
		> 5 mg/L		
	11. Sulphide	≤ 2 mg/L	1.5 mg/L	1
		> 2 mg/L		
	12. Oil and Grease	≤ 100 mg/L		
		> 100 mg/L	125 mg/L	0
Drinking WaterTreatment. Sample taken from tap water	14. Level of Bacteria	0 CFU per 100mL (Petrifilm)	0	1
		> 0 CFU per 100mL		0

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		(Petrifilm)		
	15. Amount of Viruses	0 per 100mL	0	1
		> 0 per 100mL		0
	16. Amount of Parasitic Protozoa	0 per 100mL	0	1
		> 0 per 100mL		0
	17. Level of Helminths Ova	0 per 100mL	0	1
		> 0 per 100mL		0
	18. Level of pH	6.5 – 8.5		1
		< 6.5	6.45	0
		> 8.5		0
	19. Heterotrophic Plate Count (HPC)	<500 CFU/mL	490 CFU/mL	1
		>500 CFU/mL		0
	20. Turbidity	<1 nephelometric turbidity unit (NTU)	0.53 NTU	1
		>1 NTU		0
	21. Electricity conductivity	0 µmhos/cm	0	1
		> 0 µmhos/cm		0
		>10 mg/L		0
	22. Number of metals	Hg: ≤ 0.001 mg/LAs: ≤ 0.01 mg/L Pb: ≤ 0.01 mg/L Zn: ≤ 3 mg/L Cd: ≤ 0.003 mg/LB: < 0.3 mg/L Fe: < 0.3 mg/L	Hg: 0.0003 As: 0 Pb: 0 Zn: 0.01 Cd: 0 B: 0.08 Fe: 0.08	1
		Hg: > 0.001 mg/LAs: > 0.01 mg/L Pb: > 0.01		0

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		mg/L Zn: > 3 mg/L Cd: > 0.003 mg/LB: ≥ 0.3 mg/L Fe: ≥ 0.3 mg/L		
	23. Level of Industrial Chemicals	PFOS: ≤ 70 parts pertrillion PFOA: ≤ 70 parts pertrillion PCDDs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCDFs: ≤ 0.64 pg/L, or ≤ 0.021 pg I-TEQ/L) PCBs: ≤ 500 parts per trillion (ppt)	PFOS: 35 ppt PFOA: 35 ppt PCDDs: 0.32 pg/L PCDFs: 0.32 pg/L PCBs: 250 ppt	1
		PFOS: > 70 parts pertrillion PFOA: > 70 parts pertrillion PCDDs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L)		0

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
		PCDFs: > 0.64 pg/L, or > 0.021 pg I-TEQ/L)		
		PCBs: > 500 parts per trillion (ppt)		
	24. Salinity	< 600 mg/L	100mg/L	1
		≥ 600 mg/L		0
	25. Access to drinking water by Government distribution in any function, e.g.: house, office, hotel, hospital	99% - 100%	100%	3
		90% – 98.99%		2
		80% - 89.99%		1
		< 80%		0
	26. Source of drinking water	Any source except ground water		1
		Ground water	Ground water	0
	15. Tap drinking water flow by Government distribution in any function, e.g.: house, office, hotel,hospital	≥ 0.2 m^3/s	0.2 m^3/s	1
		< 0.2 m^3/s		0
	16. Interruption of tap drinking water flow from Government distribution in any function, e.g.: house, office, hotel, hospital	0 – 1 hour per year		3
		1 – 12 hours per year	12 hours per year	2
		≥12 – 24 hours per year		1
		> 24 hours per year		0
Flood Protection.Sample from an open plaza	Puddle or flood happens in a city, minimum 30cm	0 spot in 1 month		2
		1 – 10 spots in 1	5 spots in 1	1

3. Wonderful City				
Water Infrastructures	**Criteria**	**Indicators**	**Sample Measurement**	**Score**
	depth in 1Km^2 public area for 10 minutes.	month	month	
		>10 spots in 1 month		0
Coastal erosioncontrol.	1. Riverbank eroded per year	< 2 meters per year	1 meter per year	1
		≥ 2 meters per year		0
Sample from a river and a beach	2. Beach line eroded per year	< 2 meters per year	1.5 meters per year	1
		≥ 2 meters per year		0
Total Score of Wonderful City: Advance City (27 – 36)				**28**

Radar Chart

1. Radar Chart Sunny City

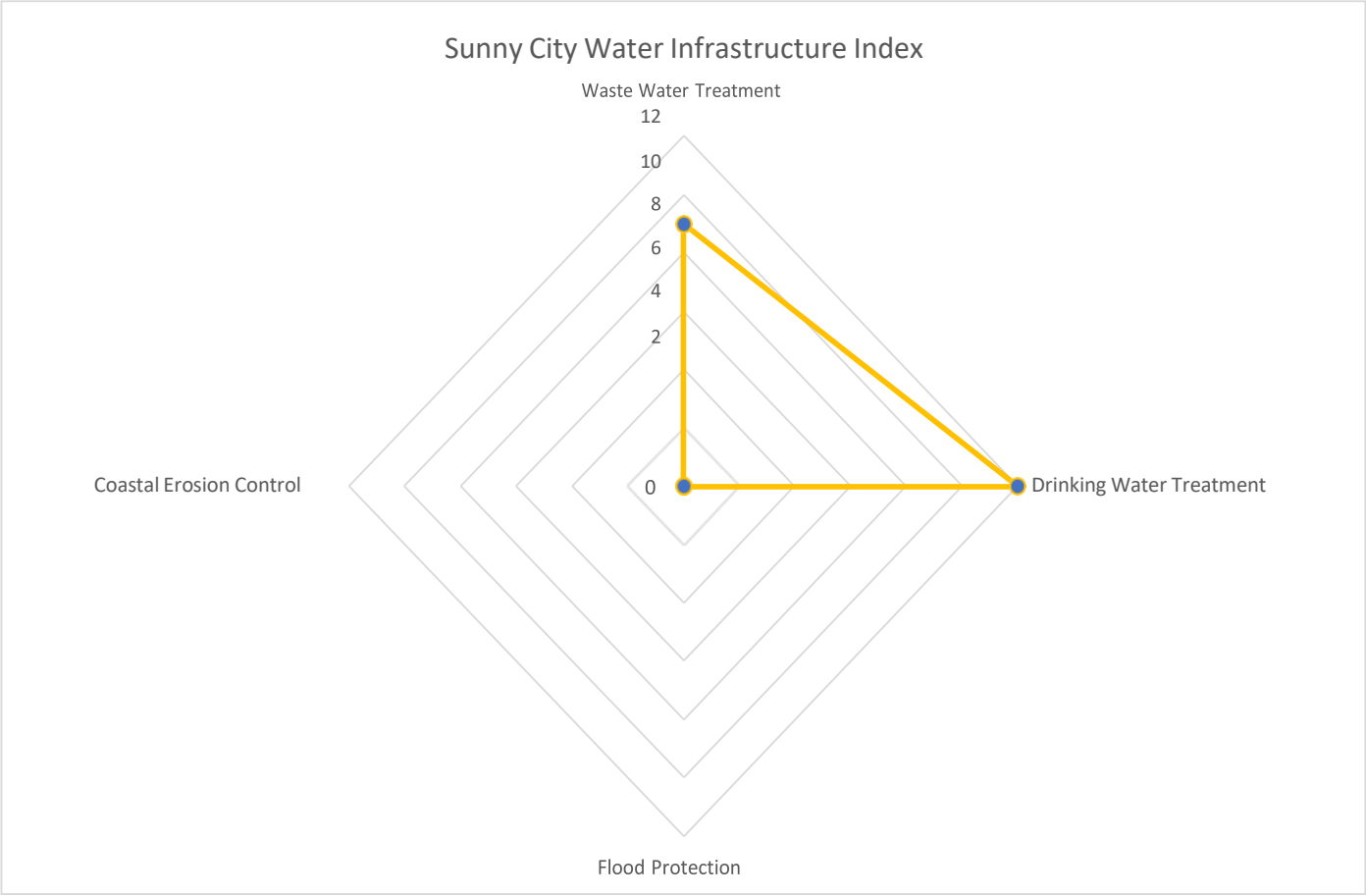

Diagram 13 Radar Chart of Water Infrastructure Index of Sunny City

2. Radar Chart Vibrant City

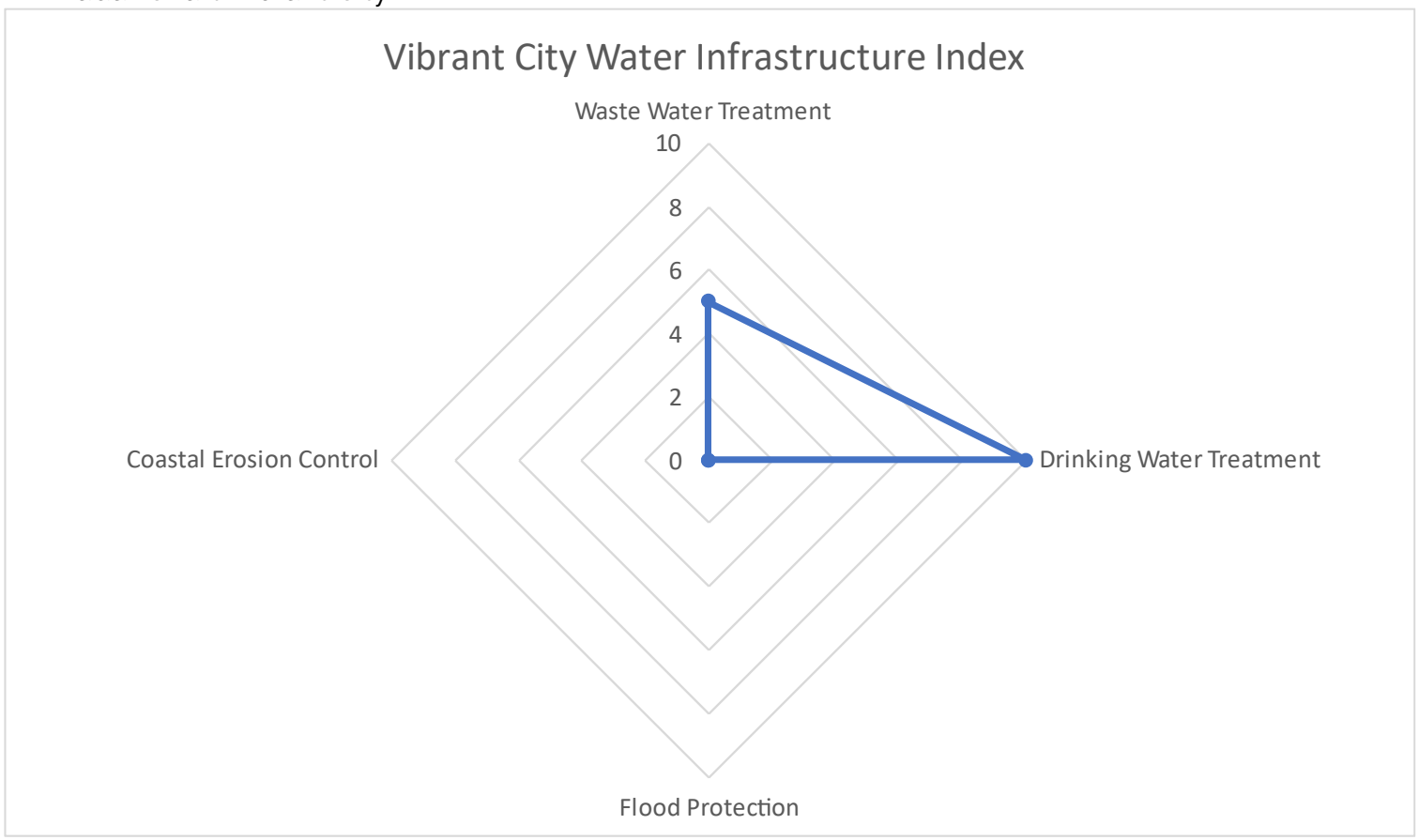

Diagram 14 Radar Chart of Water Infrastructure Index of Vibrant City

3. Radar Chart Wonderful City

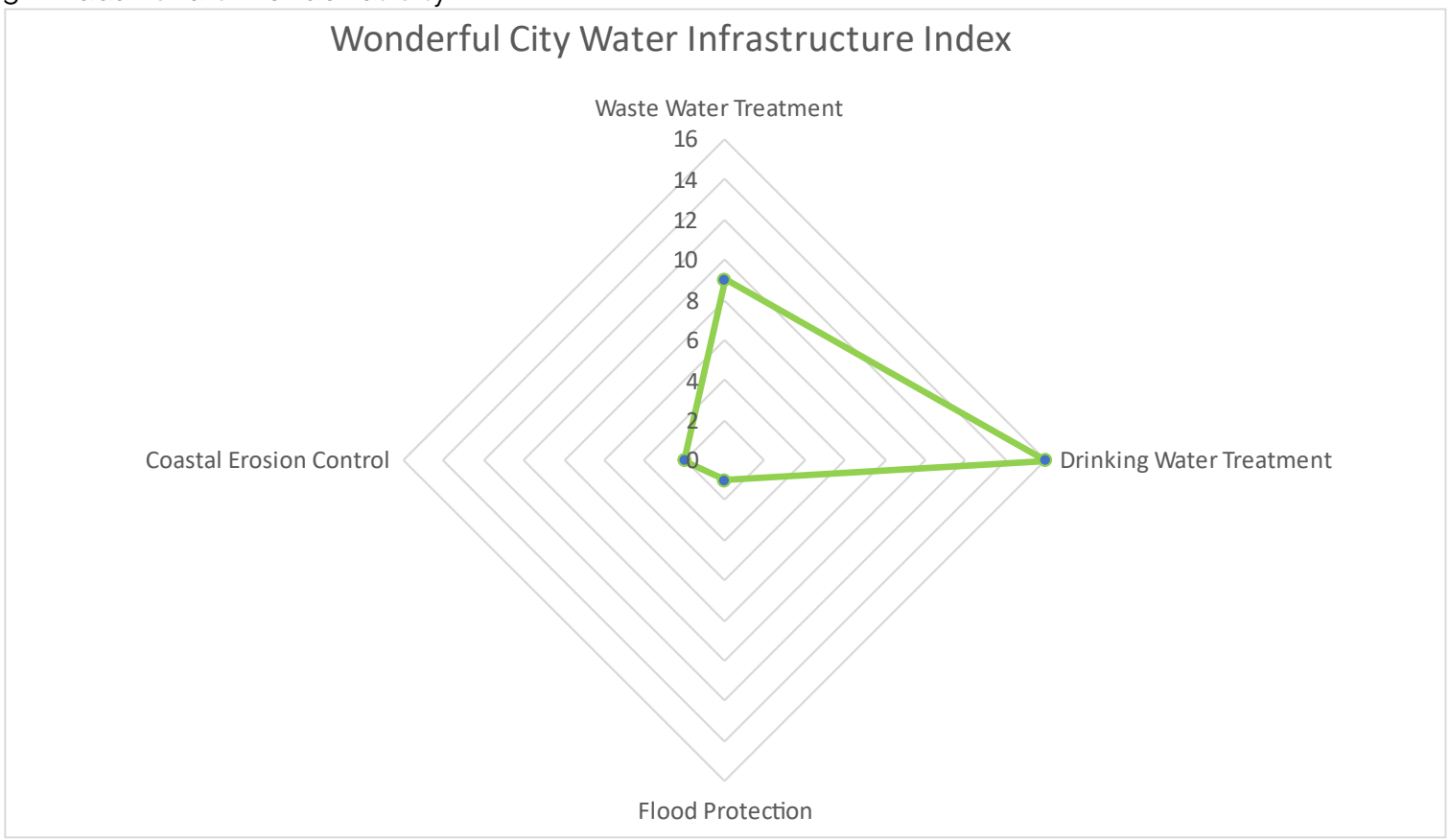

Diagram 15 Radar Chart of Water Infrastructure Index of Wonderful City

4. Comparison of All City Indexes

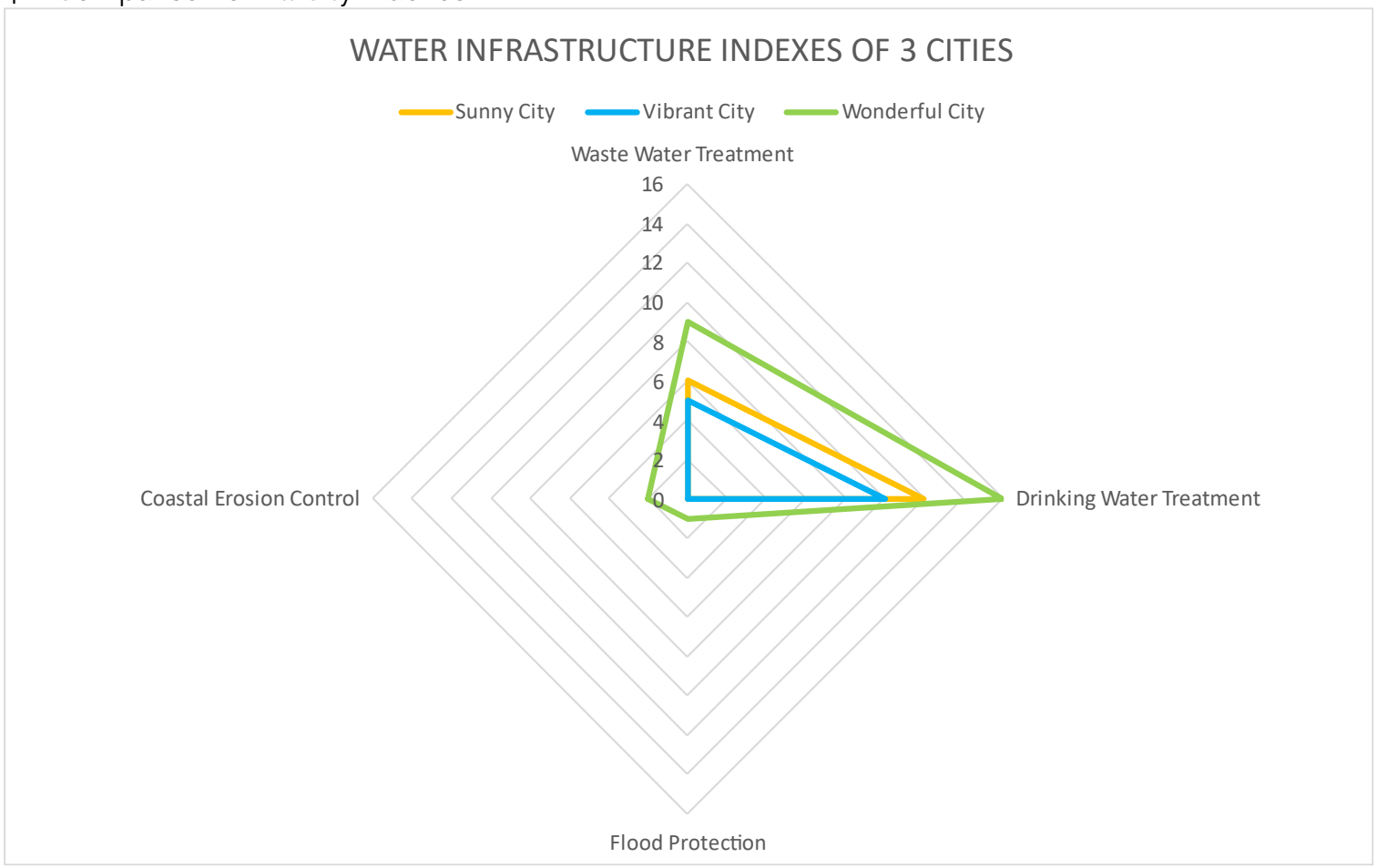

Diagram 16 Radar Chart Collage of Water Infrastructure Index of 3 Cities: Sunny City, Vibrant City, and Wonderful City

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3.5 Cultural Sustainability Index by Yuke Ardhiati

3.5.1 Definition

Cultural Sustainability in this book is defined of cultural artifacts included (a) heritage conservation, (b) cultural belief, (c) cultural practices, and (d) cultural identity in their information meaning-full of; (i) technological processes, (ii) economic development and (iii) social structures, which have availability and accessibility to sustain in the future and are useful for individual self-actualization needs of citizens that contribute to citizen quality of life.

3.5.2 Cultural Sustainability Output Based

The goal of Cultural Sustainability output is based on how the city's stakeholder can be available and accessible for all cultural artifacts in order to contribute to citizen's quality of life. Available means is related to ready for immediate use, and accessible means is related to a quality of being able to be reached or entered.

3.5.3 Cultural Sustainability Criteria

Cultural Sustainability is related to sustainable development (to sustainability) by maintaining all cultural artifacts of the city to the future generation. Examples are; (a) heritage conservation, (b) cultural belief, (c) cultural practices, and (d) cultural identity. City management role to maintain all. Cultural artifact is anything people created within cultural information related manufactured and used from archaeological sites, objects of modern, early-modern society, or social artifacts.

All cultural artifacts, whether ancient or current, have a significance because they offer an insight into: (i) technological processes, (ii) economic development and (iii) social structure, among other attributes. In early, the cultural artifact categorized (Wartofskty,1979)[4] there are; (a) primary artifacts: used in production (such as a hammer, a fork, a lamp or a camera); (b) secondary artifacts: relating to primary artifacts (such as a user-manual for a camera); (c) tertiary artifacts: representations of secondary artifacts (such as a picture of a user-manual for a camera). Then, they evolve according to the times. Examples of cultural artifacts

[4] Wartofsky, Marx W. (1979). Models: Representation And Scientific Understanding. Dordrecht, The Netherlands: Reidel.

included; (a) heritage conservation, (b) cultural belief, (c) cultural practices, (d) cultural identity.

In the Classical Age, we know pottery, weaponry, artwork, tools, and manuscripts/writing. In the Modern Age examples could be a telephone and television as these objects tell us how modern people communicate. Now is also called the Contemporary Age, many of heritage buildings as cultural artifacts within 50 years (Unesco,1992)[5]. One of guideline related Cultural Heritage refers to EU/CoE, 2012)[6].

Types of artifact refers to Smith in Four Types (Smith, 2007)[7] included;

1. Historical and Cultural items such as a historic relic or work of art.
2. Media. Media such as film, photographs or digital files that are valued for their creative or information content.
3. Knowledge. All related a theoretical or practical understanding of a subject, included practical skill or expertise, and the theoretical understanding of a subject formally, informally and also the systematic or particular.
4. Data. All related information, knowledge and wisdom are closely related concepts within meaning-full included scientific research.

Beside needs housing as their basic needs, humans also needs to their survival during life. Again, Abraham Theory of Human Motivation (Maslow, 2013)[8], guided understand the human motivation into two stages; the Deficiency Needs (D-needs) and the upper levels are named as Growth Needs or B Needs (B-needs).

As well as describe before in Housing Index, the Deficiency Needs (D-needs) phase, divided into; (a) Physiological Need, (a) Security Need, (b) Social Need, and (d) Esteem Need, which

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[5] Unesco (1992). World Heritage Convention. https://whc.unesco.org. Retrieved on March 23, 2022 from https://whc.unesco.org.

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[7] Smith, Owen F (2007). Object Artifacts, Image Artifacts and Conceptual Artifacts: Beyond the Object into the Event in Artifact • April 2007. DOI: 10.1080/17493460600610707 retrieved in March 19, 2022 from https://www.researchgate.net/publication/233327644

[8] https://www.simplypsychology.org/saul-mcleod.html

arise due to deprivation. After satisfied of these lower-level of Deficiency Needs (D-needs) human needs to the level is Growth Needs or Being Needs as the second phase.

In the Growth Needs or Being Needs (B-need) as the second phase included; (a) Cognitive Needs (Knowledge and Understanding), (b) Aesthetic Needs, (c) Self-Actualization Needs, (d) Transcendence Need. The second phase can be realization of a person's potential, self-fulfillment, seeking personal growth and peak experiences. So, an individual may have a strong desire to become her/his desire or ambition, or passion to reach the top level of the hierarchy of needs.

Example of Growth Needs Phase, will continued after Deficiency Needs Phase;

1. Cognitive Needs (Knowledge and Understanding) mean need to know, curiosity, exploration, need for meaning and predictability acquire relevant knowledge and skills. Therefore, physical facilities or building types related to them are; (a) Public Library, (b) Society Centre, (c) Convention Centre.
2. Aesthetic Needs means need to enjoy, appreciation,search for beauty, balance, form and promote the beauty of human environment. Physical facility or building type related them are; (a) Land Art, (b) Art Space, (c) Monument Site.
3. Self-Actualization Needs or Self-Realization Needs mean need for development of inborn talents, potential, resources, accomplishment. Therefore, physical facility or building type related are; (a) Art Centre, (b) Society Centre, (c) Convention Centre.
4. Transcendence Needs, means need to help others to achieve self- actualization. Therefore, physical facility or building types related them are; (a) Charity Building, (b) Orphanage house, (c) Care/Nursing House.

There are criteria of cultural artifact founded by interrelation between the Cultural Artifact Categorized that had reflected all the Human Motivation at that time;

1. World Heritage List of UNESCO, or Recognition by National or District. All Heritage Buildings in this City as well as UNESCO Recognition (1992).

   Also, National's or District's recognition that had traced all individual self-actualization of citizen needs. Categorized by theme divided into; (i) technological processes, (ii) economic development and (iii) social structures.

2. The Heritage Building Condition

All Heritage Buildings had a quality in building appearances. It also had shown how the Management of the City had maintained of them, (c) the Heritage Building's Availability and Accessibility. All Heritage Buildings can be visited by citizens. Available and accessible criteria mean, all Heritage Buildings are ready for immediate use and also have a quality of being able to be reached or entered.

3.5.4 Indicator of Livable City

Many cities were revealed to be occupied by the ancient city or colonial city (Ardhiati, 2013). Ancient civilization has contributed directly to the "sense of place" to coloring a new city and are merging between attributes of a city to offer a better quality of life. To score the cultural sustainability index, we need a minimum of 3 (tree) buildings in each criterias. And, all facilities need indicator among others;

1. Accessibility. If distance around (i) 1-5 km by walk, score is best/excellent, (ii) 6-10 km by vehicle is moderate, and (iii) more 10 km by vehicle is bad
2. Building's Performance. If in (i) intact form/ original, score is best/ excellent, and (ii) mixed form, score is moderate, (iii) change from original, score is worse.
3. Heritage Condition refers to UNESCO (2013), it need to estimate the building heritage condition, (i) How in the future for 50 years, (ii) How in the present, (iii) How the condition in the past. Therefore, the scoring can be classified as follows:
    a. Lowest score is 0 – 20
    b. Moderate Score is 21-74
    c. Highest score is more than > 75

3.5.5 Cultural Sustainability Index

Cultural Sustainability Index is a summary of calculation of all the Cultural Artifacts in City by comparing suitable content with the three criteria of Cultural Artifact. The Formula of Calculation the Cultural Sustainability Index score of a city:

Cultural Artifacts in City list is an optional criteria. It means, a city who does not have Cultural Artifacts, can out-put or exclude or does not need to count the criteria. A city may purely was created as a modern city, so it not find (a) Charity Building, (b) Orphanage House, (c) Care/Nursing House. All are optional criteria. It means, a city who does not have/ Charity Building, Orphanage House, and Care/Nursing House can out or exclude or does not need to count the criteria.

To sum all the scores, therefore, the scoring can be classified as follows:

1. Each of the index must be assessed as 1 (one) unit of index. Any amount of or more exceeding the written index above will result in 0 (zero) score.
2. Summary all the scores
3. Quantity interpretation of each index into score:
   (a) Beginner score: 1, (b) intermediate score: 2, (c) advance score: 3
4. Sum all score of indexes
   Maximum score:> 15 (b) Minimum score: 7
5. Final interpretation from the total score using these ranges
   (a) Beginner ; 0-7, (b) intermediate: 8-14, (c) advance > 15

3.5.6 Calculation of All Indexes

Table 18 Cultural Sustainability Index Table Form Sheet

NO	Cultural Sustainability Index	Criteria	Indicator	Score
1	Building Performance	How many Heritage Building Condition For50 Year	more than 3facilities	3
			have 2 facilities	2
			have one facilities	1
			without facility	0
2	Self-ActualizationNeeds Facilities	Art Center, Society Center,Convention Center	1-5 km by walk	3
			6-10 km by vehicle	2
			more than 10 km by vehicle is bad.	1
3	Cognitive Needs (Understanding)Facilities	Education Center,Library, Museum	1-5 km by walk	3
			6-10 km by vehicle	2
			more than 10 kmby vehicle is bad.	1
4	Aesthetic Needs	City Panoramic/ Art Monument	1-5 km by walk	3
			6-10 km by vehicle	2
			more than 10 kmby vehicle is bad.	1
5	Transcendence Needs Facilities	Charity House, Orphanage House, Nursing Facility	1-5 km by walk	3
			6-10 km by vehicle	2
			more than 10 kmby vehicle is bad.	1
Total Score				30

Table 19 Cultural Sustainability Indexes Calculation of Sunny City

NO	Cultural SustainabilityIndex	Criteria	Indicator	Score
1	Building Performance	Heritage Building ConditionFor 50 Year	have onefacilities	1
2	Self-Actualization NeedsFacilities	Art Center, Society Center,Convention Center	*6-10 km by vehicle*	*2*
3	Cognitive Needs (Understanding) Facilities	Education Center, Library,Museum	*6-10 km by vehicle*	*2*
4	Aesthetic Needs	City Panoramic/ Art Monument	*more than 10 km by vehicle is bad.*	*1*
5	Transcendence NeedsFacilities	Charity House, OrphanageHouse, Nursing Facility	*more than 10 km by vehicle is bad.*	*1*
Total Score				7

Table 20 Cultural Sustainability Indexes Calculation of Vibrant City

NO	Cultural Sustainability Index	Criteria	Indicator	Score
1	Building Performance	Heritage Building Condition For50 Year	have 2 facilities	2
2	Self-Actualization NeedsFacilities	Art Center, Society Center,Convention Center	*6-10 km byvehicle*	*2*
3	Cognitive Needs (Understanding) Facilities	Education Center, Library,Museum	*6-10 km byvehicle*	*2*
4	Aesthetic Needs	City Panoramic/ Art Monument	*6-10 km byvehicle*	*2*
5	Transcendence Needs Facilities	Charity House, Orphanage House,Nursing Facility	*6-10 km byvehicle*	*2*
Total Score				10

Table 21 Cultural Sustainability Indexes Calculation of Wonderful City

NO	Cultural SustainabilityIndex	Criteria	Indicator	Score
1	Building Performance	Heritage Building Condition For50 Year	*more than 3 facilities*	3
2	Self-Actualization NeedsFacilities	Art Center, Society Center, Convention Center	*1-5 km by walk*	*3*
3	Cognitive Needs (Understanding) Facilities	Education Center, Library, Museum	*1-5 km by walk*	*3*
4	Aesthetic Needs	City Panoramic/ Art Monument	*1-5 km by walk*	*3*
5	Transcendence NeedsFacilities	Charity House, Orphanage House, Nursing Facility	*1-5 km by walk*	*3*
Total Score				*15*

How to Calculate the Cultural Sustainability Index Score of a City?

Because of city existing condition, a city may purely was created as a modern city, so it does not find (a) Charity Building, (b) Orphanage House, (c) Care/Nursing House. All are optional criteria, so all are optional criteria. To sum all the scores, therefore, the scoring can be classified as follows:

a. Beginner score is 4 – 7
b. Intermediate score is 8-10
c. Advance score is more than > 10

Conclusion

Based on the scoring simulation then, the conclusion are:

a. Sunny city having a total score of 7 is considered as Beginner
b. Vibrant City having a total score of 10 is considered as Moderate
c. Wonderful City having a total score of 15 is considered as Advance.

Radar Chart of Cultural Sustainability Index

1. Radar Chart of Cultural Sustainability Index of Sunny City.

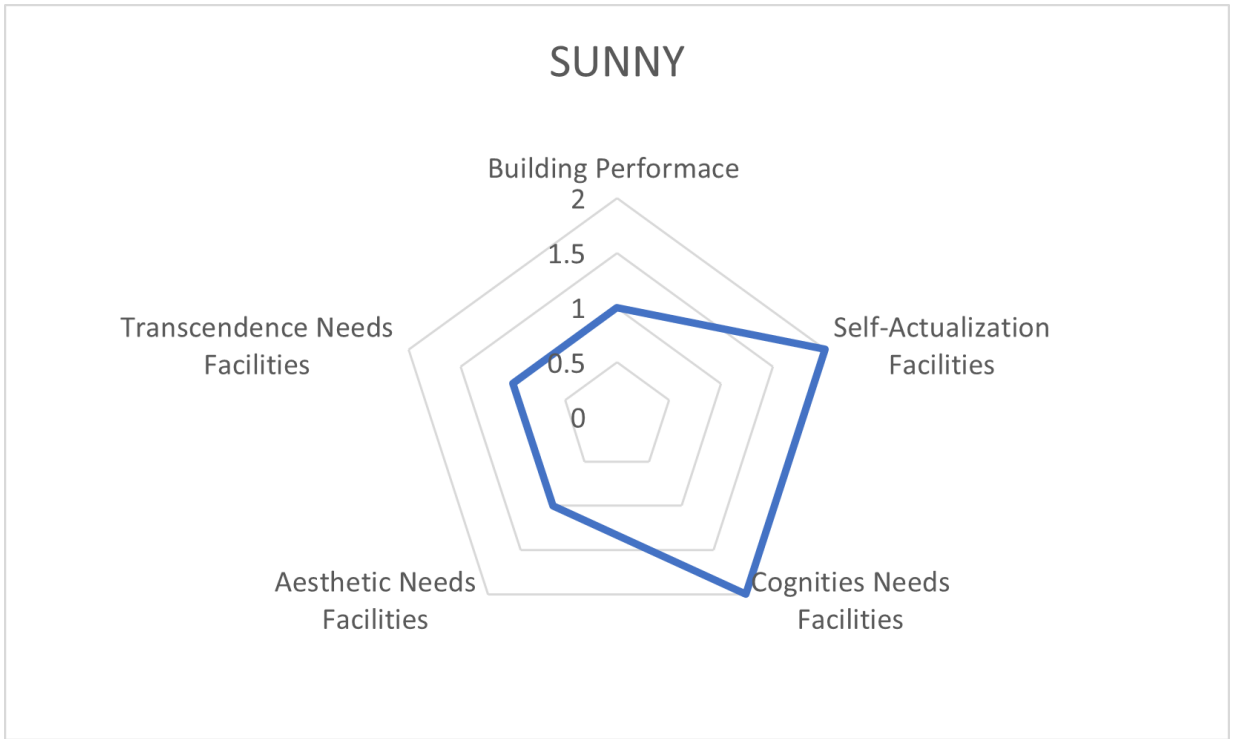

Diagram 17 Radar Chart of Cultural Sustainability Index of Sunny City.

2. Radar Chart of Cultural Sustainability Index of Vibrant City

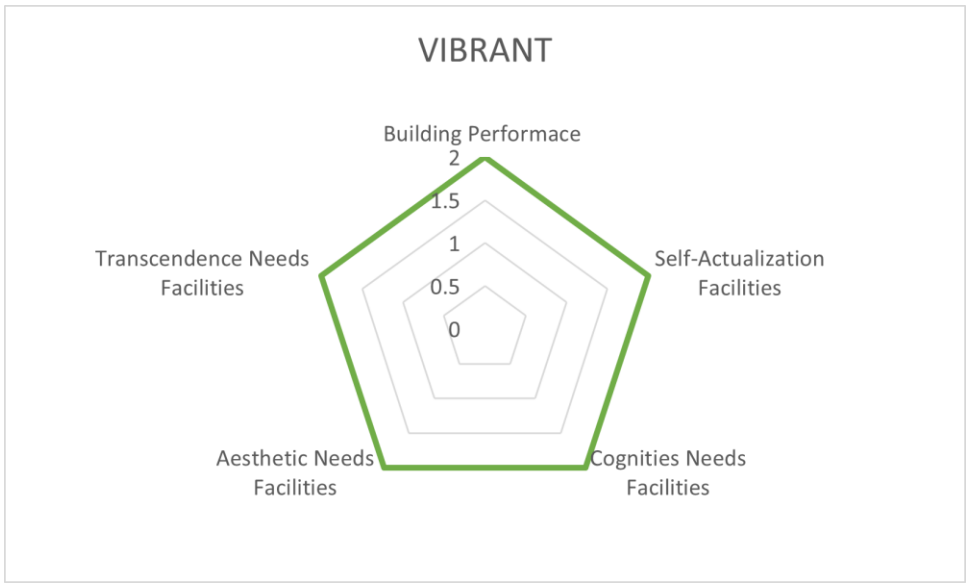

Diagram 18 Radar Chart of Cultural Sustainability Index of Vibrant City

3. Radar Chart of Cultural Sustainability Index of Wonderful City.

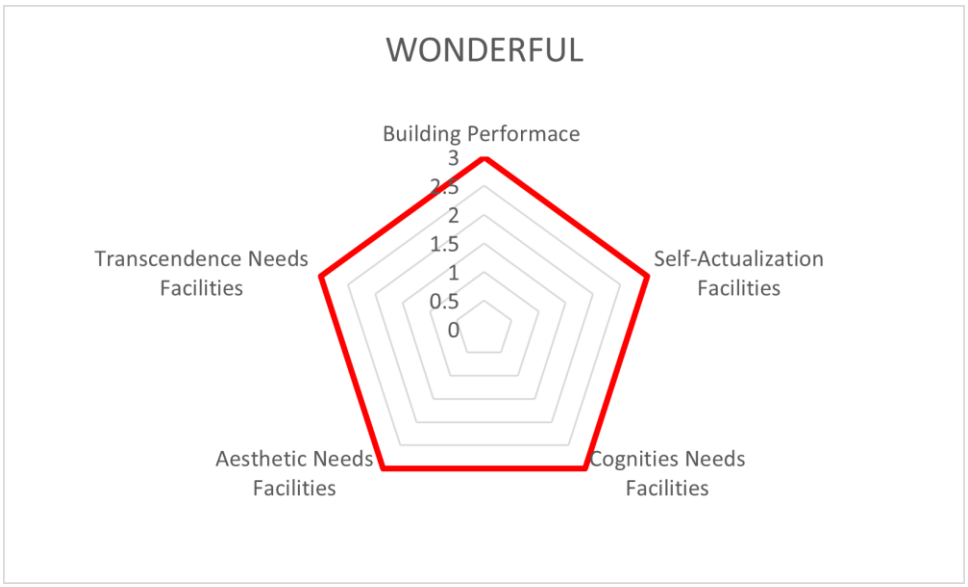

Diagram 19 Radar Chart of Cultural Sustainability Index of Wonderful City.

4. Radar Chart Comparison in 3 Cities

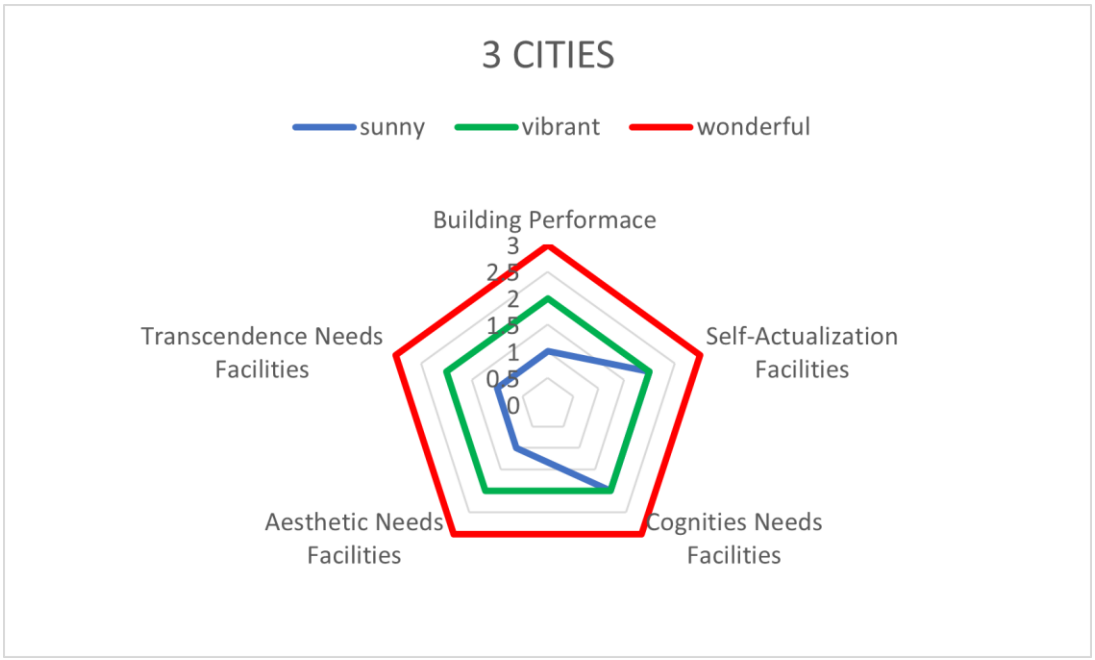

Diagram 20 Radar Chart Collage of Cultural Sustainability Index of 3 Cities : Sunny City, Vibrant City, and Wonderful City.

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3.6 Public Security Index by Yuke Ardhiati

3.6.1 Definition

Public Security in this book is defined as physical and non physical facilities that all necessary to feel secure from all citizen threats. Public Security role of the governments to protect citizens, persons in their territory, organizations, and institutions against threats to their well-being – and to the prosperity of their communities. Because of this significance then, recently public security roles have increased by synergies with private organizations.

3.6.2 Public Security Output Based

The goal of Public Security output is based on how the city's stakeholder reflects to portray the citizen's happiness to contribute to the citizen's quality of life. Means, Public Security as one of requirement in order citizens recognize the government reliability as the basis to create Political stability.

3.6.3 Public Security Criteria

Public Security is related to how citizens maintain all physical and non physical facilities to give all citizens and organizations safety. Physical public security traced by the documentary archive of city masterplan, housing masterplan and housing plan itself in many level, such us into (a) regional /international planning, (b) national boundary plan, included (i) the national borders and illegal refugees that occur due to the shifting of state standards, then resettled by illegal immigrants. It could also be sovereign terrorism, or terror against state sovereignty, which makes the public as insecure as Gerakan Aceh Merdeka (GAM), (ii) city/province area boundaries,(iii) village boundaries, (iv) residential boundaries.

Then, (c) city/ regional masterplan, (d) building/ housing site plan. Meanwhile, non physic public security created by government reinforcement have a significance into policies of violent crime prevention can produce effects rapidly, at low cost with reference here to the municipalities and their governments since, by their proximity "to the point," accessibility, agility and leanness constitute the greatest likeliness of executing preventive policies (Soares, 2017).

All can be traced by archives that contribute to citizen security life including (i) homeland security, such us army forces, (ii) justice, for reinventing public trustworthiness, related to the corruption accident;(a) corruption watch institution, (b) constitution court, (c) prison, (iv) Law enforcement by reinventing the policy bureaucracy.

Traced by institutional reformation, (iv) Public Safety, by create based camp in any level to anticipated from physical dangerous and social situations; (a) Security /Police Station,(b) Policy Guard, (c) Tourism Police, (v) societal security, as well as in Indonesia such as People's Safety post- Keamanan Rakyat (Karma), People's Resistance Perlawanan Rakyat (Wanra), (ii) by create traditional security post - pos ronda tradisional, balai bengong in Bali), security post by political party/paramiliter.

To understand how the public security does that can be traced by all accident documentaries, reports, images and archives. And also the documentary of city masterplan, and renewal of city masterplan (usually after 20 years).

Individual Physical Security divided into:

1. Individual bodies, such as (i) injuries and defects. Could be the result of theft, robbery or accident, (ii) murder, can be due to robbery, riot or accident, (iii) rape,
2. Individual assets, such as (i) money, with indicator loss, robbery/theft /mugging. Both physically and electronically, (ii) land. Loss/grab indicators, and double certificates, (iii) house, with indicators of loss and destruction/looting, 4) vehicles. Indicators of loss, and destruction (could be due to robbery or accident). Including lost or damaged vehicles, in the parking lot.

Non-physical individual Security divided

1. Personal psychology included (i) personal harassment/bullying. Due to race, face, language, skin colour, dialect, low grades, not having children/partners, etc, (ii) personal stress-out. Due to economic burden, workload, academic burden, or routine, (iii) fear of being terrorized by threats (to be killed, or to spread disgrace),
2. Data/cyber: data loss or leak/spread of data without the owner's permission, (i) individual data and (ii) company data.

3.6.4 Indicator of Public Security Index

Behind this creates a new, many countries whose cities were revealed to be occupied by the ancient city or colonial city (Ardhiati, 2013). The ancient city has contributed to colouring the public security index. Physical public security traced by the documentary archive that show to reduce the attractiveness of crime targets of city masterplan, housing masterplan and housing plan itself in many levels, such us into (a) regional /international planning, (b) national boundary plan, (c) city/regional masterplan, (d) building/ housing plan. Meanwhile, Public Security may trace by design that shows images as security of natural surveillance; (i) Access Control, by putting a gate and territorial security post in residential complex, (ii) Device Controls; Lighting, camera, pedestrian pathways, streetlights, radio pager, CCTV monitor.

Non Physical public security included how government created public security services:

1. Homeland Security, is public security from enemy in state level, divided into; (a) Elite Forces (pasukan elit) as Presidential Guard/ Pasukan Pengawal Presiden, (b) Special Elite Squad / Pasukan Khusus included frog squad, (c) Intelligence Squad such as Badan Inteligen Nasional (BIN), Central Intelligence Agency (CIA) as the principal foreign intelligence and counterintelligence agency of the U.S. government, Komitet Gosudarstvennoy Bezopasnosti (KGB) as Committee for State Security of Russia, (d) security from disaster mitigation such as Badan Nasional Penanggulangan Bencana (BNPB) included their services to flood disaster security post, forest security post, volcano security post,
2. Justice, for reinventing public trustworthy, related to the corruption accident;(a) corruption watch institution, (b) constitution court, (c) prison
3. Law Enforcement by reinventing the policy bureaucracy. Traced by institutional reformation
4. Public Safety, by create based camp in any level to anticipated from physical dangerous and social situations, for example in Indonesia included; (a) Security /Police Station, (b) pos kamling desa/ dusun (c). Kepolisian Sektor/ Polsek tingkat kota kecamatan, (d) pos keamanan bencana banjir/ tsunami, gunung berapi, (e) Security city neighborhood. Physical facility or building type related them are;(a) polres, (b) polda, (c) polisi pariwisata, (d) pos polisi militer, (e) kopassus, (f) pasukan penjaga presiden is, (g) pos penjaga teritorial darat/ laut/ udara the limited edition in cities/ country.
5. Societal security, by create access control, by put a gate and territorial security post in residential complex in Indonesia such as People's Safety post named Keamanan Rakyat (Karma), People's Resistance named Perlawanan Rakyat (Wanra) by create traditional

security post (pos ronda tradisional, balai bengong in Bali), security post by political party/paramiliter, Campus Security, District Business Security etc.

To understand how the public security does that can be traced by all accident documentaries, reports, images and archives. To score the public security index, need a minimum amount of 3 (tree) items in each criteria. And, all facilities need indicators among others; To score the public security index, need minimum mount 3 (tree) in each criteria. And, all facilities need indicator among others;

1. Masterplan Traced. If traced (i) 1-5 images, score is bad, (ii) 6-10 images is moderate, and (iii) more 10 images best/excellent,
2. Public Security Building's Performance. If in (i) intact form/ original, score is best/ excellent, and (ii) mixed form, score is moderate, (iii) change from original, score is worse.
3. Accident Documentary Report, (i) documentaries report, (ii) images documentary report and (iii) archives.

Therefore, the scoring can be classified as follows:

1. Lowest score is 0 – 13
2. Moderate Score is 14-26
3. Highest score is more than > 39

3.6.5. Calculation of All Indexes

Table 22 Public Security Index Table Form Sheet

No	Public Security	Criteria	Indicator	Score
1	Physical Public Security by Design	Regional /International Planning	more than 3 images	3
			have 2 images	2
			have one images	1
			without images	0
		City Masterplan	more than 3 images	3
			have 2 images	2
			have one images	1
			without images	0
		Residential/ Housing	more than 3 images	3

No	Public Security	Criteria	Indicator	Score
		Plan	have 2 images	2
			have one images	1
			without images	0
2	Natural Surveillance	Access Control/ Device Control	more than 3 images	3
			have 2 images	2
			have one images	1
			without images	0
		Traditional Security Post	more than 3 images	3
			have 2 images	2
			have one images	1
			without images	0
3	Individual Physical Security	Individual bodies	more than 3 report	3
			have 5-10 report	2
			have more than 10 report	1
			without report	0
		individual asset	more than 3 report	3
			have 5-10 report	2
			have more than 10 report	1
			without report	0
4	Non-Physical For IndividualSecurity	Personal Psychology	more than 3 report	3
			have 5-10 report	2
			have more than 10 report	1
			without report	0
		Data/cyber	more than 3 report	3
			have 5-10 report	2
			have more than 10 report	1
			without report	0
5	Non Physical Public Security	Homeland Security	more than 3 squad	3
			have 2 images	2
			have one images	1
			without images	0

No	Public Security	Criteria	Indicator	Score
		Justice	more than 3 regulation system	3
			have 2 regulation	2
			have one regulation	1
			without regulation	0
		Law enforcement	more than 3 regulation system	3
			have 2 regulation	2
			have one regulation	1
			without regulation	0
		Public Safety	more than 3 regulation system	3
			have 2 regulation	2
			have one regulation	1
			without regulation	0
Total Score				

Table 23 Public Security Indexes Calculation of Sunny City

NO	Public Security	Criteria	Indicator	Score
1	Physical Public Security by Design	Regional /International Planning	more than 3 images	
			have 2 images	
			have one images	1
			without images	
		City Masterplan	more than 3 images	
			have 2 images	
			have one images	1
			without images	
		Residential/ Housing Plan	more than 3 images	
			have 2 images	

			have one images	1
			without images	
2	Natural Surveillance	Access Control/ Device Control	more than 3 images	
			have 2 images	
			have one images	1
			without images	
		Traditional Security Post	more than 3 images	
			have 2 images	
			have one images	1
			without images	
3	Individual Physical Security	Individual bodies	more than 3 report	
			have 5-10 report	
			have more than 10 report	1
			without report	
		individual asset	more than 3 report	
			have 5-10 report	
			have more than 10 report	1
			without report	
4	Non-Physical For Individual Security	Personal Psychology	more than 3 report	
			have 5-10 report	
			have more than 10 report	1
			without report	
		Data/cyber	more than 3 report	
			have 5-10 report	
			have more than 10 report	1
			without report	
5	Non Phisical Public Security	Homeland Security	more than 3 squad	
			have 2 images	
			have one images	1
			without images	
		Justice	more than 3 regulation system	
			have 2 regulation	

			have one regulation	1
			without regulation	
		Law enforcement	more than 3 regulation system	
			have 2 regulation	
			have one regulation	1
			without regulation	
		Public Safety	more than 3 regulation system	
			have 2 regulation	
			have one regulation	1
			without regulation	
Total Score				13

Table 24 Public Security Indexes Calculation of Vibrant City

NO	Public Security	Criteria	Indicator	Score
1	Physical Public Security by Design	Regional /International Planning	more than 3 images	
			have 2 images	2
			have one images	
			without images	
		City Masterplan	more than 3 images	
			have 2 images	2
			have one images	
			without images	
		Residential/ Housing Plan	more than 3 images	
			have 2 images	2
			have one images	
			without images	
2	Natural Surveillance	Access Control/ Device Control	more than 3 images	
			have 2 images	2
			have one images	
			without images	

NO	Public Security	Criteria	Indicator	Score
		Traditional Security Post	more than 3 images	
			have 2 images	2
			have one images	
			without images	
3	Individual Physical Security	Individual bodies	more than 3 report	
			have 5-10 report	2
			have more than 10 report	
			without report	
		individual asset	more than 3 report	
			have 5-10 report	2
			have more than 10 report	
			without report	
4	Non-Physical For Individual Security	Personal Psychology	more than 3 report	
			have 5-10 report	2
			have more than 10 report	
			without report	
		Data/cyber	more than 3 report	
			have 5-10 report	2
			have more than 10 report	
			without report	
5	Non Physical Public Security	Homeland Security	more than 3 squad	
			have 2 images	2
			have one images	
			without images	
		Justice	more than 3 regulation system	
			have 2 regulation	2
			have one regulation	
			without regulation	
		Law enforcement	more than 3 regulation system	

NO	Public Security	Criteria	Indicator	Score
			have 2 regulation	2
			have one regulation	
			without regulation	
		Public Safety	more than 3 regulation system	
			have 2 regulation	2
			have one regulation	
			without regulation	
Total Score				*26*

Table 25 Public Security Indexes Calculation Sample of Wonderful City

NO	Public Security	Criteria	Indicator	Score
1	Physical Public Security by Design	Regional /International Planning	more than 3 images	3
			have 2 images	
			have one images	
			without images	
		City Masterplan	more than 3 images	3
			have 2 images	
			have one images	
			without images	
		Residential/ Housing Plan	more than 3 images	3
			have 2 images	
			have one images	
			without images	
2	Natural Surveillance	Access Control/ Device Control	more than 3 images	3
			have 2 images	
			have one images	
			without images	
		Traditional Security Post	more than 3 images	3

NO	Public Security	Criteria	Indicator	Score
			have 2 images	
			have one images	
			without images	
3	Individual Physical Security	Individual bodies	more than 3 report	3
			have 5-10 report	
			have more than 10 report	
			without report	
		individual asset	more than 3 report	3
			have 5-10 report	
			have more than 10 report	
			without report	
4	Non-Physical For Individual Security	Personal Psychology	more than 3 report	3
			have 5-10 report	
			have more than 10 report	
			without report	
		Data/cyber	more than 3 report	3
			have 5-10 report	
			have more than 10 report	
			without report	
5	Non Physical Public Security	Homeland Security	more than 3 squad	3
			have 2 images	
			have one images	
			without images	
		Justice	more than 3 regulation system	3
			have 2 regulation	
			have one regulation	
			without regulation	
		Law Enforcement	more than 3 regulation system	3
			have 2 regulation	
			have one regulation	
			without regulation	

NO	Public Security	Criteria	Indicator	Score
		Public Safety	more than 3 regulation system	3
			have 2 regulation	
			have one regulation	
			without regulation	
Total Score				*39*

How to Calculate the Public Security Index Score of a City?

Because of city existing condition, a city may purely was created as a modern city, so it does not find (a) Charity Building, (b) Orphanage House, (c) Care/Nursing House. All are optional criteria, so all are optional criteria. To sum all the scores, therefore, the scoring can be classified as follows:

a. Lowest score is > 20
b. Moderate score is 21-24
c. Highest score is more than > 25

Conclusion

Based on the scoring simulation then, the conclusion are:

a. A city having total score of 18 is considered as Sunny city / Beginner
b. A city having total score of 99 is considered as Vibrant city / Moderate
c. A city having a total score of 120 is considered as Wonderful city / Advance.

Radar Chart of the Public Security Index

1. Radar Chart of the Public Security Index of Sunny City.

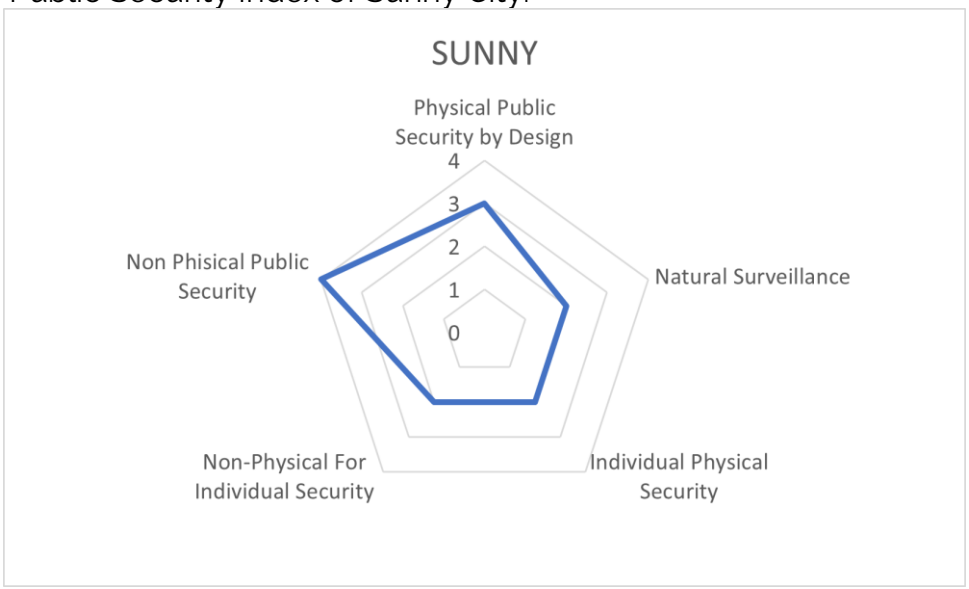

Diagram 21 Radar Chart of the Public Security Index of Sunny City

2. Radar Chart of the Public Security Index of Vibrant City.

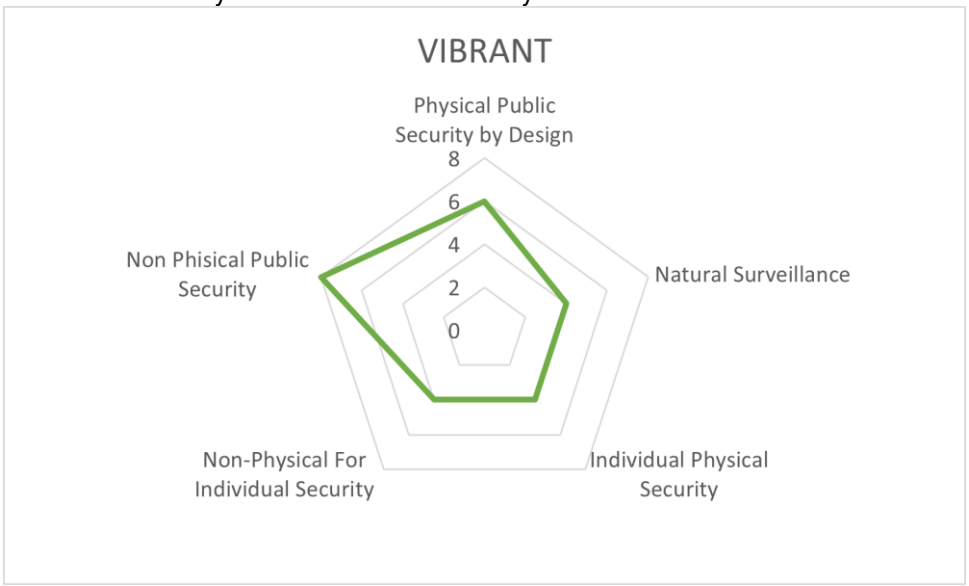

Diagram 22 Radar Chart of the Public Security Index of Vibrant City

3. Radar Chart of the Public Security Index of Wonderful City

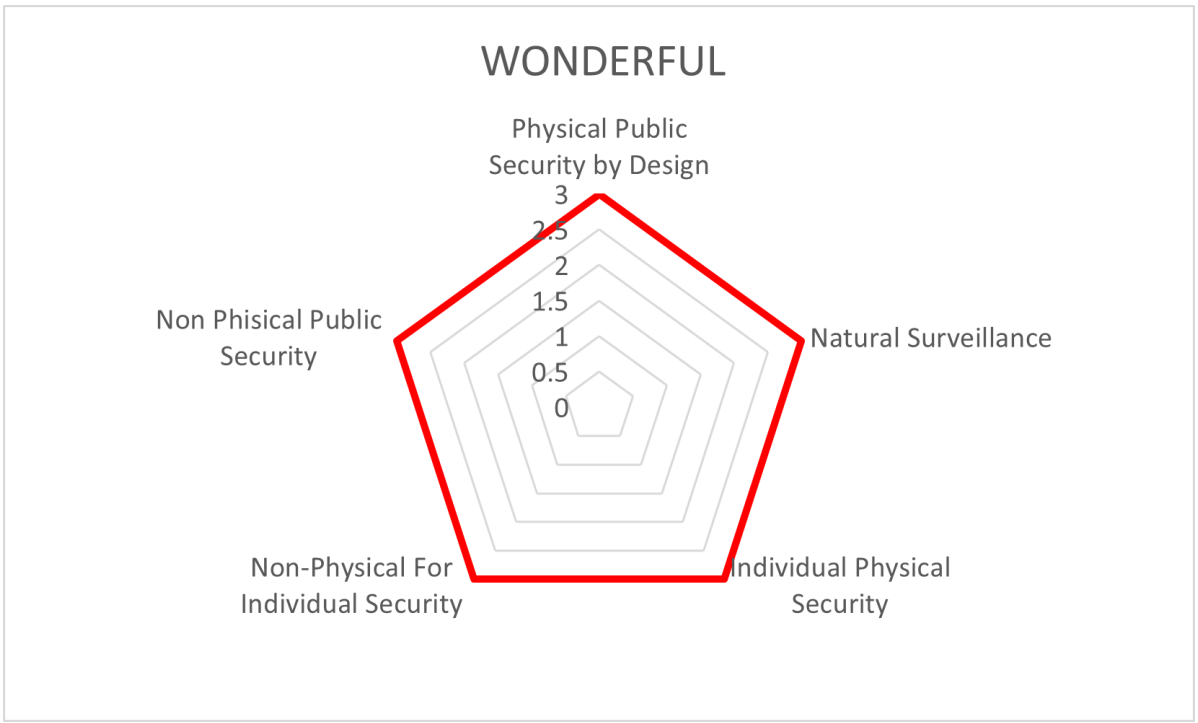

Diagram 23 Radar Chart of the Public Security Index of Wonderful City

4. Radar Chart Comparison of All City Indexes

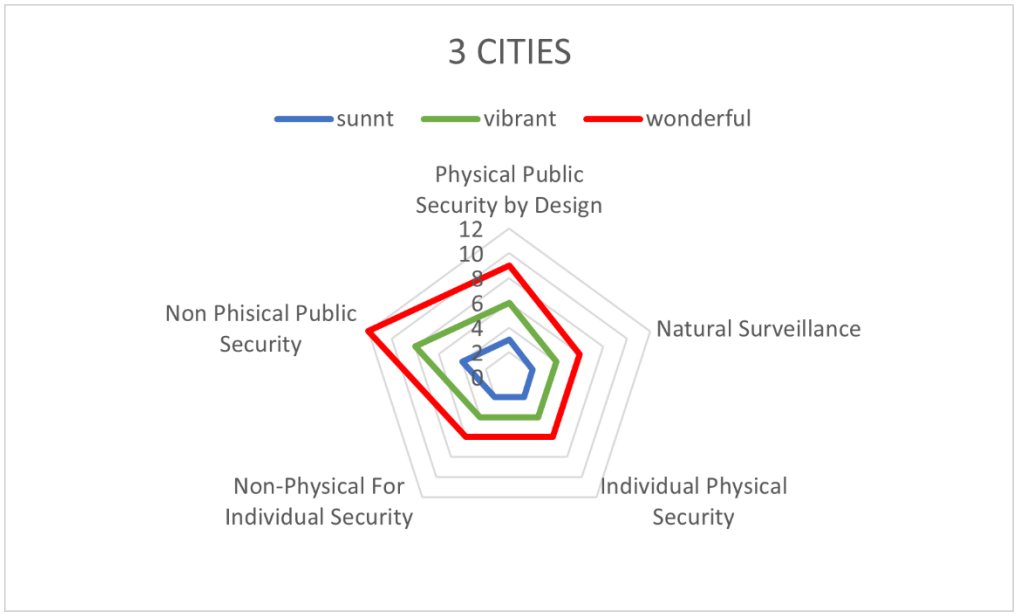

Diagram 24 Radar Chart Collage of Public Security Index of 3 Cities: Sunny City, Vibrant City, and Wonderful City.

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3.7 Calculation of All Indexes on Chapter 3.1. to 3.6.

Simulation of the measurement on 3 (three) dummy cities: Sunny City, Vibrant City, and Wonderful City, on indexes of Housing, Public Transportation, Waste Management, Water Infrastructures, Cultural Sustainability, and Public Security, isas follows.

1. We compile the indexes in 1 table for each city, such as below. Then we quantify the interpretation of each index (resulted previously from the calculation on each index chapter) into score:
    a. Beginner Score: 1
    b. Intermediate score: 2
    c. Advance score: 3

Table 26 Total Indexes of Sunny City

1. Sunny City			
Number	Index	Interpretation	Score
1	Population Density		
2	Healthcare		
3	Natural Disaster Mitigation		
4	Green Coverage Plot Ratio		
5	Environmental Comfort		
6	Natural Environment Preservation		
7	Development Independence		
8	Energy		
9	Food Security		
10	Housing	Beginner	1
11	Public Transportation	Advance	3
12	Waste Management	Beginner	1
13	Water Infrastructures	Intermediate	2
14	Information and Communication Technology (ICT)		
15	Cultural Sustainability	Beginner	1
16	Public Facility Provision		
17	Education		
18	Public Participation		
19	Neighbourhood Plot Ratio		
20	Economic Stability		
21	Political Stability		
22	Public Security	Beginner	1
Total score of Sunny City: Beginner (6 – 10)			9

Table 27 Total Indexes of Vibrant City

2. Vibrant City			
Number	Index	Interpretation	Score
1	Population Density		
2	Healthcare		
3	Natural Disaster Mitigation		
4	Green Coverage Plot Ratio		
5	Environmental Comfort		
6	Natural Environment Preservation		
7	Development Independence		
8	Energy		
9	Food Security		
10	Housing	Intermediate	2
11	Public Transportation	Intermediate	2
12	Waste Management	Intermediate	2
13	Water Infrastructures	Beginner	1
14	Information and Communication Technology (ICT)		
15	Cultural Sustainability	Intermediate	2
16	Public Facility Provision		
17	Education		
18	Public Participation		
19	Neighbourhood Plot Ratio		
20	Economic Stability		
21	Political Stability		
22	Public Security	Intermediate	2
Total score of Vibrant City: Intermediate (11 – 15)			11

Table 28 Total Indexes of Wonderful City

3. Wonderful City			
Number	Index	Interpretation	Score
1	Population Density		
2	Healthcare		
3	Natural Disaster Mitigation		
4	Green Coverage Plot Ratio		
5	Environmental Comfort		
6	Natural Environment Preservation		
7	Development Independence		
8	Energy		
9	Food Security		
10	Housing	Advance	3
11	Public Transportation	Beginner	1
12	Waste Management	Advance	3
13	Water Infrastructures	Advance	3
14	Information and Communication Technology (ICT)		
15	Cultural Sustainability	Advance	3
16	Public Facility Provision		
17	Education		
18	Public Participation		
19	Neighbourhood Plot Ratio		
20	Economic Stability		
21	Political Stability		
22	Public Security	Advance	3
Total score of Wonderful City: Advance (16 – 18)			16

2. We sum all scores of 6 indexes. Since we cover 6 indexes in this book,therefore
    a. Minimum Score: 6
    b. Maximum Score: 18

As we can see on the table above, We have scores on 6 indexes for each city as follows:

a. Sunny City: 9
b. Vibrant City: 11
c. Wonderful City: 16

3. Our final interpretation from the total score on 6 indexes for each city is as follows:
    a. Beginner: 6 – 10
    b. Intermediate: 11 – 15
    c. Advance: 16 – 18

    As we can see on the table above, We have scores on 6 indexes and therefore the interpretation for each city as follows:
    a. Sunny City: 9, as Beginner
    b. Vibrant City: 11, as intermediate
    c. Wonderful City: 16, as advance
4. We make final radar charts of 3 cities on 6 indaxes.
    a. Sunny City: 9, as beginner

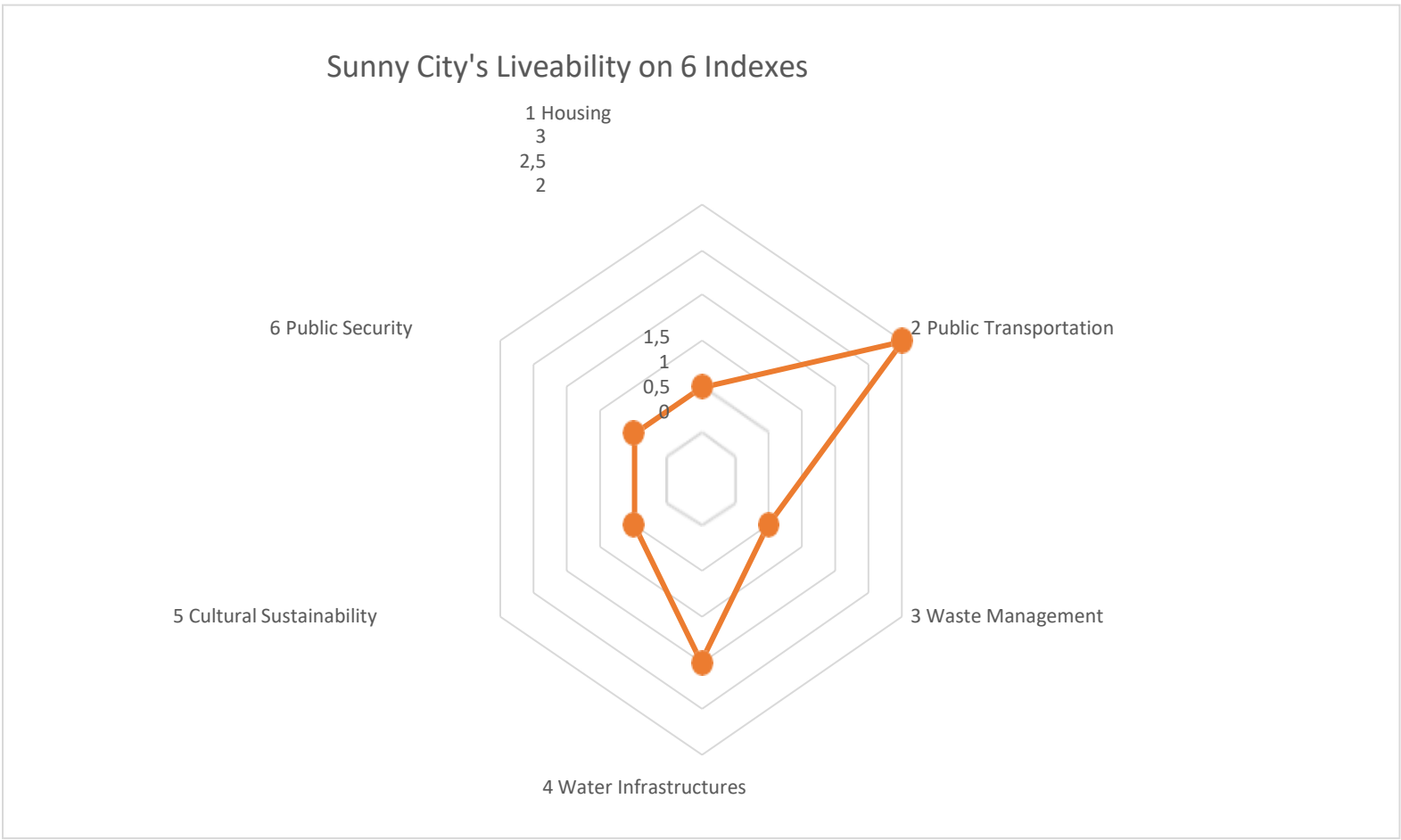

Diagram 25 Final Radar Chart of Sunny City

b. Vibrant City: 11, as intermediate

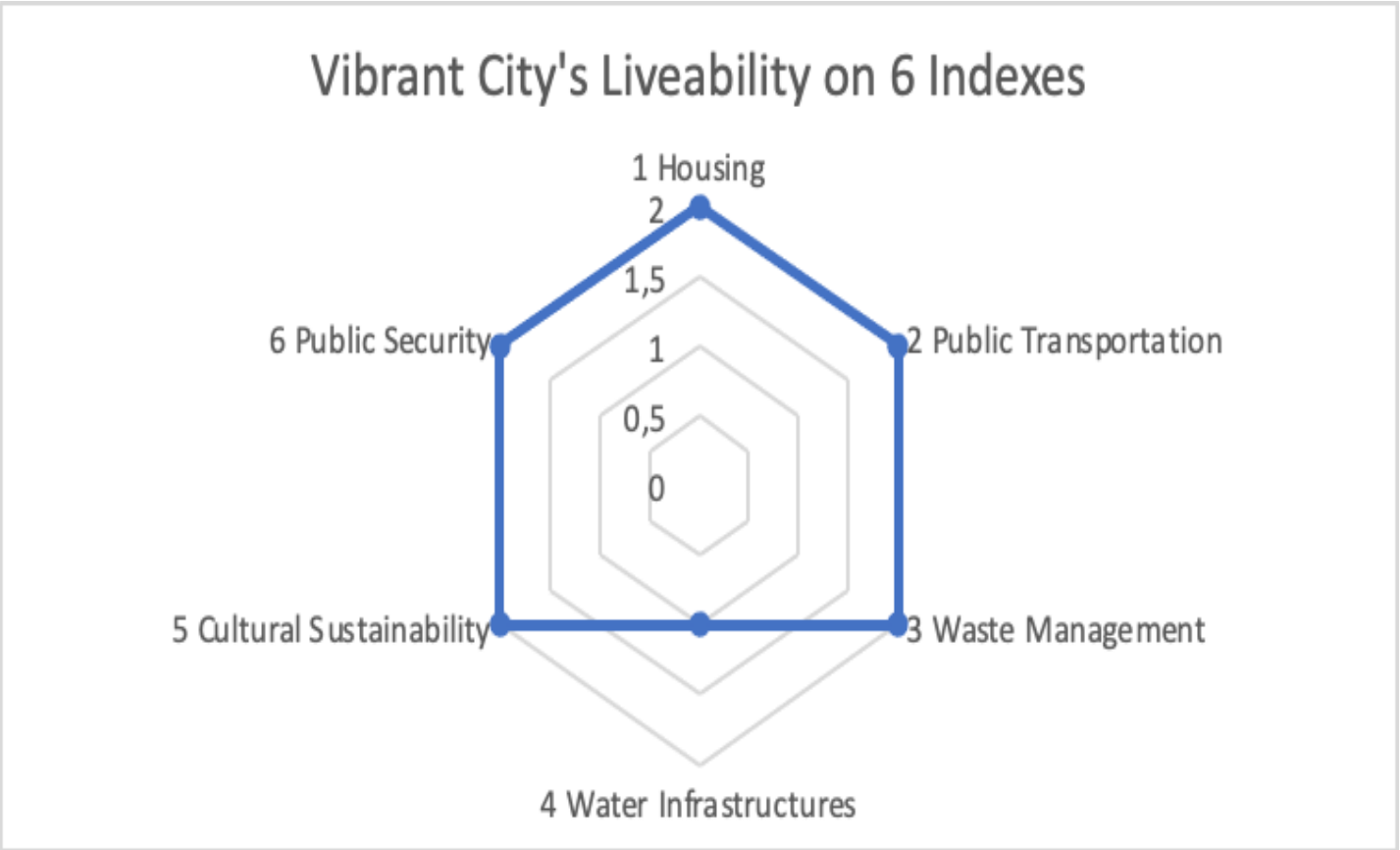

Diagram 26 Final Radar Chart of Vibrant City

c. Wonderful City: 16, as advance

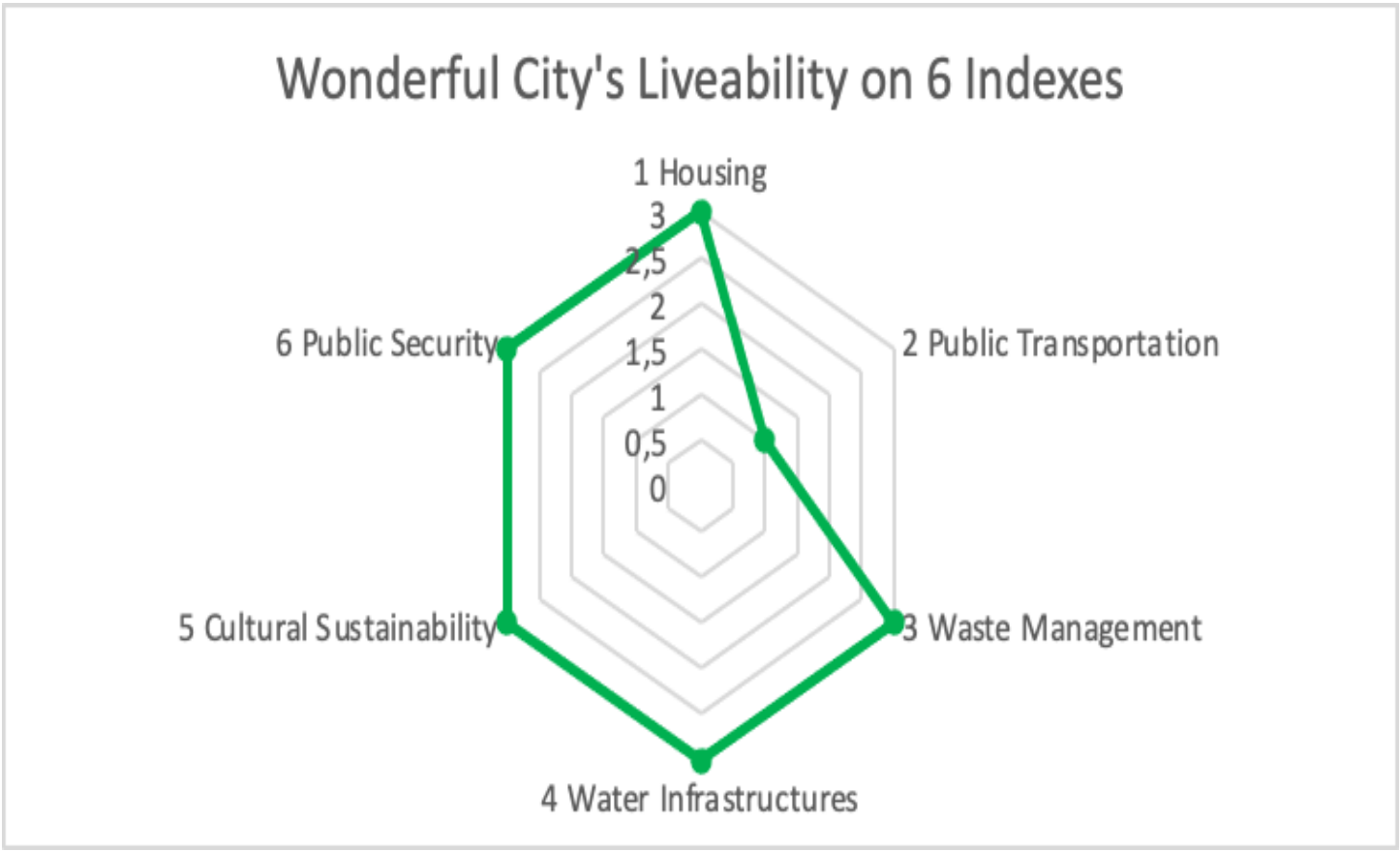

Diagram 27 Final Radar Chart of Wonderful City

d. Compilation / comparison chart of the 3 charts above

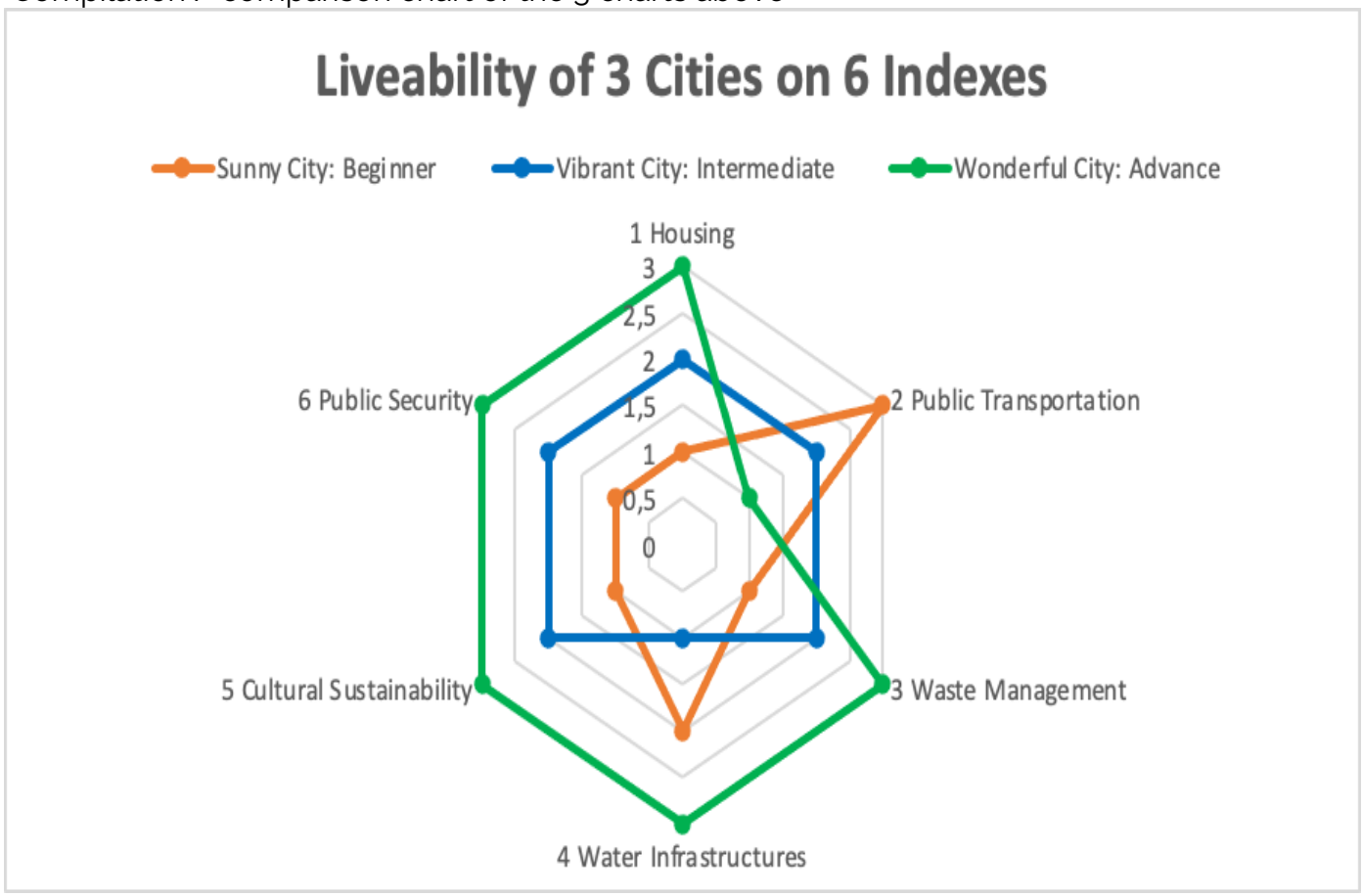

Diagram 28 Comparison Chart of 3 Cities

CHAPTER IV

Best Practices of Liveable Cities

4. 1. Housing

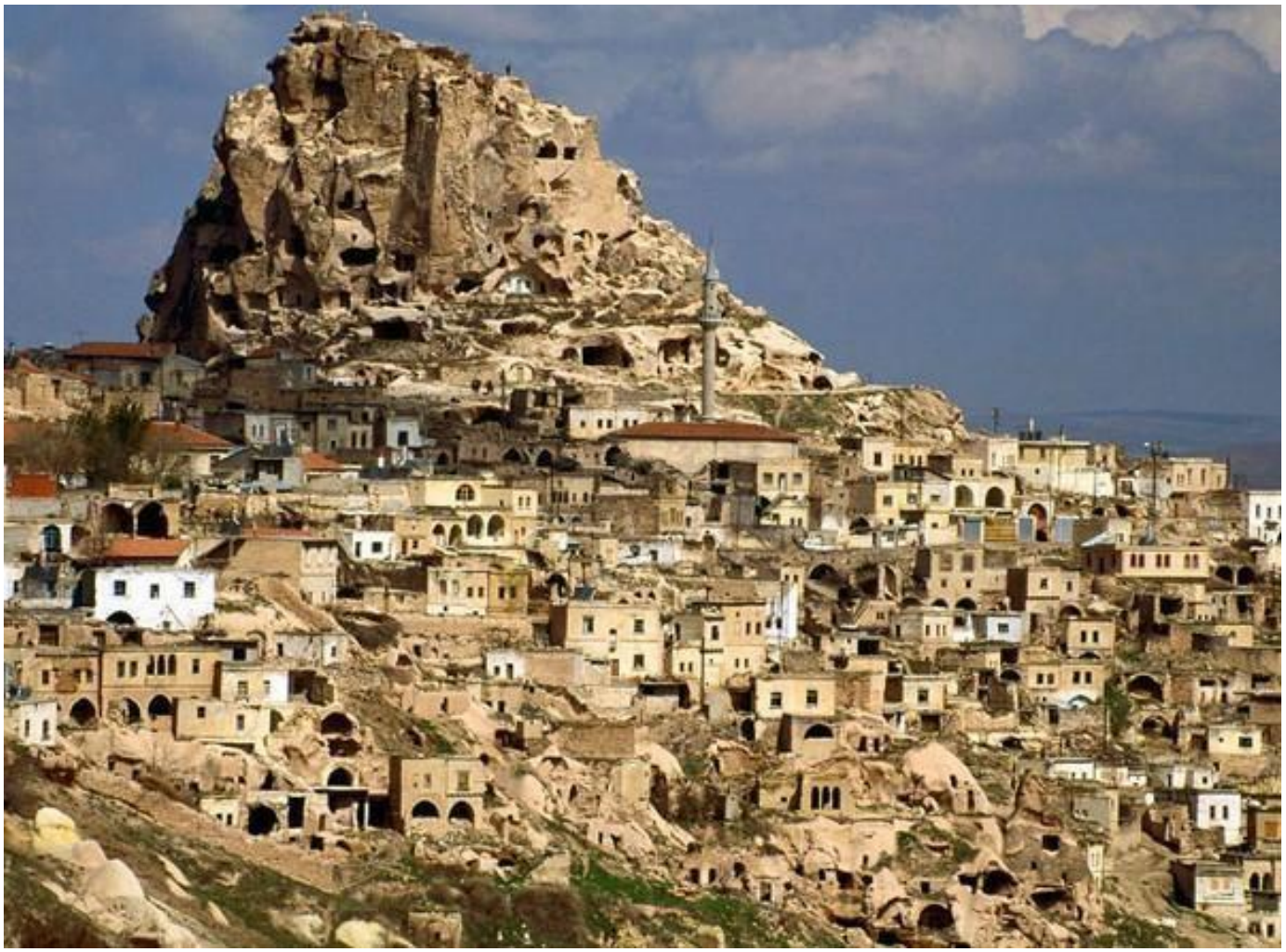

Figure 1. Ancient Housing in Cappadocia Turkey
Source: Detiktravel.com

https://travel.detik.com/cerita-perjalanan/d-5405213/jelajah-eksotisme-kota-batu-di-lembah-cappadocia-turki

Figure 2. The Cappadocia Area of Turkey
Source: Detiktravel.com
https://travel.detik.com/cerita-perjalanan/d-5405213/jelajah-eksotisme-kota-batu-di-lembah-cappadocia-turki

Figure 3. Earth Houses of Switzerland
Source: harpersbazaar.co.id
https://harpersbazaar.co.id/articles/read/2/2020/9847/sejumlah-komplek-perumahan-paling-unik-di-dunia

Figure 4. The Circular Plan Housing Designed by Architect Erik Mygind (1964). Inspired by Danish Villages of the 18th Century
Source: https://www.openculture.com/2020/10/denmarks-utopian-garden-city-built-entirely-in-circles.html

Figure 5. The Barcelona City Housing
Source: https://id.pinterest.com

Figure 6. The Chandigarh City Masterplan Designed by Le Corbusier in 1947s
Source: https://whereisthenorth.com/le-corbusier-architects-perspective-series/

Figure 7. The VM Apartments, Copenhagen, Denmark
Source: Bazaar Indonesia
https://harpersbazaar.co.id/articles/read/2/2020/9847/sejumlah-komplek-perumahan-paling-unik-di-dunia

4. 2. Public Transportation

1. Singapore

Singapore was ranked as one of the top cities profiled in McKinsey's Report: Elements of Success: Urban Transportation Systems of 24 Global Cities (Knupfer et al., 2018). As the best in urban mobility and the second after Hongkong for public transport in the list of top 10 cities ranking (**Figure** 1), Singapore proves the best in its' achievement on the intelligent and resilience transportation system. The residents of Singapore are highly satisfied with its' transportation system, despite the high barrier for car usage, but Singapore serves the best in the area of affordability (offering discounts for low wage workers and free for children) and outstanding flexibility of ticketing.

Singapore's best transportation system today is technically the result of a comprehensive planning and management that has been strategized ever since earlier time of national independent. Project report by Centre for Liveable Cities, Singapore and The Seoul Institute (2016) reported that Singapore have aimed people as the center of urban plans by controlling the traffic volume through the limitation of car population and accommodating the needs of city's dwellers on urban mobility by providing good policies on public transportation integrated with the pedestrian and cyclist friendly (**Figure** 2).

As result, Singapore serves around five million public transportation daily passenger in 2020, lower compared to previous year due to limitation of urban mobility during Covid 19 crisis (Muller, 2021). Dossier report also described that in 2020, Singapore has already managed 216.5 kilometers of MRT railway network, 28.8 kilometers of LRT railway network and 18,500 buses. Those transport facilities are spearheaded by the Land Transport Authority (LTA) that that includes the planning, design, construction and management of Singapore's land transport infrastructure and systems (LTA Government of Singapore, 2022). The LTA seeks for holistic long-term planning for land use and mobility as the major consideration in achieving the effective smart green friendly transportation in the dense development and limited area of Singapore.

The great integrated transportation system that meets the needs of the urban – country mobility is inseparable from the role of the State and City Planning (SCP) project in 1967 (Centre for Liveable Cities, Singapore and The Seoul Institute Project Report, 2016). The concept plan proposed the 'Ring Plan' that strategized the holistic planning between the masterplan of land use and transportation network. This concept plan aimed to avoid the main city problems of uncontrolled urban development and poor urban mobility due to growing city population. The Mass Rapid Transit (MRT) system was planned to connect the towns to the developed city center and major commercial and industrial land- use.

The concern of Singapore on urban mobility planning and management could be clearly seen from their priorities to the public transportation and placing urban dwellers as the center of urban plan. The construction of land transportation network is always in line with the accommodating the needs of pedestrians. The facilities for pedestrians, tress and shelters along the city roads for protection from the tropical climate barriers, consideration of inclusivity of the special need pedestrian, and accessibility to public transportation network were among the major concerns to encourage people to use public transportation and limit the use of private cars in the city. The integration of pedestrian friendly features and public transportation system could be seen in commercial area Orchard Road Singapore (Figure 3). The focus on public transportation, pedestrian and cyclist (were also strategized to mitigate the traffic congestion issue in the limited space city of Singapore.

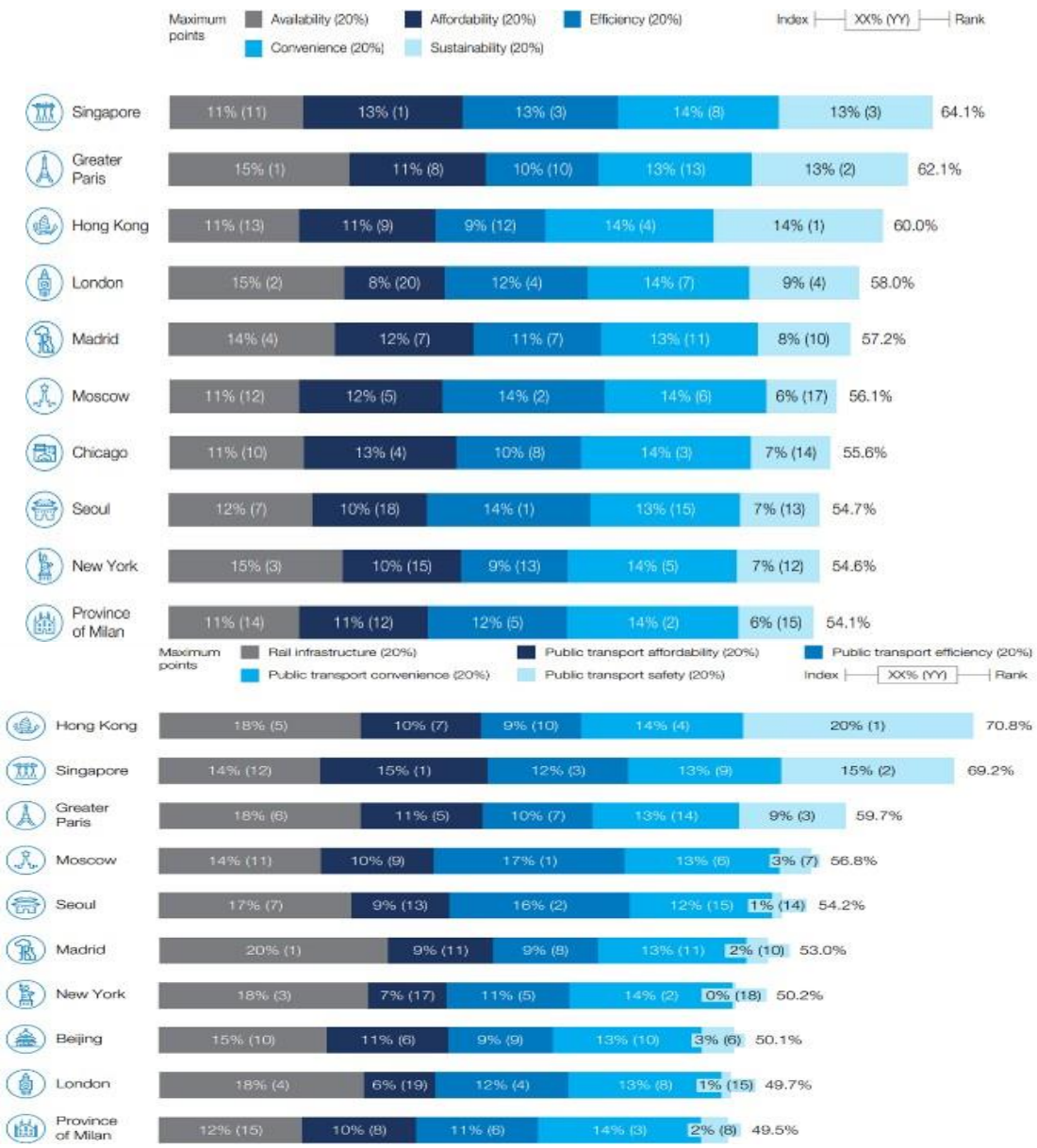

Figure 8. Top ten cities ranking: Overarching urban mobility ranking (top) and Public transport ranking (below)
Source : (Knupfer et al., 2018).

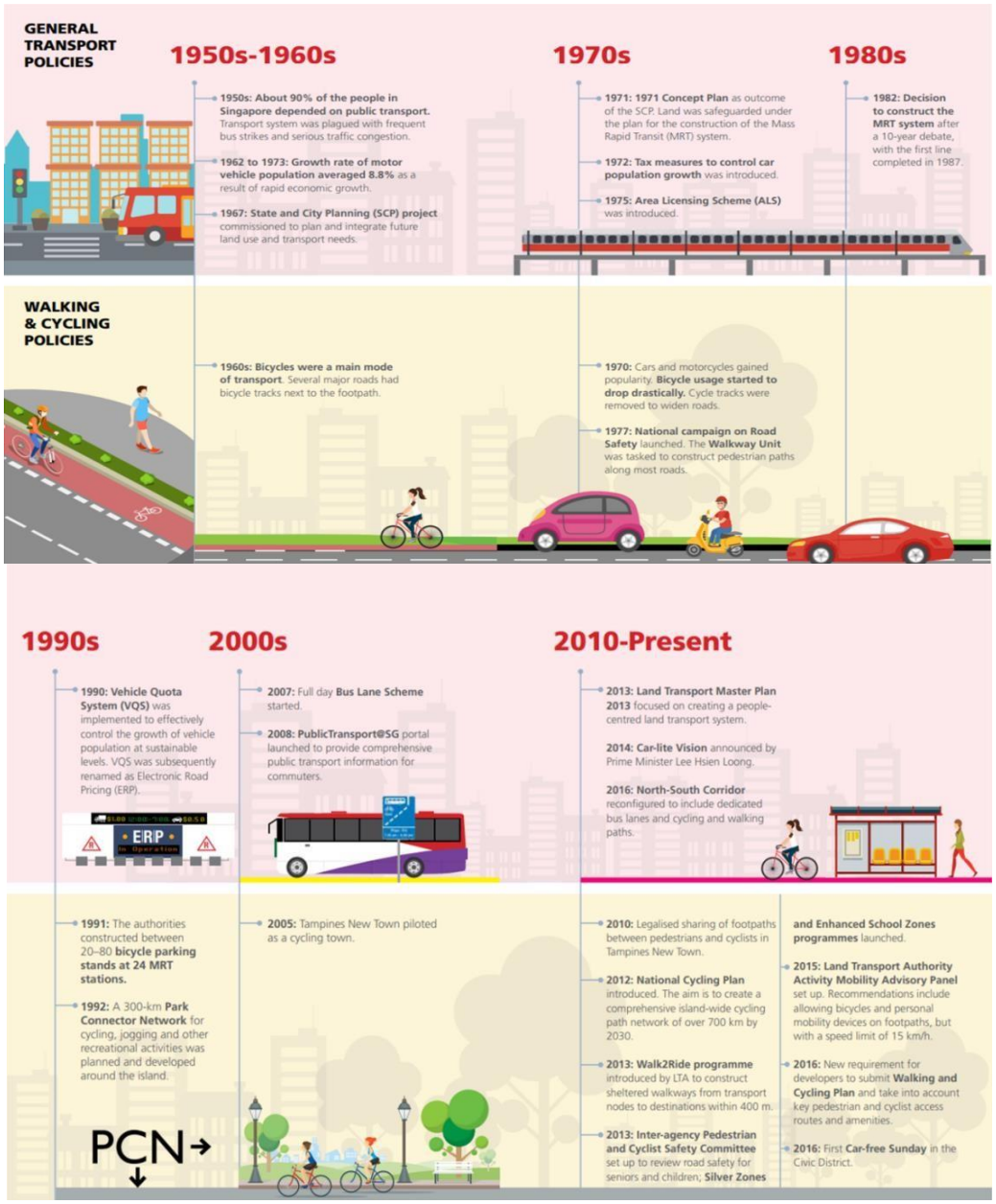

Figure 9. Milestone of Singapore's Transportation Policies from 1950s to 2016
Source: Centre for Liveable Cities, Singapore and The Seoul Institute. (2016)

The concerns for pedestrians could also be seen through the ranges of outreach programs (Figure 4) in the street space during the weekends or occasional events. The Park(ing) days, Car Free Sunday (Figure 5) and Car Free Zones are among the programs offered on street space for the city communities. The programs create the liveliness of the street and also form of giving back the city spaces and neighborhood to the communities.

The good transportation system in Singapore that was strategised through long term planning for city mobility has significantly mitigate the city issues on traffic congestion, high energy demand and city pollution. However, the concern for pedestrians and streets for people has created the liveliness of the city. It offers the city to support the achievemnet on the sustainability, resilience, and centerfor people.

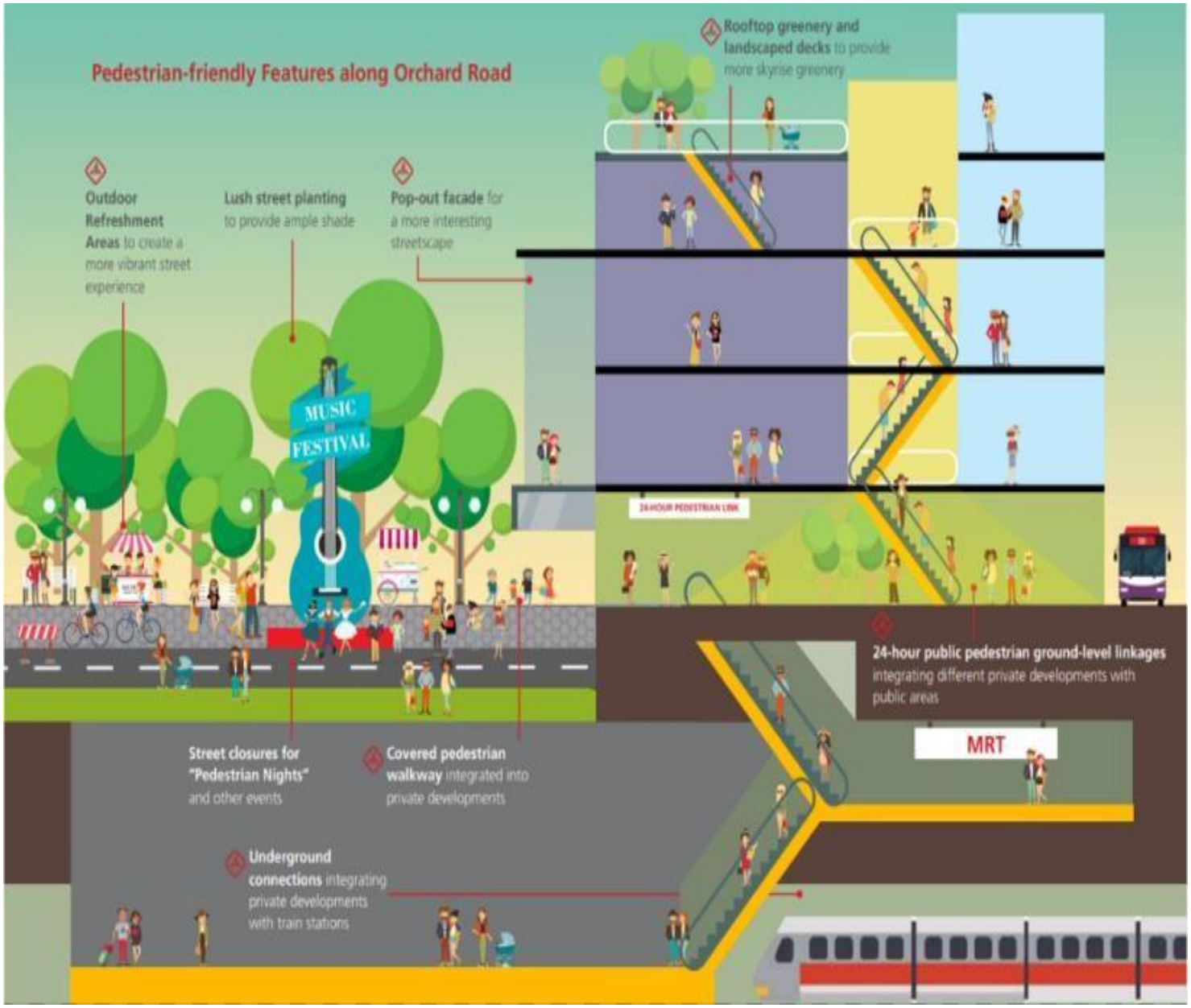

Figure 10. Integration of Pedestrian Friendly Features and Public Transportation system in Orchard Road Singapore
Source: Centre for Liveable Cities, Singapore and The Seoul Institute. (2016)

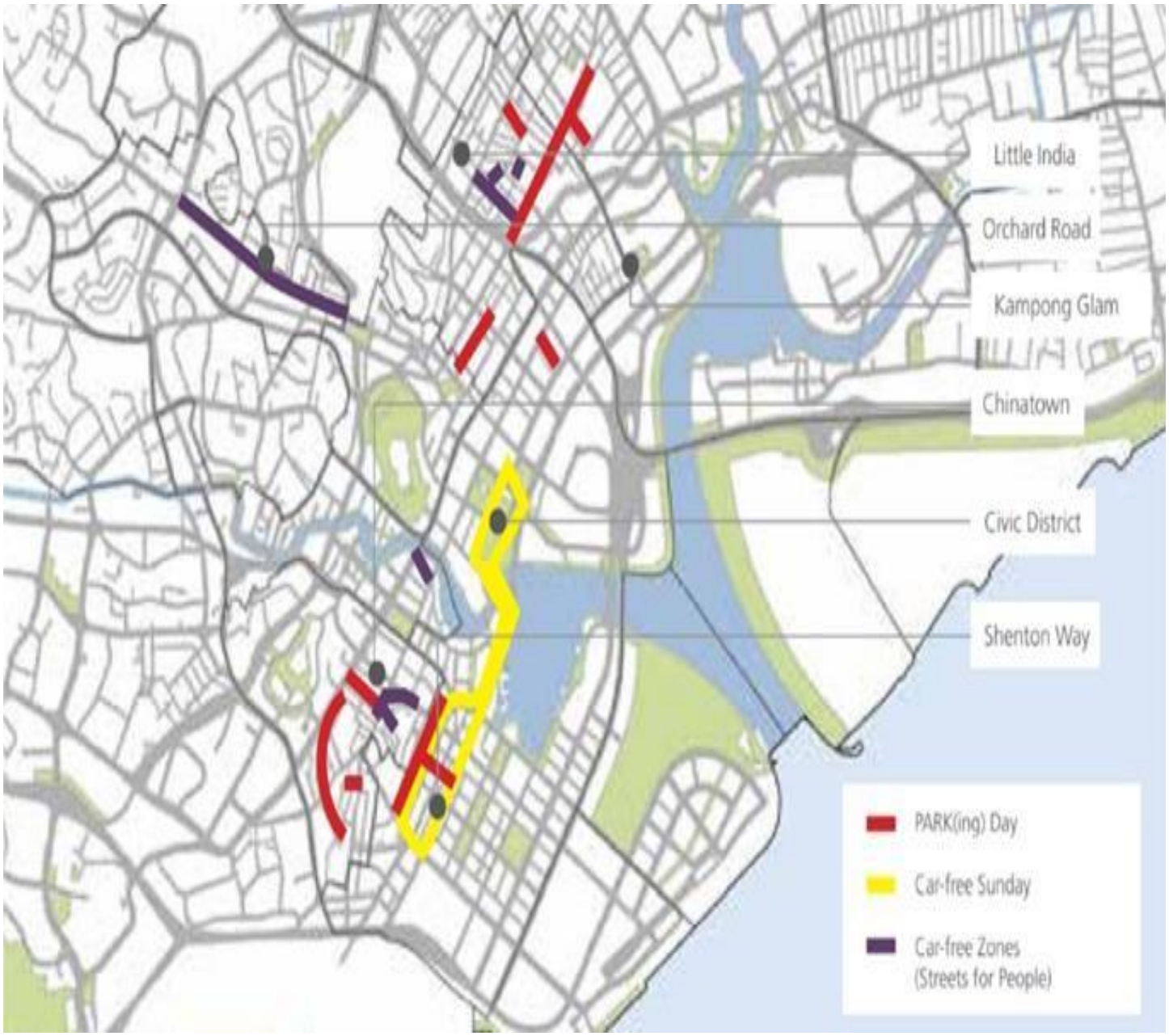

Figure 11. Distribution of Outreach Program as Form of Concerns for Pedestrians

Source: Centre for Liveable Cities, Singapore and The Seoul Institute. (2016)

Figure 12 . City Dwellers Activities during the Park (ing) Day (top) and Car Free Day Sunday (buttom)
Source: Centre for Liveable Cities, Singapore and The Seoul Institute. (2016)

2. Tokyo

Tokyo as the capital city and center of Greater Tokyo area, is known as clean and effective Japan's biggest hub for rail and land transportation system. McKinsey & Company Report on 'Elements of Success: Urban Transportation Systems of 24 Global Cities', ranked Tokyo within the top three cities with the best rail infrastructures and eighty percent of its' population live within radius one kilometer from the rail station. The integrated and complex Tokyo transportation network (Figure 6) and integrated transportation modes in the rail station (Figure 7) show the key to the success of its' system. Orientation – Tokyo Travel Guide on 2017 reported Tokyo has 62 electric train lines with over 900 stations and over 40 million daily passengers. The active Tokyo transportation system could be seen from the Shibuya Crossing (Figure 8), known as the "world's busiest pedestrian crossing", that passed by over 3,000 pedestrians at a time (WorldAtlas, 2018).

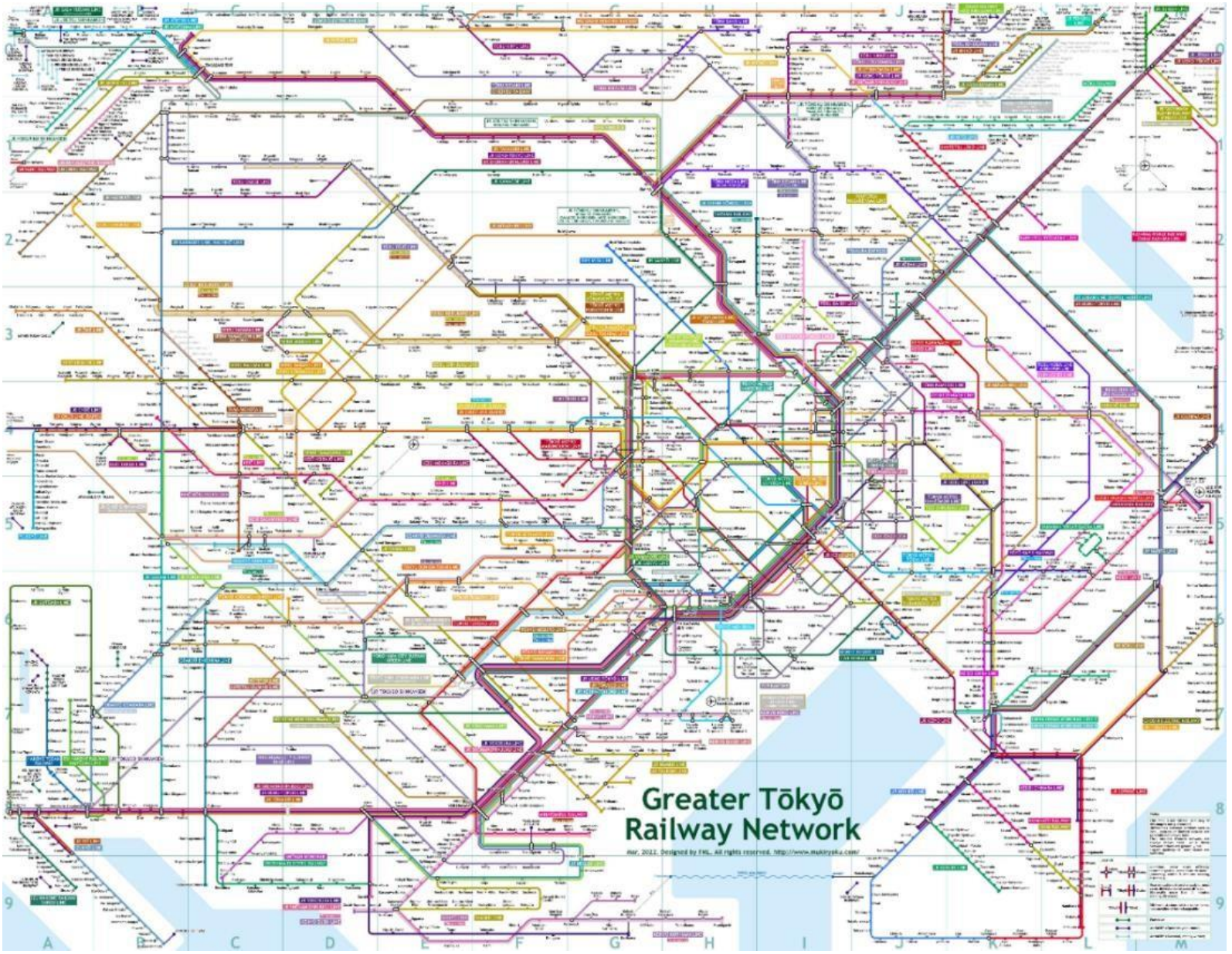

Figure 13. Greater Tōkyō Railway Network
Source: https://www.flickr.com/photos/kzaral/3373021846/sizes/o/

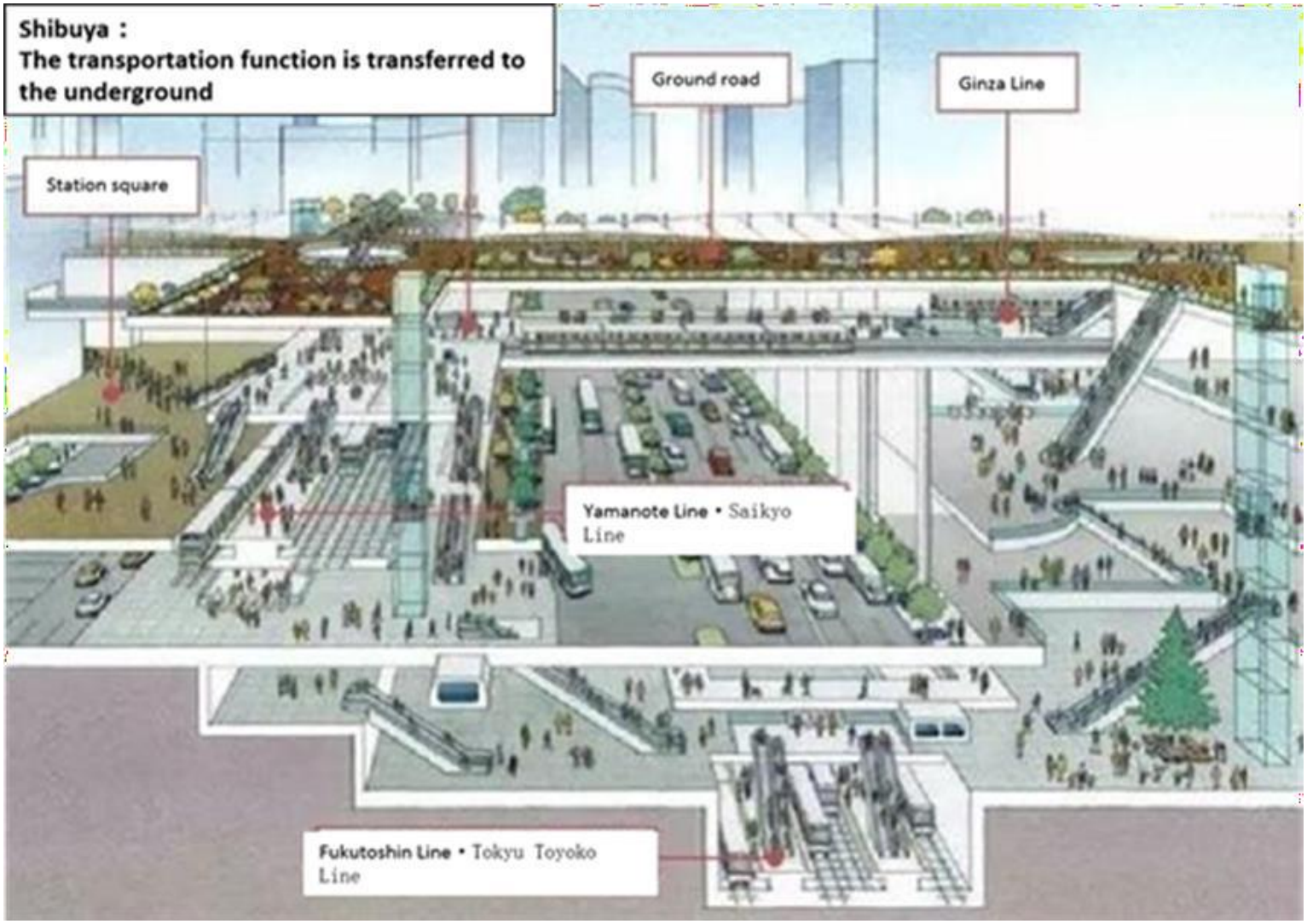

Figure 14. Section of Shibuya Station
Source: Bian (2021)

Figure 15. Shibuya Crossing
Source: https://www.flickr.com/photos/kzaral/3373021846/sizes/o/

The success of Tokyo transportation system is the results of its' holistic long-term planning, management and policies (Bian, 2021). The integrated and complex Tokyo subway transportation system are managed by the Tokyo Metro (private) and the Tokyo Metropolitan Bureau of Transportation (government). The well planned and designed Tokyo public transportation system offers the accessibility, effectivity, comfortability and affordability to its' people, so it embraces the community and the livability of the city. The maximum use of subway as the primary mode of public transportation and limitation of use of private vehicles in Tokyo aims the good city mobility and avoiding the chaos of urban traffic congestion.

3. The Guizhou Gui'an New District
   The application of technology is the key to create the smart transportation system (Ugale et al., 2020) and one of the tools to achieve the environmental consideration in the transportation system. In this context, the Asian Development Bank proposed project of intelligent transport system (ITS) in The Guizhou Gui'an New District is presented as the selected case in Asia Pacific.

   Thisproject (Asian Development Bank, 2019, Sustainia, 2021) shows that the

   ITS concept targets not only resolving the urban traffic Zissues, but the technology also aiming the green and livable city. It 'anticipated to become a key economic hub in the western PRC, Gui'an is targeting 60 percent public transport and 80 percent green transport mode shares to meet a planned population increase of over 120 percent by 2030' to achieve the mission of safe, accessible, sustainableand smart city.

   The ADB report pinpointed that the Gui'an ITS concept accommodates the information processing technology, data communication technology, electronic sensing technology, control technology, Internet of Things, and cloud computing methods in a big data center. It brings the innovation of the information and communication technology to link the integrated public transportation system among the managers, users, and the database center (Figure 9). The ITS makes the effectivity to stakeholders in managing the public transportation system, and inviting the contribution of talent, business and research development in proposing the innovative high technology to solve the city problems and boostingits' potential to serve the people's mobility.

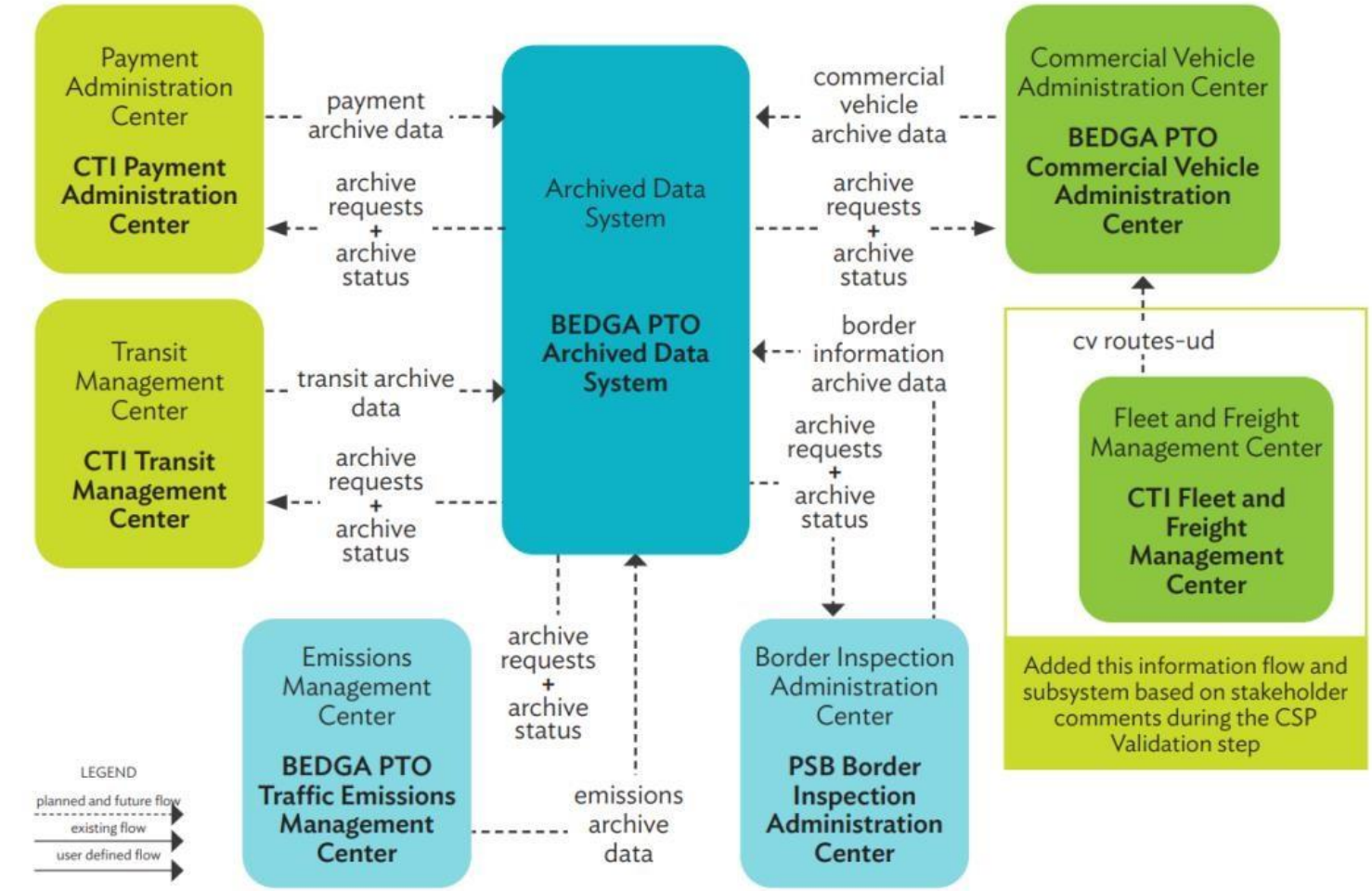

Figure 16. Customer Service Flow for Basic Surveillance System
Source: Asian Development Bank. 2019. Gui'an New District ITS Conceptual Design, Consultant's Draft Final Report. Manila (TA9437-PRC).

Besides meeting the urban development direction on the sustainable and people- centered development, Gui'an ITS concept project presents how the public transportation system tries to meet the needs of services on safety, efficiency, affordability, and the flexibility to adapt to city and global changes. The advancement of technology also anticipates the needs of integrity of involvement of society, managers, business players and stakeholders in playing their roles in project planning, procurement, operation, maintenance and policy making.

4. 3. Waste Management

Best practices for solid waste management shall be designed to protect the environment and improve conditions in cities. It shall be comprehensive, effective and integrated. All aspects in the solid waste flow shall be planned and managed starting from waste generation and separation at source, storage, collection and transportation, recycling and recovery facilities, treatment facilities and final disposal. Some of the components of best practicesfor solid waste management are as follows:

1. International Solid Waste Management Hierarchy

Figure 17 Solid Waste Management Hierarchy
Source: Asian Development Bank. 2019. Gui'an New District ITS Conceptual Design, Consultant's Draft Final Report. Manila (TA9437-PRC).

Any city shall try to adopt the new waste management hierarchy, least waste disposal and high waste reduction and recycle. By adopting this, minimal waste would be disposed of at landfill, therefore minimal land area is required for development of sanitary landfill.

2. High Recycling Rate

One of the best practices in waste management is indicated by the high percentage of recycling rate. Germany has the best recycling rate in the world. Austria comes in second, followed by South Korea and Wales. All four countries manage to recycle between 52% and 56% of their municipal waste. Switzerland, in fifth place, recycles almost half of its municipal waste.

According to Eunomia, the environmental consultancy that compiled the report, these countries all have in common government policies that encourage recycling, such as making it easy for households to recycle waste; good funding for recycling; and financial incentives. They also set clear performance targets and policy objectives forlocal governments.

Some countries, such as Wales, have ambitious recycling targets. Wales aims to achieve zero waste by 2050, and the EU is looking at adopting a new target for 2030,thought to be at least 65%.

The report singles out Wales, which it says outperforms many larger European countries because of its "political leadership and investment". It says that Wales is a "global leader" in recycling and could outdo Germany, as early as 2018
.

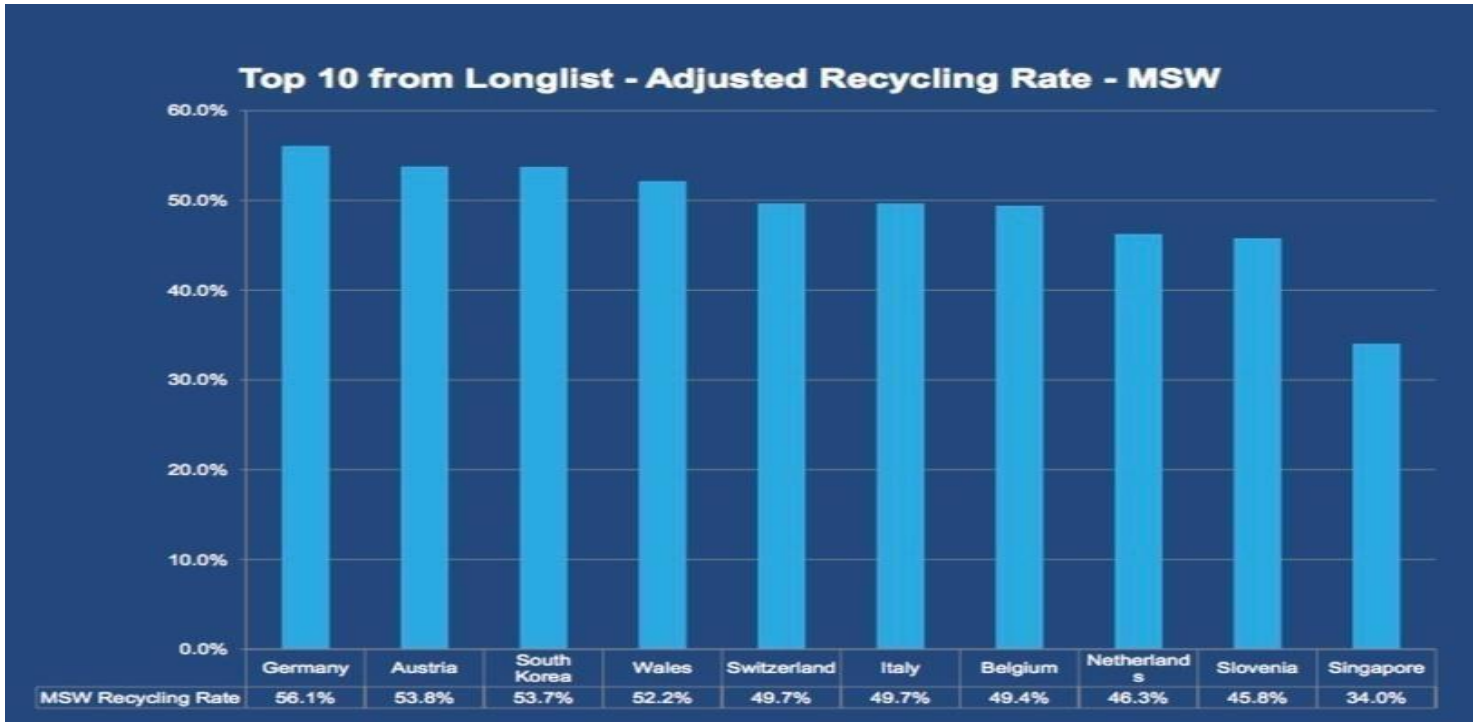

Figure 18. Top 10 from Longlist - Adjusted Recycling Rate- MSW

3. Legislative, Policy and Collection Service Landscape

Legislative / Policy / Collection Service Element											
Widespread separate collection of key dry recyclable materials	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Widespread separate collection of biowaste	✓		✓	✓	✓	✓	✓	✓	✓		✓
Landfill and/or incineration bans for some materials	✓	✓	✓	✓	✓		✓	✓			
Statutory recycling rate/separate collection targets	✓	✓		✓	✓	✓	✓	✓	✓	✓	
Restrictions on collection of residual waste e.g. fortnightly or less collections, restrictions on bin volume				✓			✓	✓	✓		
Variable-rate charging (e.g. Pay As You Throw)		✓			✓	✓	✓	✓	✓		✓
Extended Producer Responsibility scheme(s)	✓	✓			✓	✓	✓	✓			✓
Deposit Refund Scheme(s) for packaging	✓	✓	✓		✓	✓	✓	✓			✓

Figure 19 .Legislative, Policy and Collection Service Element
Source: Images, Eunomia

Best practice waste management shall have a policy on Circular Economy

Figure 20. Best practice waste management: A policy on circular economy

4. Systematic Waste Collection
   Waste collection shall include bins, suitable collection trucks, collection routes, collection frequency and schedule for different type of waste. The system must cater for waste separation at source.

5. Efficient Materials Recovery Facilities (MRF)
   MRFs is essential to maximize recycling rate. The facility will segregate all recyclables which have market demand and potential market.

6. Waste to Energy (WtE)
   Waste to Energy(WtE) or Energy from Waste(EfW) is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste or the processing of waste into a fuel source.

4. 4. Water Infrastructure

1. Design Example for Waste-water Treatment system/plant in Netherlands

   a. The Drainage and Treatment of Waste Water

   The collection and transport of waste water from households to sewage treatment plants happens through sewage systems (the public sewers). The Netherlands has more than 90,000 kilometres of sewer lines. This falls under theresponsibility of the municipal governments.

   At the sewage treatment plants, the foul water is treated and purified. This is the responsibility of the district water boards. The Netherlands has 25 district water boards that together manage 350 sewage treatment plants.

   A large part of the industrial waste water comes to the sewage treatment plants via the sewer system as well. This commercial waste water is often pre- purified by the discharging companies themselves.

   There are exceptions to this: a small proportion of private citizens purify their waste water themselves because it is not cost-effective to lay a sewer line in the area where they live. This could be because they live way out in the country.

   b. Responsibility of Citizens and Companies

   The waste-water system cannot handle everything, despite the efforts of municipalities and district water boards. Private citizens and companies bear their own responsibility to keep environmental risks at an acceptable level. For households this means giving some thought to what can and what cannot be taken away by the sewer. Oil, deep-frying oil, wet wipes, kitty litter, paint waste, food waste, medicines or other chemicals should not be put into the sewer. They can cause stoppages or hinder purification.

   Companies should make their water as clean as possible before releasing it into the sewer. They should also take measures to pollute water as little as possible. The rules for this are recorded in the permit of the company or in general regulations.

   c. Separate Drainage of Rainwater

   In addition to waste water, a substantial amount of rainwater also flows into the sewer. This is actually a waste of good water. Rainwater is (relatively) clean water, so transporting it to and

treating it at sewage treatment plants is senseless. For this reason, rainwater in newly built districts is not drained into the sewer. Instead, companies and private citizens are connected to a system that drains the rainwater directly into lakes and drainage ditches or ground water. Municipalities can also drain the water via a separate sewage system (rainfall system). This practice is called disconnecting the rainwater.

Disconnecting rainwater means that, during heavy rainfall, the sewers have a smaller chance of overflowing and thus causing a part of the sewer water to flow into lakes and canals or flood the streets. The sewage treatment plants also operate more efficiently when the waste-water is no longer diluted by rainwater.

d. Nereda Process

The groundbreaking Nereda process has been in development for nearly 20 years, but it only first hit the market in 2009 when Van Loosdrecht and his research team at TU Delft partnered with Dutch engineering and consulting firm RoyalHaskoningDHV, five district water boards and STOWA (Foundation for Applied Water Research) to transform the lab results into a commercially viableproduct.

The Nereda process works like this: microorganisms grow into heavy, compact granules, forcing the waste product in the dirty water to sink down, leaving clean, filtered water at the top. The outer layer of the granules removes organic material through an aerobic process and simultaneously converts ammonium to nitrate. Inside the granules, microorganisms that follow anaerobic processes convert the nitrate to nitrogen gas (which floats to the surface) and remove phosphate from the water. The treatment process occurs in just one cycle, eliminating the need for separate tanks, pumps and secondary filtration, and saving time, money and square meters.

According to RoyalHaskoningDHV, the Nereda process is estimated to cost about 25 to 30 percent less than traditional, chemical-based treatment methods. Nereda facilities also use about 30 percent less energy than typical activated-sludge systems. In short, this means that the process can treat higher capacities of water using a much smaller footprint than alternative methods. In fact, it uses about 75 percent less space than traditional wastewater treatment plants.

e. Waste Water Treatment Plaint in Epe, Netherlands

In 2012, the Dutch town of Epe adopted the Nereda process during its renovation of a 40-year-old water treatment facility. The upgraded plant, which provides clean drinking water to about 60,000 residents, incorporated the biological treatment process into three 4,500-cubic-meter reactors. Design and construction of the renovations cost the water board

Waterschap Veluwe about €15 million. Since the Epe plant's successful trailblazing two years ago, sevenother Nereda plants have opened across the Netherlands.

Table 29 Epe Waste Water Treatment Plant Factsheet

Authority	Water Authority Vallei & Veluwe
Wastewater type	Municipal
Location	Epe, The Netherlands
Start-up	2011
Status	Operational
Average capacity	8,000 m3/day | 41,000 p.e. (54 g BOD)* *inclusive 13,750 p.e. from industrial discharges
Peak Flow	1,500 m^3/hour
Pre-treatment	screening, sand trap and oil & grease removal (to cope with slaughterhouse emissions)
Post-treatment	sand filtration
MLD	8
Number of reactors	3
Total Nereda volume	13,500 m^3
Volume of each reactor	4,500 m^3
Shape of reactors	Circular
Size of reactors	D = 25 m
Depth of reactors	9.2 m
Buffer size	no buffer
Design temp. min	9˚C
Design temp. max	23˚C

Source:
https://www.royalhaskoningdhv.com/en-gb/nereda/nereda-plants-a-to-z/the-netherlands epe/6803

Figure 21. Epe waste water treatment plant was the first municipal waste water treatment plant with a full Nereda process, commissioned in May 2012.

Source : https://www.royalhaskoningdhv.com/en-gb/nereda/nereda-plants-a-to-z/the- netherlands-epe/474

2. Design Example for Drinking Water System / Plant in Norway

   One of the developed countries in Europe is famous for its clean water. The Norwegian government manages water through a groundwater protection program, namely "*The Midgard Snake*". The program is driven by the Oslo Department of Waterand Wastewater Department.

   The Oslo Water and Wastewater Department developed the “Midgard Snake” project to address pressure on the water mains and increased risks of flooding and water damage resulting from increased urban development and increasing precipitation due to climate change. The Midgard Snake (finished in 2014) functions as an interruptive drainage system, preventing polluted water from reaching the Oslo Fjord. The tunnel (with a capacity of 50,000 m3) is both a transport route and a retention reservoir, storing water if the purifying plant lacks capacity. The project is designed to improve water quality in the fjord, address climate change impacts and reduce energy consumption (because the water is not being transported as far as it was previously).

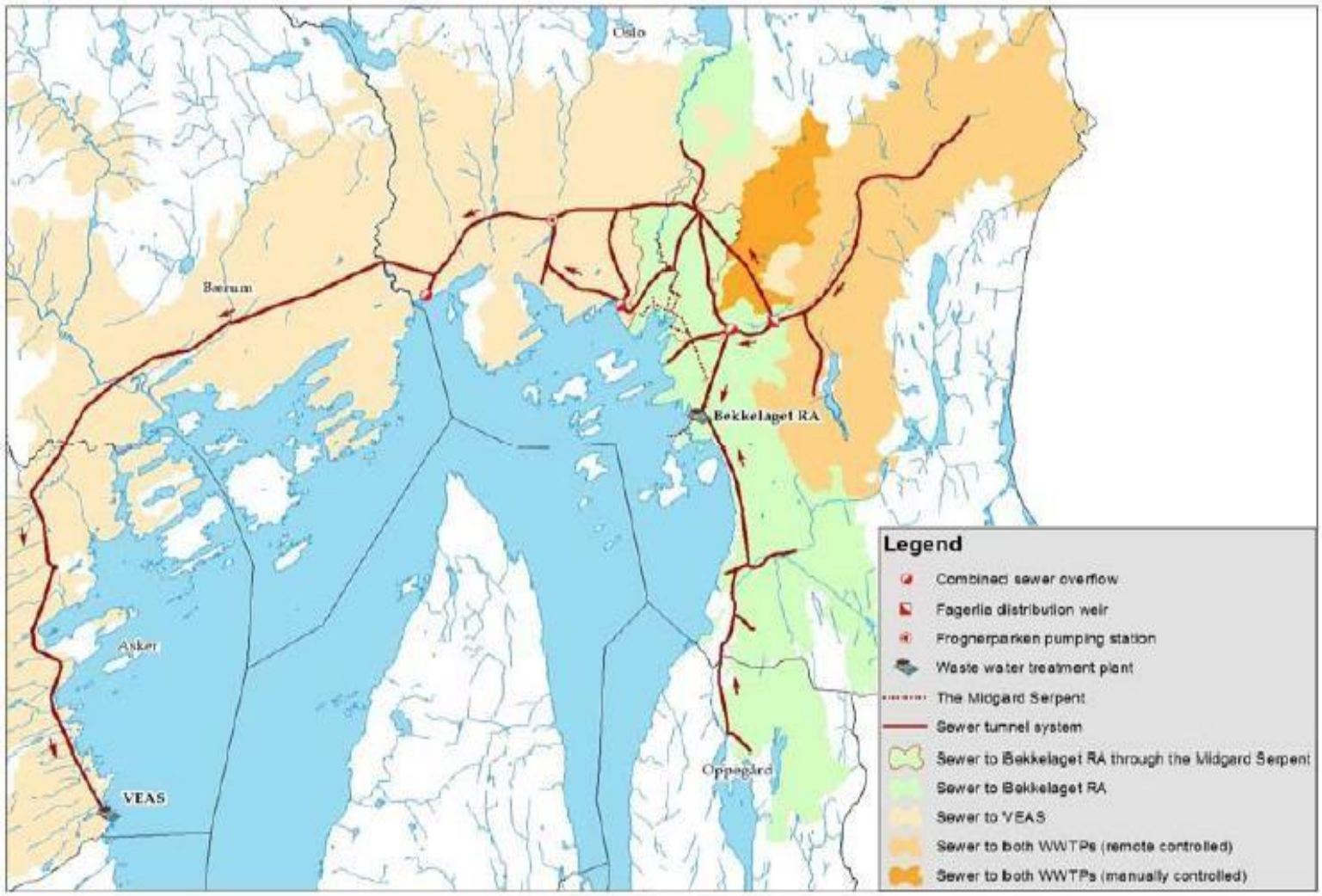

Figure 22. Map of Midgard Serpent tunnel among sewer system of Norway. Application Form for the European Green Capital Award 2019

Figure 23. Biogas bus in front of the Opera House in Oslo with the Midgard Serpent underground. 15% of the bus fleet in Oslo runs on biogas. Application Form for the European Green Capital Award 2019.

Figure 24. Teglverksdammen is a large scale reopening of the stream Hovinbekken. All together 650 meters of the stream has been opened, with sedimentation basins, water rapids, indigenous plant species, a small lake, shallow waters, with dense vegetations.

In 2014, approximately 90% of the population (4.6 million) received drinking water from ones of the 1500 waterworks that must be approved and are registered in the Waterworks Register at the Norwegian Institute of Public Health. 10% of the supply came from surface water basins and 90% of supplies from lakes, ponds, streams and brooks.

Norway has access to good water sources that can be protected against pollution. The level of pollutants, pesticides, heavy metals and other unwanted substances in water is low. In some cases, groundwater may be hygienically safe but water from surface water basins must always be disinfected.

There are two groups of waterworks in Norway:

1. Waterworks that supply at least 50 people
   These waterworks must be approved by the Norwegian Food Safety Authority. The waterworks can be municipal, intermunicipal or private. In total, 1,500 plants are registered in Norway, and these are included in the water statistics (NIPH, 2016a). The reports show that most supply good quality water.

   The Norwegian Food Safety Authority collects water data annually via the MATS system. Data about the waterworks that require approval are recorded in the Waterworks Register at the Norwegian Institute of Public Health.

2. Smaller waterworks and individual supplies that deliver drinking water to lessthan 50 people
   These waterworks do not need approval. In total, these small waterworks supply water to approximately 525,000 people (about 10 per cent of the population).

   In Norway, the quality of drinking water (from waterworks that require approval) is measured by checking whether residents in the municipality receive water from a waterwork that supplies safe drinking water. Indicators of safe drinking water are the prevalence of *E. coli* bacteria in the water and delivery stability.

   Drinking water supplies are considered "good" if no *E.coli* bacteria have been detected in the drinking water for at least 95 per cent of 12 or more samples and that there are less than 30 minutes of non-planned interruptions to the water supplyper year.

   New drinking water regulations were introduced in January 2017. The regulations require safe delivery of adequate amounts of safe drinking water. The water must be clear and without any odour, taste or colour. The new regulations can help secure drinking water supplies through more stringent requirements for the operation and maintenance of the pipeline network

.

In January 2017, the Norwegian Institute of Public Health established a 24-hour advice service. If acute incidents threaten the water supply, this service will provide advice and assistance to the waterworks.

The advice will prioritise assessments of infection risk from microbiological contamination and acute health hazards from chemical pollutants. Support from personnel with experience from water treatment plant operation and emergency preparedness will also be available. The service can gather experiences that can be used to further strengthen safety at Norwegian water treatment plants.

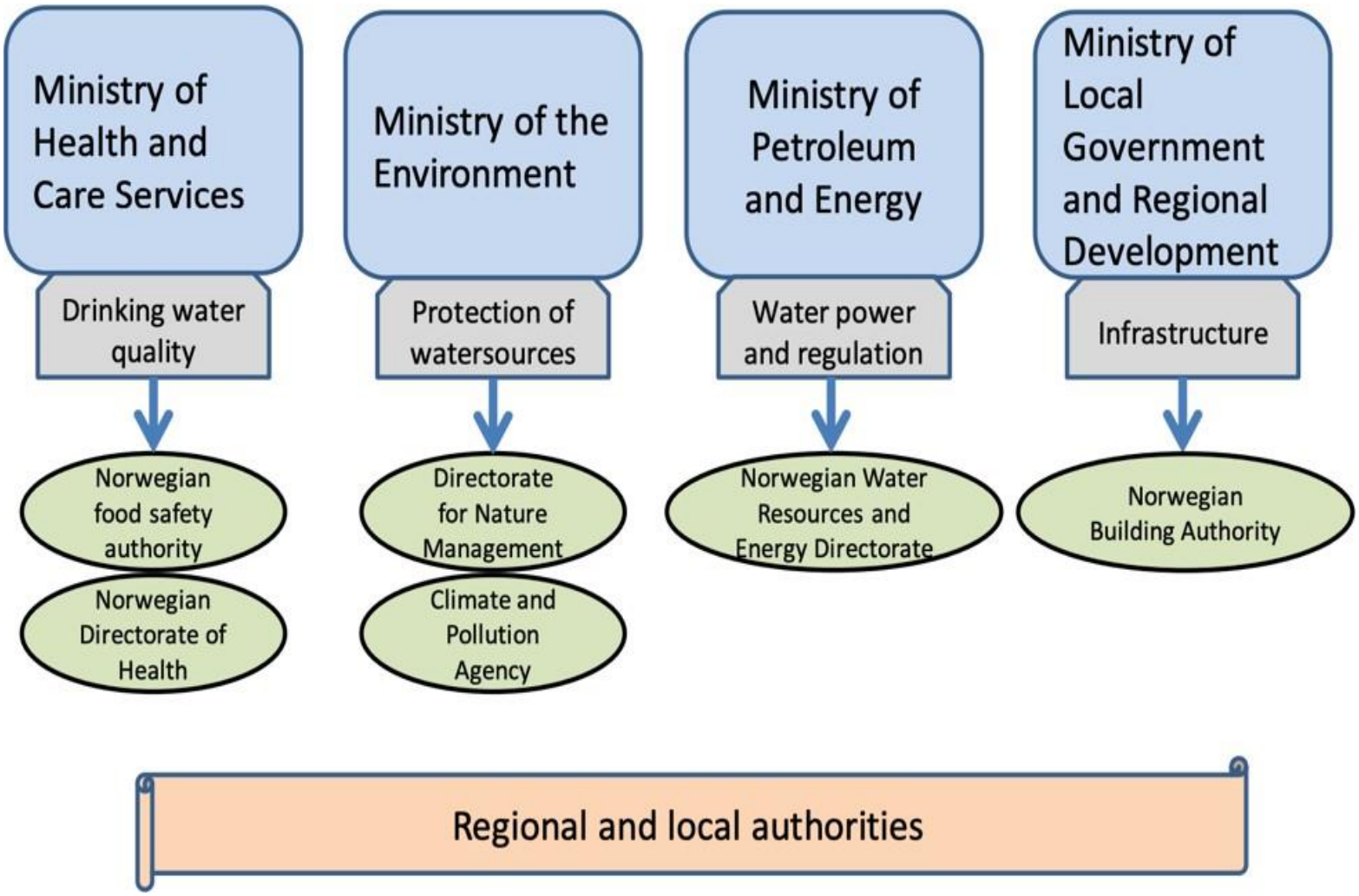

Figure 25. Ministries and directorates involved in freshwater management. Water management and challenges in Norway by Geir Stene-Larsen, Ministry of Health and Care Services, 2012.

Minicipality-State-reporting: municipal watersupply				
	2015	2019	2020	Change in per cent 2019 - 2020
Percentage of population connected to municipal water supply	84.6	84.4	84.7	0.4
Total length of water pipelines (metres)	46 131 122	49 337 193	49 657 195	0.6
Percentage of total water pipeline system renewed, 3-year-average (per cent)	0.67	0.68	0.71	4.4
Percentage of population supplied with hygienically safe drinking water with regard to E. Coli	98.3	99.5	99.3	-0.2
Total water delivered via the municipal distribution system (m3)	693 086 321	691 240 765	690 885 966	-0.1
Percentage of total water supply leaking out of the water pipelines (per cent)	30.1	30.7	30.5	-0.7
Average household consumption per person per day (litre/person./day)	182	178	180	1.1
Percentage of households with water meter installed (per cent)	..	35.4	34.6	-2.3

Figure 26. Municipality-state-reporting: municipal watersupply.

Source: https://www.ssb.no/en/natur-og-miljo/vann-og-avlop/statistikk/kommunal- vannforsyning.

Figure 27. New water supply project includes an underground treatment plant at Huseby.
Source: https://www.tunneltalk.com/Norway-17Jun2020-Procurement-begins-for-19km-TBM-bored-water-tunnel-for-Oslo.php

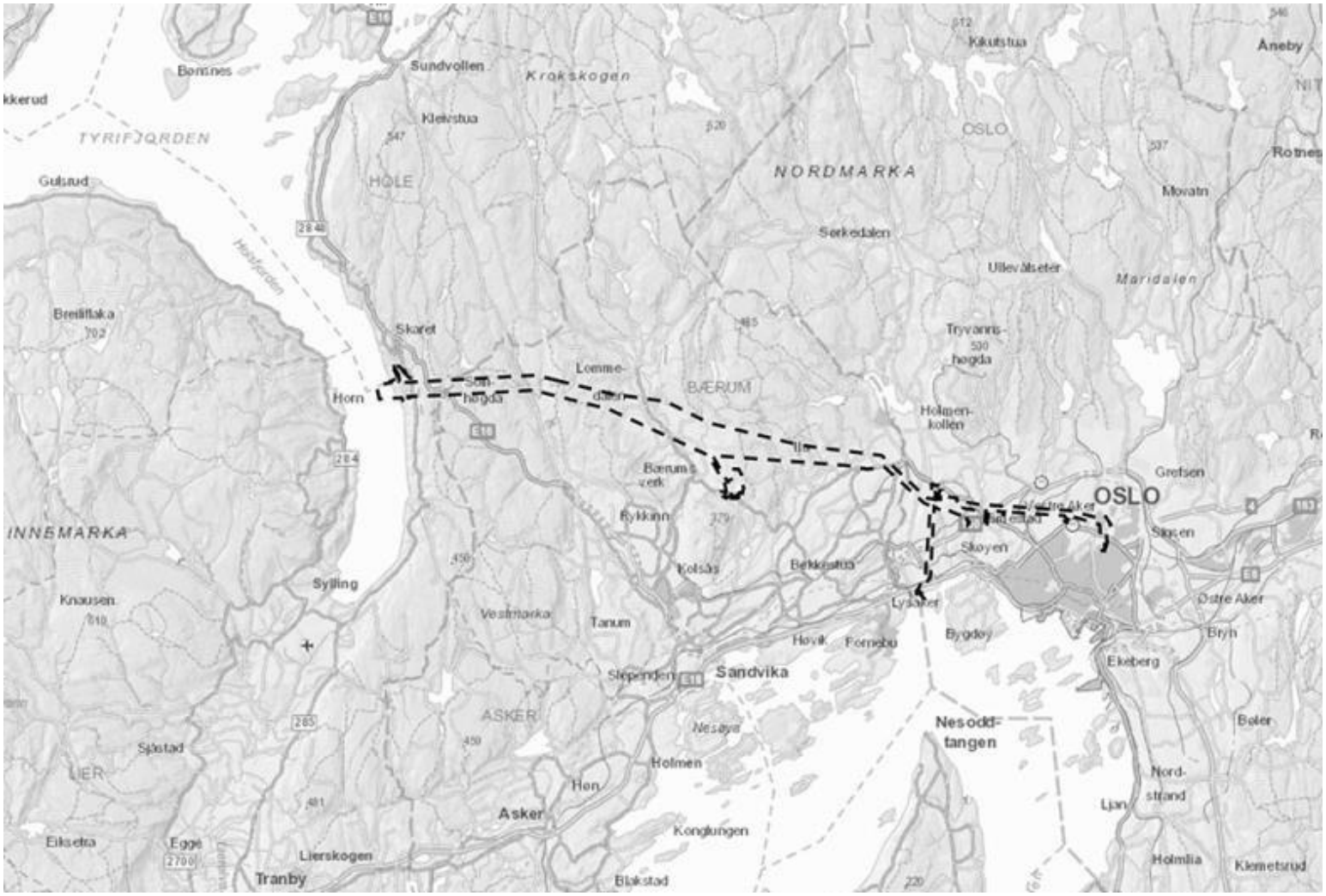

Figure 28. Two TBMs will excavate the 19km from the intake to the new treatment plant
Source: https://www.tunneltalk.com/Norway-17Jun2020-Procurement-begins-for-19km-TBM-bored-water-tunnel-for-Oslo.php

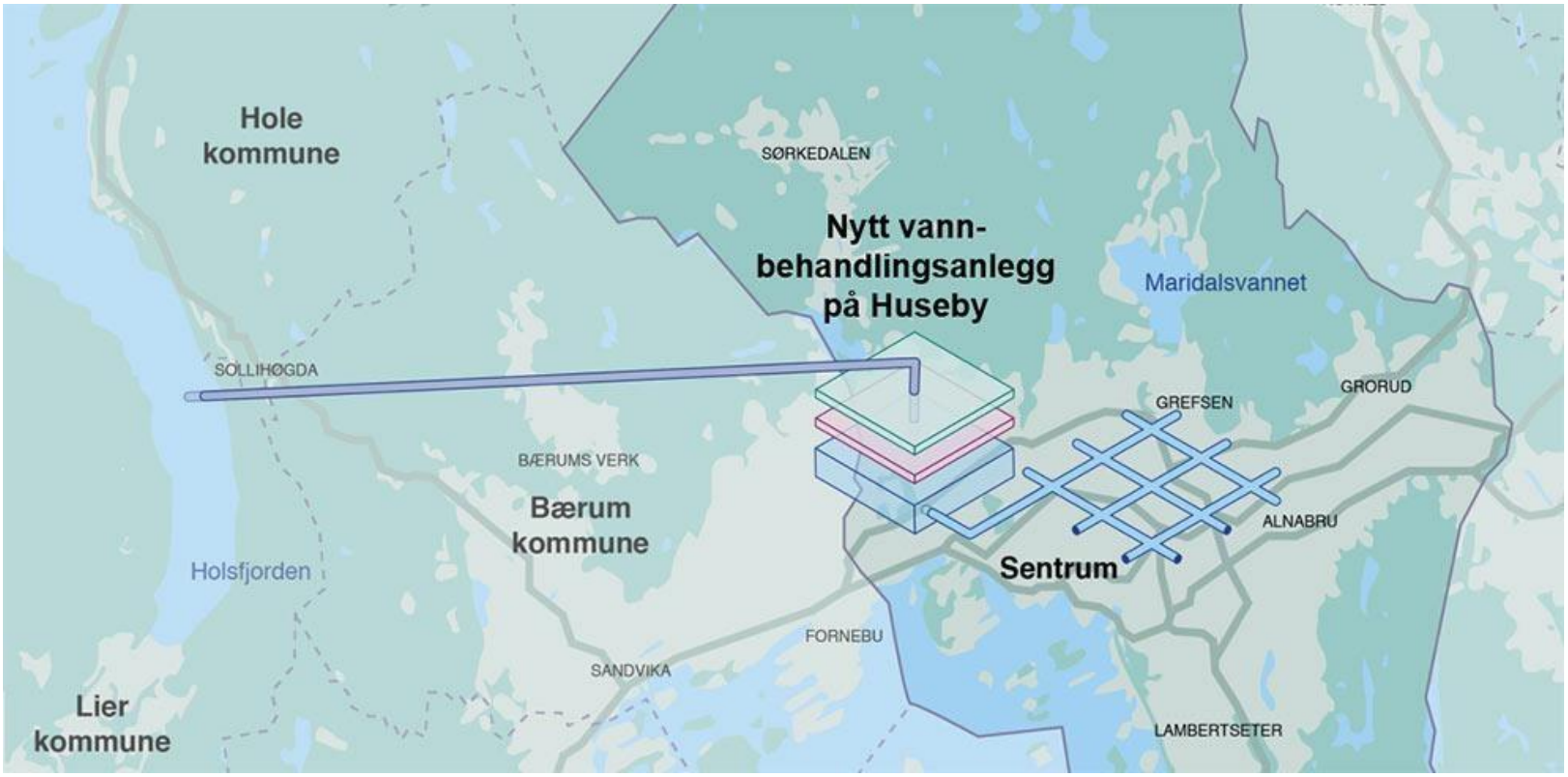

Figure 29. Raw water will pass through the treatment plant and into the Oslo delivery network
Source : https://www.tunneltalk.com/Norway-17Jun2020-Procurement-begins-for-19km-TBM-bored-water-tunnel-for-Oslo.php

3. Design Example for Flood Protection in Netherlands
   Rijkswaterstaat/Ministry of Infrastructure and Water Management, and the district water boards are charged with water management in the Netherlands. Among other tasks, they are responsible for ensuring a sufficient supply of water and keeping the country protected against flooding. Provinces and municipalities are alsoinvolved in water management.

   a. Duties of The Water Managers
      A water manager is responsible for the protection of flooding. In addition, a water manager must ensure a sufficient volume of groundwater and surface water, and keep the water quality up to par. Responsibility for water management in the Netherlands is vested with Rijkswaterstaat (the executive branch of the Ministry of Infrastructure and Water Management) and the districtwater (control) boards. Their duties are:

- Rijkswaterstaat (RWS)
  Rijkswaterstaat is responsible for the management of the major waters, such as the sea and the rivers. RWS ensures that the government authorities responsible are alerted in good time to floods or stormy seas. In addition, RWS maintains dykes, dams, weirs, and storm surge barriers. Furthermore, RWS protects the coast and gives more room to rivers, for example, by deepening floodplains and constructing secondary channels.
- District water boards
  District water boards are responsible for regional waters, such as canals and polder waterways. For example, they ensure that the water is clean in order to keep fish stock up to par. The district water boards also protect the country from flooding and ensure that farmers have sufficient water for their crops. Furthermore, they are responsible for waste water purification.

b. Government authorities involved in water management
   The Water Act sets out the responsibilities of the various government authorities involved in water management. These are:
   - Central government
     The central government is responsible for national policy and national measures. In addition, the central government bears responsibility for the flood protection standards pertaining to the primary flood defence systems, i.e., dykes and dunes that protect the country against water from the sea and the major rivers.
   - Provinces
     The provinces are responsible for translating national water policy into regional measures. The provinces have operational duties with respect to some water management issues, such as the removal of groundwater from the soil. The Soil Protection Act stipulates that the management of groundwater quality is a task vested with the provinces.
   - District water boards
     The district water boards draw up management plans regarding the water quality of the waters within their district. In addition, the district water boards are responsible for the regional flood defence systems, that protect the country against, e.g., water from the canals.
   - Municipalities
     Groundwater in urban areas is the responsibility of the municipalities. In addition, the municipalities are responsible for the drainage of waste water and excess rain water through the sewer systems, as dictated by the Water Act and the Environmental Management Act.

c. National Water Plan
   The National Water Plan 2016-2021 sets out the Dutch flood risk management and freshwater supply policies. The National Water Plan also specifies the strategies to be pursued with respect to areas particularly abounding in water, such as the Rhine-Meuse delta and the coastal area. It

also examines optimum ways to accommodate water in the spatial planning of the Netherlands, and the costs involved.

d. Delta Works
Rijkswaterstaat started building the Delta Works in the year following the Great Flood of 1953. The massive project, with 3 locks, 6 dams and 5 storm surge barriers, was completed in 1997. Since 2018 the Haringvliet Barrier also functions as a storm surge barrier, making the number of storm surge barriersmanaged by Rijkswaterstaat a total of 6.

Figure 30. Map of Netherlands Delta Works
Source: https://www.dutchwatermanagement.com/delta-works-1997-netherlands

The Delta Works are impressive structures and some, such as the Dutch IJssel barrier and the Haringvliet sluices, have been declared national monuments. In 2013, the International Federation of Engineers declared the Delta Works to be the most prestigious hydraulic engineering project

in the world. The jury praised the project's innovative technology, sound structure and sustainability.

The principal purpose of the Delta Works is to protect the country against flooding, but the flood barriers also have other benefits:

- The dams allow the flow of water to be manipulated to admit fresh water and release polluted water, thus improving the quality of thewater.
- They ensure a larger supply of fresh water on the landward side, whichbenefits agriculture.
- They improve access to large parts of the province of Zeeland for inland shipping, for example by mitigating the impact of tidal movements.
- They have helped to create new nature reserves and recreational areas. The Oosterschelde National park, for instance, has been created from exposed sand and mud flats. Whilst new bodies of water are popular with visitors for the walking and cycling paths

Figure 31. Maeslant Barrier, part of the Delta Works.
Source: https://www.rijkswaterstaat.nl/en/water/water-safety/delta-works

Figure 32 . The Hollandsche Ijssel storm surge barrier and Algera Bridge, part of the Delta Works.
Source: https://www.rijkswaterstaat.nl/en/water/water-safety/delta-works

Figure 33. Oester Dam, part of the Delta Works
. Source: https://www.rijkswaterstaat.nl/en/water/water-safety/delta-works

Figure 34. The Oosterscheldekering (Eastern Scheldt storm surge barrier), between the islands Schouwen-Duiveland and Noord-Beveland, is the largest of the 13 ambitious Delta Works series of dams and storm surge barriers, designed to protect the Netherlands

Source: https://www.smithsonianmag.com/innovation/cities- around-globe-eagerly- importing-dutch-speciality- flood-prevention-180973679/

e. Room for the Rivers / Ijsseldelta
The risk of flooding in the Netherlands is steadily growing because the flood plains of rivers are shrinking. Water levels are also rising because there is more frequent and heavier rainfall. Rijkswaterstaat is taking measures to increase the capacity of rivers to cope with high water levels at 30 locations in the Netherlands.

Each river needs its own solution. There are many ways to give rivers more room. These measures will reduce the risk of flooding:

4. Change in Land Use
More room for rivers also means a change in the land use around rivers. It not only delivers greater water safety, but also new natural and recreational areas. In other words, an attractive environment for both people and animals. But sometimes a price has to be paid. In the event of depoldering or the relocation of dykes, people and businesses may be forced to move in order to give more room to the river.

Figure 35. Waal river and its secondary channel with surrounding land uses in Nijmegen City and Lent Town, The Netherlands.
Source : https://www.rijkswaterstaat.nl/en/water/water- safety/room-for-the-rivers

Figure 36 . Pedestrian path and green outdoor space surrounding a riverbank in The Netherlands.
Source: https://www.rijkswaterstaat.nl/en/about-us/gems-of-rijkswaterstaat/room-for-the-river

5. Measures in and around the river: water levels in rivers have to belowered to create more room for rivers.
   a. Dyke relocation. It is moving the dykes further inland, which makes the floodplains more extensive. That helps give the river more room, and there is more space to absorb high water.
   b. High-water channel. It is for discharging excess water. The channel is a branch of the river that we create by building two extra dykes in the landscape. At high water, some of the river water is then diverted via another route.
   c. Lowering of perpendicular groynes and building attracting groynes. Lowering lower a groyne (a short stone dam at right angles to the river) or build attracting groynes (parallel to the river), helps with the discharge of the river water.
   d. Removal of obstacles. It is removing obstacles in the river, such as jetties or bridge heads, that can block the flow of water.
   e. Depoldering. It is moving the dyke further inland. This means that the river can flow into and out of the area at high water.

f. Lowering the flood plain. Over the centuries, floodplains have risen due to deposition of substances such as sand and clay. By lowering flood plains, the river is given more room at high water.
g. Water retention. It is storing excess water, as is the case in the Volkerak-Zoommeer, where river water can no longer be discharged into the sea because the Maeslant storm-surge barrier, Hartel
h. Deepening the summer bed. It is lowering the river bed by excavating the ground. As a result, the river bed will be deepened.This allows more space to accommodate the water.
i. Improvement of dykes. Where space is unavailable for the widening of watercourses, the dyke can be strengthened and, if necessary, raised.

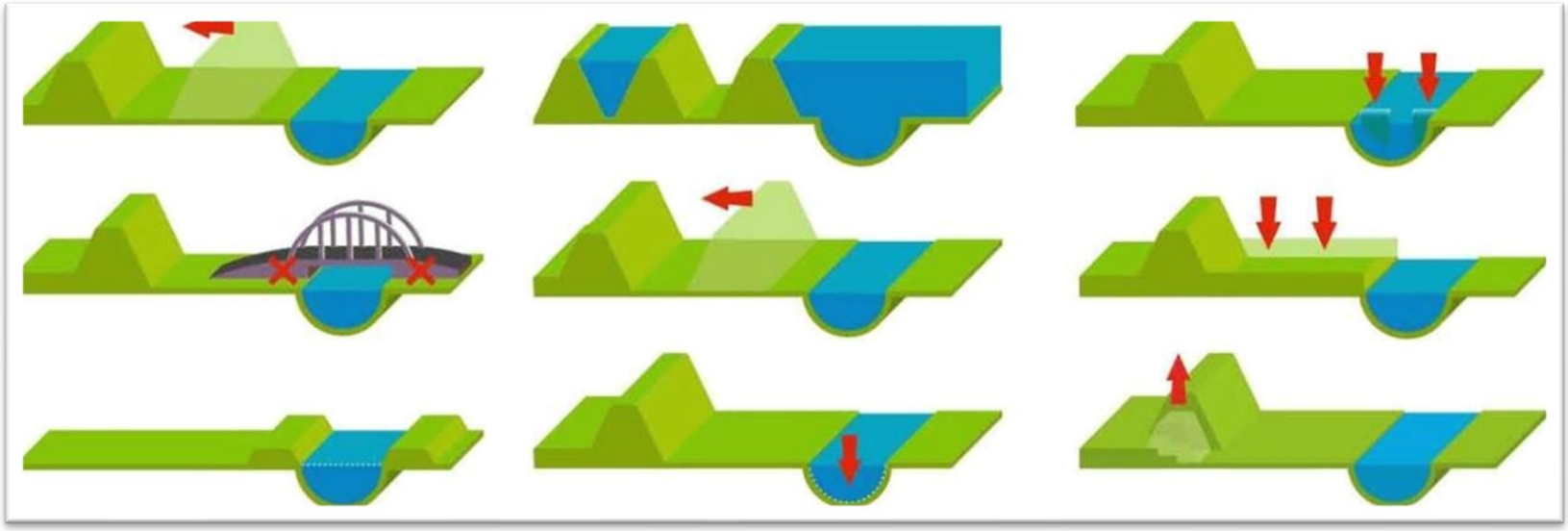

Figure 37. Measures in and around the river, such as dyke relocation, depoldering, and digging side channels.
Source : https://www.rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers

6. Design Example for Flood Protection in Netherlands
   There are 4 types of coastal erosion control infrastructures in Japan:
   a. Natural
      The shore (beach or rocky shore) and the terrestrial area immediately behind the shore have been preserved, allowing the existence of a buffer zone made byvegetation and/or dunes.
   b. Soft Armor
      The shore has been hardened by walls or other human-made constructions. Hardening blocks are on land and the components of the natural coastline (vegetation, sand, intertidal zone, etc.) are still preserved.
   c. Hard Armor
      The shore has been hardened by seawalls, breakwaters, or other human-made constructions, placed into the water and/or at the interface between water and land. One or more components of the former natural coastline have been compromised by something human-made (roads, seawalls, coastal buildings, breakwaters, etc.), so that simply removing the hardening would not restore thenatural coastline.
   d. Landfill
      It is a tract of hardened coastline obtained from human-made land reclamation of the intertidal and, in some cases, subtidal zones.

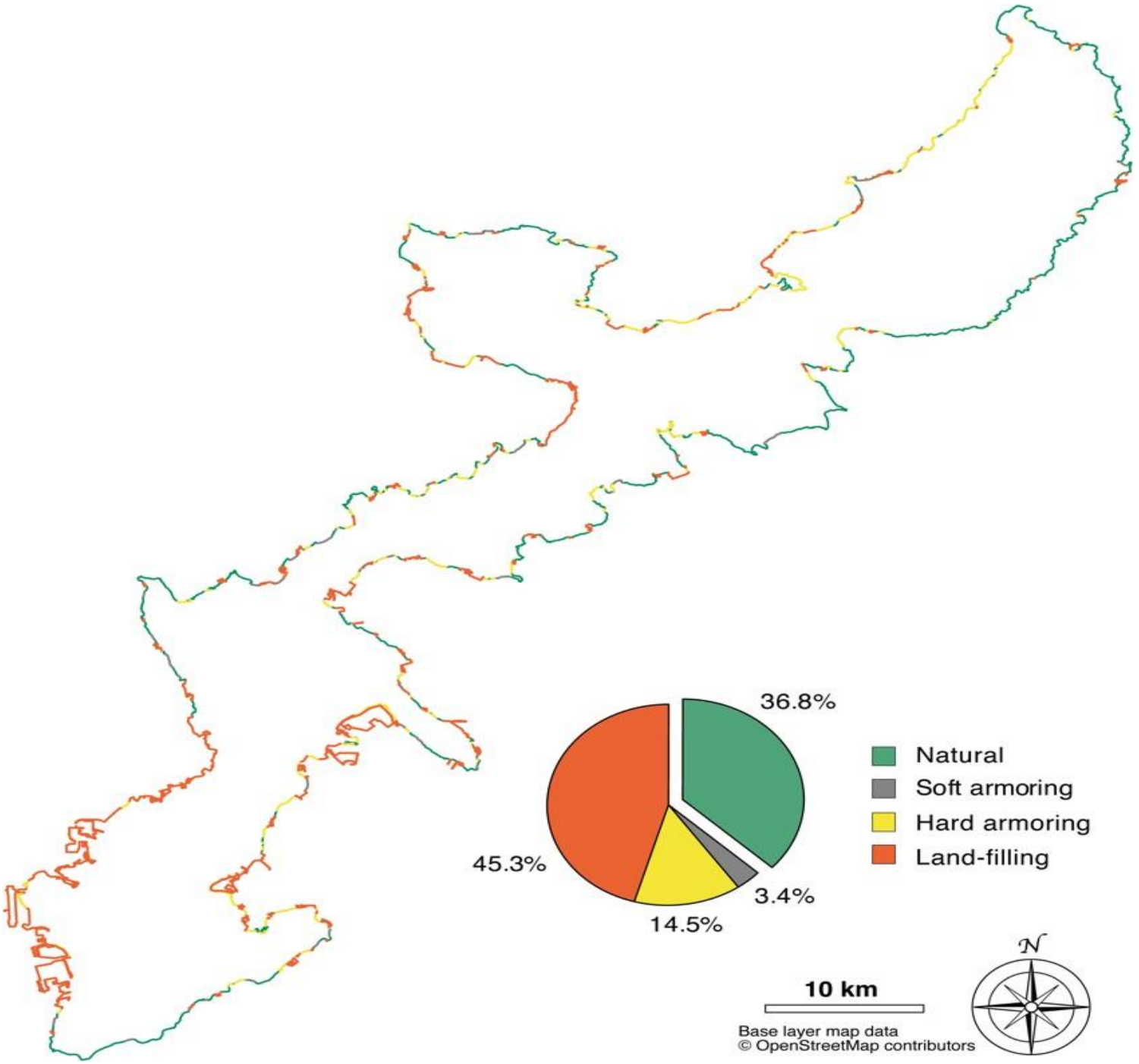

Figure 38. Map of human-made alterations to the Okinawa Island coastline. Different alteration categories are represented by different colors and summarized in the pie chart, which shows their relative abundances (%). Base layer map data © OpenStreetMap contribut
Source: https://peerj.com/articles/7520/

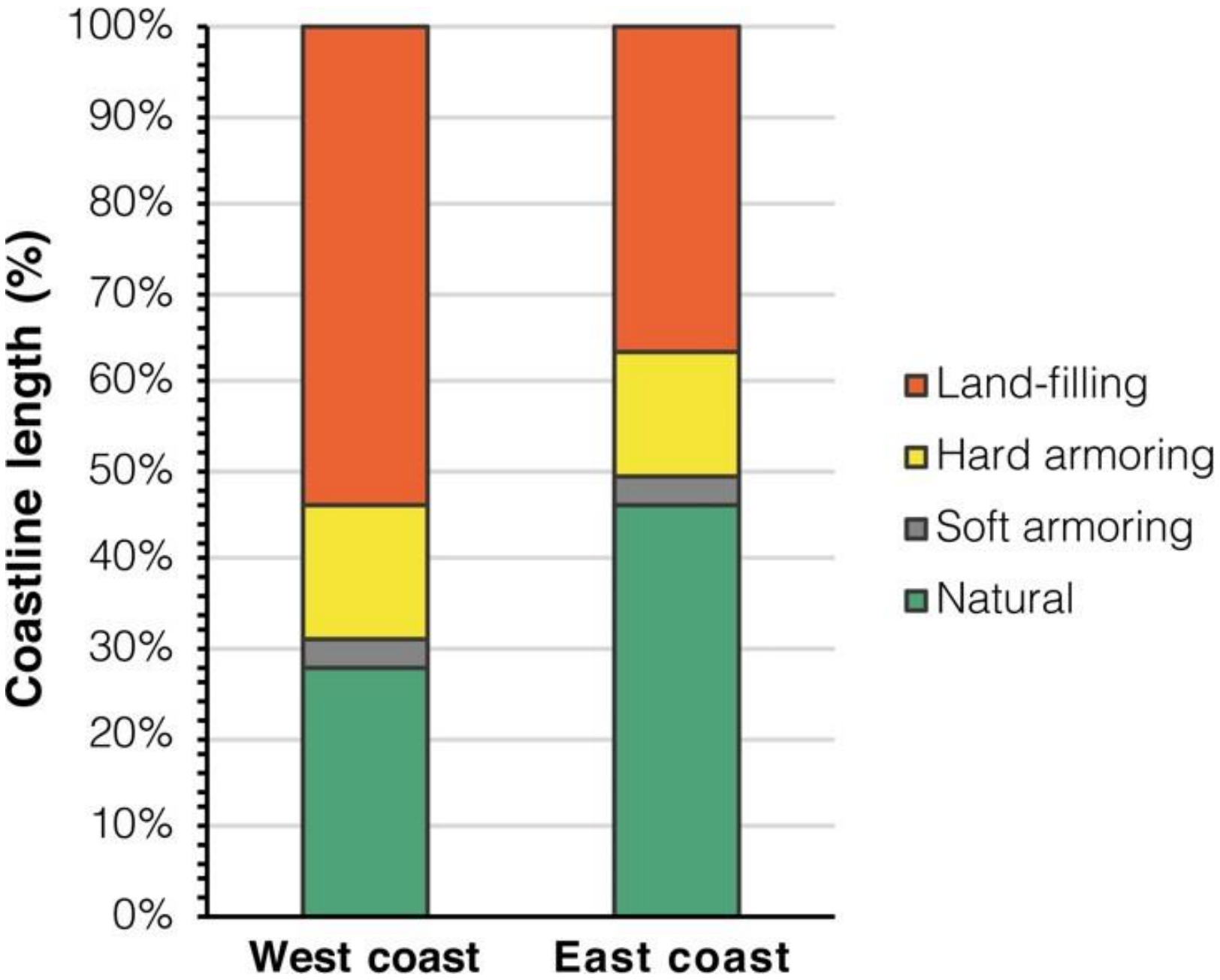

Figure 39. Coastal development categories divided between the east and west coasts of Okinawa Island.
Source: https://peerj.com/articles/7520/

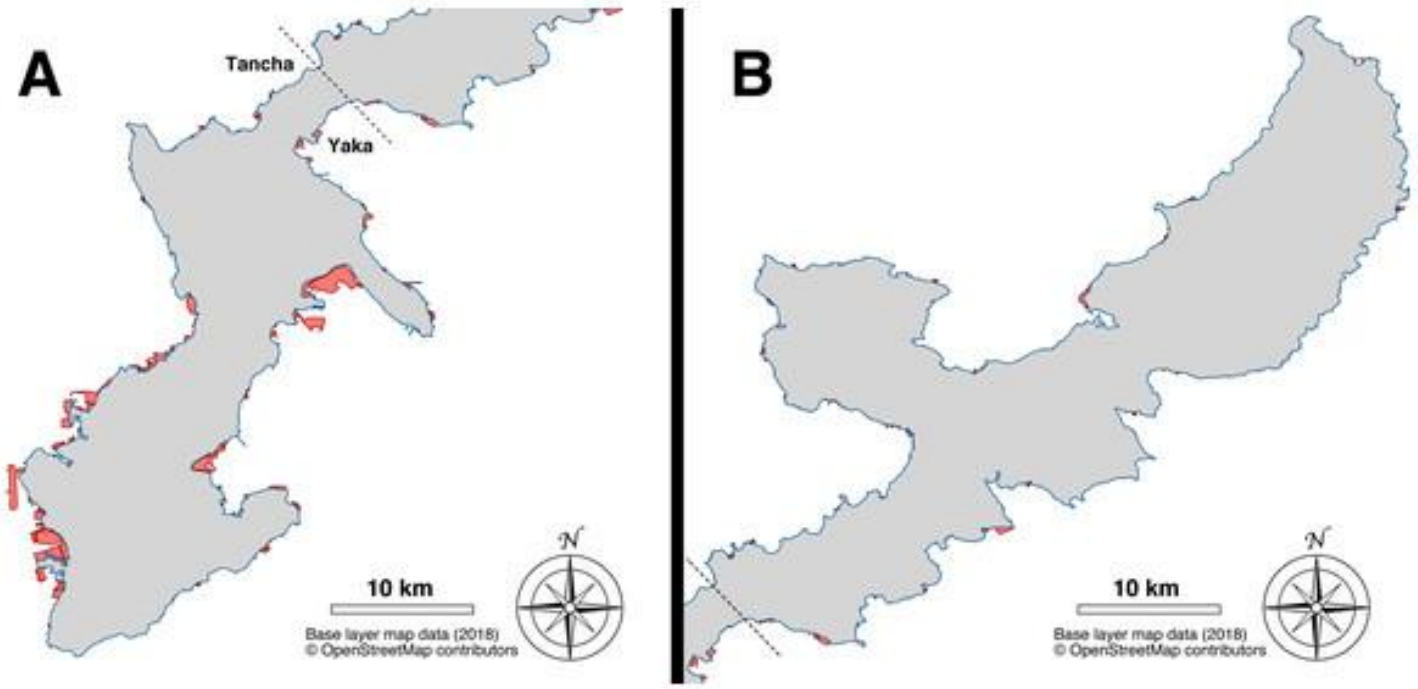

Figure 40. Map of the land-filling that occurred in Okinawa Island over a period of 41 years (1977–2018). (A) South part of Okinawa Island (south of Tancha and Yaka). Base layer map data (2018) © OpenStreetMap contributors. (B) North part of Okinawa Island
Source : https://peerj.com/articles/7520/

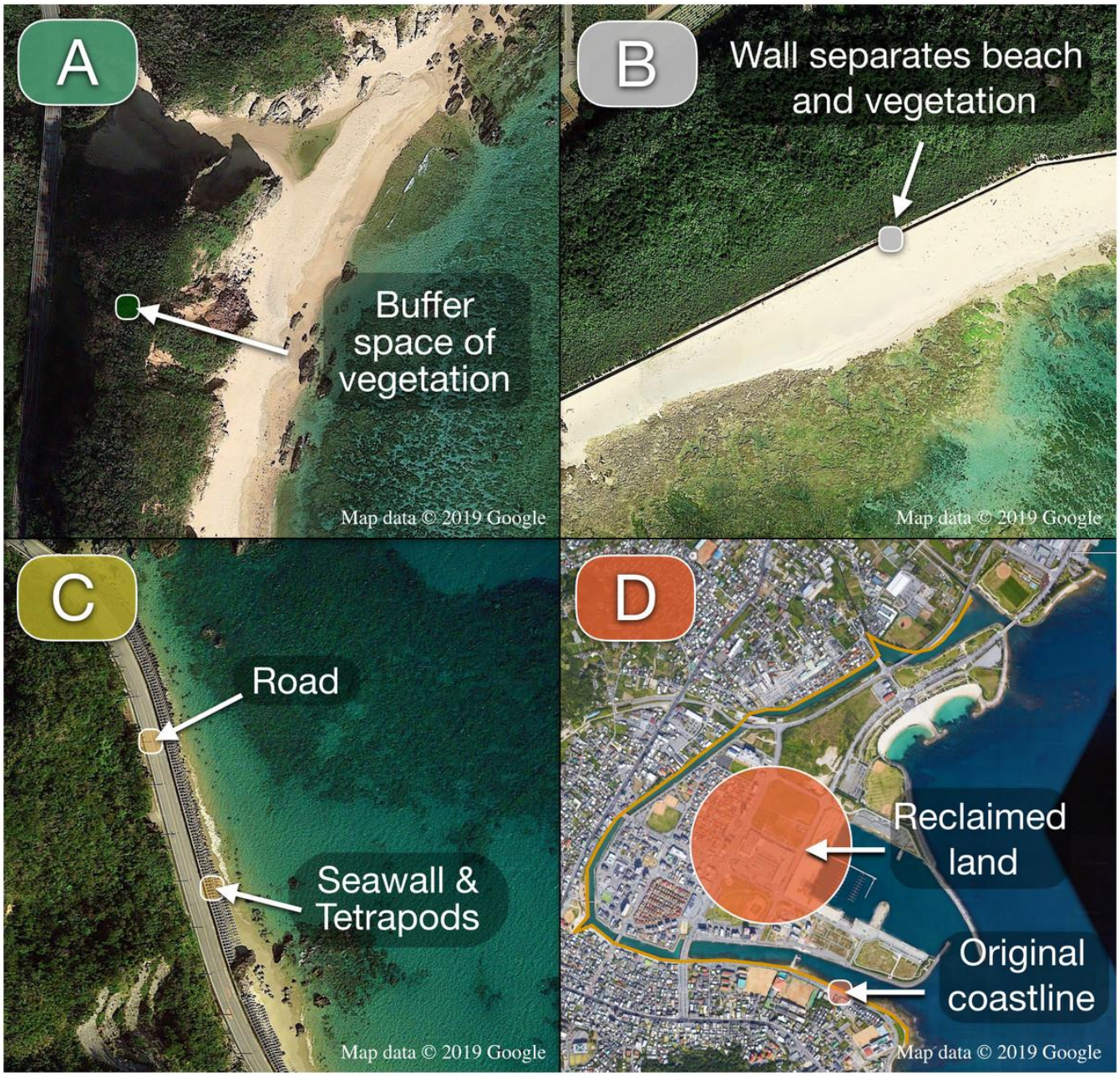

Figure 41. Coastline categories. (A) Natural (east Kunigami). Vegetation acts as buffer between shoreline and road. (B) Soft armoring (Odo). Beach and vegetation preserved but disconnected due to the presence of human-made structures above the intertidal zone.
Source : https://peerj.com/articles/7520/

4. 5. Cultural Sustainability

1. The Heritage Building of Colonial of Jakarta

Figure 42. The Museum Sejarah of Jakarta, built as Stadhuis in early of 20 ages by Dutch Colonial Era
Source :https://www.tripadvisor.com/AttractionToursAndTickets-g294229-d379312- Jakarta_History_Museum_Fatahillah_Museum-Jakarta_Java.html

Figure 43. The Museum of Bank Indonesia in Jakarta (Javasche Bank in 1828).

Source: bi.go.id https://www.portonews.com/2020/keuangan-dan portfolio/pariwisata/mengenal-sejarah-perbankan-dari-museum-ini/

2. Heritage Building of The Modern Architecture in Early Independent inJakarta

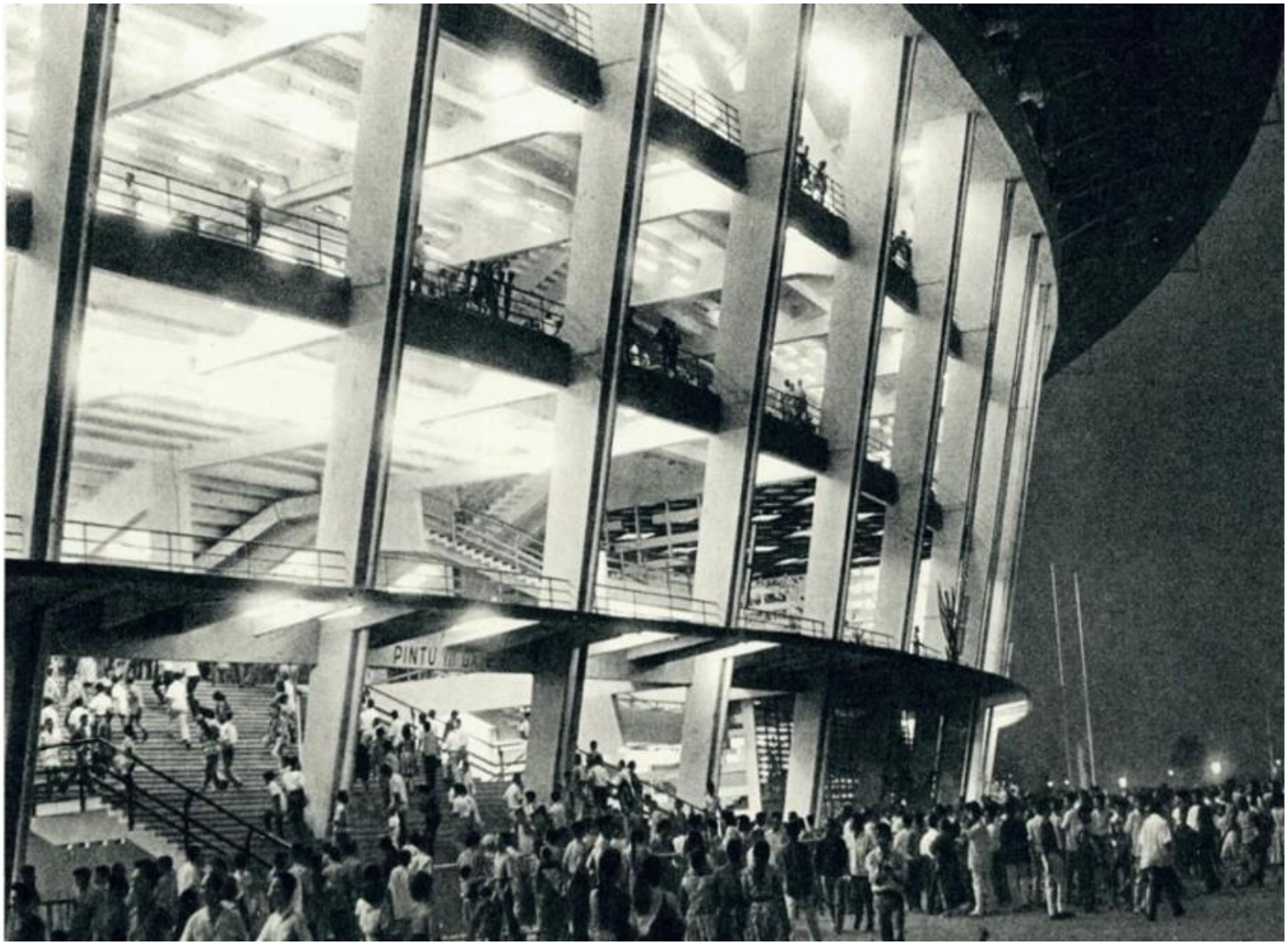

Figure 44. The Old of Gelora Bung Karno Main Stadium around 1960s built by Moscow
(Source: PT Adhi Karya, 2018)

Figure 45. The New of Gelora Bung Karno Main Stadium around 2018s and Renovation under PT Adhi Karya, Tbk
(Source: PT Adhi Karya, 2018)

3. The Heritage Building of Acropolis Athens

Figure 46. The Caryatids statues, A detail of the south porch of the Erectheion temple on the Athenian acropolis. Constructed between 421 to 406 BCE.
Source : https://www.worldhistory.org/image/975/caryatids-of-the-erechtheion/

Figure 47. The Caryatid Conservation By Using Specially Laser Technology
(Source: Eirini Vourloumis for The New York Times)

Figure 48. The Caryatid Scluptures after Conservation.

Source: https://www.thejakartapost.com/culture/2022/01/12/gay-sex-scene-on-athens-acropolis-sparks-outcry-in-greece.html

Figure 49. Because Role of Significance in Science, then the Caryatids Replica from Greece on the Museum of Science and Industry of Chicago
Source: https://www.pinterest.com/pin/211317407486182800/

4. 6. Public Security

Figure 50. The Great Wall of China Reflected the Public Security in Natural Surveillance.
Source: quaerocapital.com .https://quaerocapital.com/en/category/news/regional-equity/page/2/

Figure 51. The Pentagon Building as Military Department of USA in Washington
Source: viva.com
https://www.viva.co.id/berita/dunia/1455523-selalu-pantau-rusia-ini-10-fakta-rahasia-mengenai-pentagon-amerik

Figure 52. The Fortress, the Turkey's New Intelligence HQ in Ankara
Source: Daily Sabah
https://www.dailysabah.com/turkey/2020/01/06/the-fortress-turkeys-new-intelligence-hq-opens-in-ankara

Figure 53. The KPK Building, the Indonesian Corruption Building in Jakarta
Source: Tribunnews https://www.tribunnewswiki.com/2019/06/12/tribunnewswiki-komisi-pemberantasan-korupsi

ASIA-PACIFIC URBAN DESIGNERS
for sustainable urban life

LIVEABLE CITY

A Guide to Easy and Measurable Evaluation

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