TARGET 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

Indicator 11.2.1: Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities.
1. INTRODUCTION

1.1 Background

A
ccessibility to urban mobility paradigm critically needs good, high-capacity public transport systems that are well integrated in a multimodal arrangement with public transport access points located within comfortable walking or cycling distances from homes and jobs for all.

Achieving SDG 11 target 11.2 requires a fundamental shift in the thinking on transport with the focus on the goal of transport rather than on its means. With accessibility to services, goods and opportunities for all as the ultimate objective, priority is given to making cities more compact and walkable through better planning and the integration of land-use planning with transport planning. The means of transport are also important but the SDG’s imperative to make cities more inclusive means that cities will have to move away from car-based travel to public transport and active modes of transport such as walking and cycling with good inter-modal connectivity.

It is empirically proven that public transport makes cities more inclusive, safe and sustainable. Effective and low-cost transportation is critical for reducing urban poverty and inequalities and enhancing economic development because it provides access to jobs, health care, education services and other public goods.

Mobility contributes to quality of life. It is the pre-condition for economic growth, trade and creativity as well as for personal wellbeing. People who can easily move around in the city can enjoy more of life’s opportunities. Mobility creates access to opportunities for advancement, for individuals and communities.

**Improving public transport, improving lives**

“South Africa faces pressing challenges as it aims to create an efficient intermodal public transport sector that seeks to improve the lives of its citizens. Public transport is a challenge for the majority of users, but more so for the poor. More than 60% of households spend on average 20% of their income monthly on transport. It can be as high as 31% in rural areas.

The challenges faced by the transport sector range from high operating and social costs to inefficiencies within the different public transport modes. Additionally, the commuting distance from homes to the work places (many people live far away from their places of work) is highly influenced by planning of residential in pre-democracy days. Well planned transport systems that guide all public transport investments, need to be implemented for South Africa to achieve a better transport system with the limited financial resources at hand. It should ultimately lead to an intermodal transport system aligning all the different modes of public transport in the country. This is the key for improving the passenger experience”.

Malijeng Ngqaleni, Deputy Director-General: Intergovernmental Relations, speaking on the first plenary session of the 35th Southern African Transport Conference (SATC)
1.2 Rationale for Monitoring

In general, monitoring promotes higher accountability, better performance assessment and strong coordination between central governments and the regional and local governments. It enables cities to collect accurate, timely, disaggregated data and information, adopting a systemic approach to the city, with clear policy implications that are based on evidence. This way, countries and cities can make appropriate decisions on the best policies and actions to adopt, whilst systematically documenting their performance at the outcome and impact levels.

The purpose of monitoring progress against the SDG target 11.2 is therefore to provide necessary and timely information to decision makers and stakeholders in order to accelerate progress against the target and goal. The transport target emphasizes on new paradigm of sustainable mobility with its emphasis on accessibility and inclusiveness recognizing that development of a sustainable transportation system begins with the organization of urban space. Therefore, every decision on transport infrastructure ultimately determines the cityscape for decades to come and has a long-term influence on the mobility behavior of residents.

For this reason, it is imperative to include and integrate all relevant actors in the decision-making process. Transport will only become modern and sustainable when people have access to and start using these new mobility options.

National governments and city authorities have the primary role in matters relating to public transport provision thus to be effective, the monitoring framework will need their full support and ownership.

With approximately 2.7 million inhabitants living in both mountain and valley zones, Medellin has been very innovative in the modes of public transportation the city offers to its citizens—which consists of an elevated rail system, a bus system and cable cars.

The priority in the planning and development of the traffic network is the inclusion of disadvantaged population groups, in order to provide equal access to transport services for all residents. The cable cars provide access to the poor neighbourhoods on the mountainsides of the city.
1.3 Monitoring and Reporting Process

DATA COLLECTION
National Statistical Offices (NSOs) are responsible for data collection.

CAPACITY DEVELOPMENT
UN Habitat and its partner organizations and National Focal points will work closely to provide capacity building and quality assurance support.

DATA RELEASE
- Survey data will be available every 2 to 5 years.
- Monitoring of the indicator will be repeated at annual intervals, allowing several reporting points until 2030.
- NSOs are responsible for national level reporting. Global and Regional level reporting will be conducted by custodian agency-UN-Habitat.
- Comprehensive reporting will be undertaken on a biennial basis.
1.4 Concepts and definitions

PUBLIC TRANSPORT

Defined as passenger service that is available to the public, shared by strangers without prior arrangement. It includes cars, buses, trolleys, trams, trains, subways, and ferries that are shared by strangers without prior arrangement. However, it excludes taxis, car pools, and hired buses, which are not shared by strangers without prior arrangement. It also excludes informal, unregulated modes of transport (paratransit), motorcycle taxis, three-wheelers, etc.

2. FREQUENT SERVICE

Public transport with frequent service during peak travel times with an average waiting time of 30 minutes.

3. SAFE AND COMFORTABLE STOPS

Public transport stops that present a safe and comfortable station environment.

CONVENIENT ACCESS TO PUBLIC TRANSPORT

Refers to 500m walking distance to the nearest public transport stop. Additional Criteria for defining convenient include:

1. PUBLIC TRANSPORT ACCESSIBLE TO ALL SPECIAL NEEDS

Includes those who are physically, visually, and/or hearing-impaired, as well as those with temporary disabilities, the elderly, children and other people in vulnerable situations.
HOW DO WE MEASURE ACCESS TO PUBLIC TRANSPORT?

This section focuses on the potential data sources, software and stepwise criteria for assessing access to public transport. First, we will identify the service area of each Public Transport Stop (PTS). Next, we will identify the population served by PTS by overlaying the service area onto socio-demographic data (such as population figures) and lastly estimate the proportion of population with convenient access to public transport from the total city population. This analysis requires data on two aspects of public transport, location of formal/designated stops, and population data.

National Transport Agencies/City Administration/Service providers
- Data on location of public transport stops
- Frequency of service
- Transport routes

Household surveys
- Income expenditure on public transport and quality of service.

National Population and Housing Census
- Population data by sex, age, etc
- Mode of transport
- Dwelling units

GIS Data
- City boundary
- Fieldwork to collect data on PTS where it lacks GPS.
- Buffer-Service areas
PART A : Using Network Analyst tool in ArcMap

Demo data:
- Street network provided by ESRI
- Public stops provided by U.S. Government’s open data portal.

This will follow the following exercises
1. Creating the network dataset
2. Creating the service area (500m walking distance to the nearest public transport stop)
3. Identifying the population within the service area
4. Calculating the indicator

Exercise 1. Creating the network dataset

In this exercise, you will create a network dataset in a geodatabase using San Francisco Street and include any other traffic data related to streets.

Step 1: Start by opening ArcMap. Click the ArcCatalog icon on the standard tool bar to open ArcCatalog window.

Step 2: To Enable the Network Analyst extension.
   a). Click Customize > Extensions.
   b). Check Network Analyst.
   c). Click Close

Step 3: Navigate to the folder with the data required for analysis by clicking Connect to Folder button on the ArcCatalog standard toolbar.
Step 4: Click OK. A shortcut to the folder is added to the Catalog Tree under Folder Connections.

Step 5: In the Catalog Tree, expand the folder containing the data under step 2 and right click to create a file geodatabase (basis for the network dataset creation).

A file geodatabase is a collection of files in a folder on disk that can store, query, and manage both spatial and non-spatial data.

Step 6: To add data to the feature dataset, right click on the feature datasets, and click on Import option and select either Feature class single or Multiple.

The feature classes are listed in the contents of the feature dataset contained in the file geodatabase.
**Step 7:** Right Click **Public Transportation** feature dataset and click **New > Network Dataset**

![Screenshot of right-clicking on the feature dataset and selecting 'New > Network Dataset']

The **New Network Dataset** wizard opens.

**Step 8:** Type **Public Transportation _ND** for the name of the network dataset.

**Step 9:** Click **Next** and Check the **Streets** feature class to use it as a source for the network dataset and click **Next**.

**Step 10:** Click **Yes** to model turns in the network.

**Step 11:** Check **<Global Turns>**, which enables you to add default turn penalties.

**Step 12:** Click **Next**.
**Step 13:** Click **Connectivity**. The Connectivity dialog box opens. Here you can set up the connectivity model for the network. For this Streets feature class, all streets connect to each other at endpoints. Make sure that the connectivity policy of **Streets** is set to **End Point**.

![Connectivity dialog box](image)

**Step 14:** Click **OK** to return to the **New Network Dataset** wizard and Click **Next**.

**Step 15:** This dataset has elevation fields, so make sure that the **Using Elevation Fields** option is chosen.

**Note:** Elevation settings in a network dataset further defines connectivity. To understand why, assume two edges have coincident endpoints in X and Y space but have different elevations (one endpoint is higher than the other is). Furthermore, assume their connectivity policy is set to Endpoint. If elevation is ignored, the edges connect. However, if elevation is considered, they will not connect.

**There are two ways to model elevations:** using true elevation values from geometry or using logical elevation values from elevation fields.

The Streets feature class has logical elevation values stored as integers in the **F_ELEV** and **T_ELEV** fields. If two coincident endpoints have field elevation values of 1, for example, the edges will connect. However, if one endpoint has a value of 1, and the other coincident endpoint has a value of 0 (zero), the edges will not connect. ArcGIS Network Analyst recognizes the field names in this dataset and automatically maps them, as...
shown in the graphic below. (Only integer fields can serve as elevation fields.)

Step 16: Click Next. Here you can configure historical traffic data with this page of the wizard.

![New Network Dataset window](image)

Step 17: Click Next to set the network attributes.

Network attributes are properties of the network that control navigation. Common examples are cost attributes that function as impedances over the network and restriction attributes that prohibit traversal in either directions or one direction, like one-way roads.

ArcGIS Network Analyst analyses the source feature class (or classes) and looks for common fields like Meters, Minutes (TF_Minutes and TF_Minutes, one for each direction), and One-way. If it finds these fields, it automatically creates the corresponding network attributes and assigns the respective fields to them. (This can be viewed by clicking Evaluators.)

Network Analyst automatically sets up eight attributes for this San Francisco data: HierarchyMultiNet, Meters, Minutes, One-way, RoadClass, Travel Time. It also assigns evaluators to the attributes.

Step 18: From the Attribute drop-down list, click each type of attribute, one at a time, and inspect the evaluator types and values for the source feature classes.

Step 19: Click OK to return to the New Network Dataset wizard.
Step 20: Right-click the HierarchyMultiNet row and choose Use By Default. The blue symbol is removed from the attribute. This means the hierarchy will not be used by default when an analysis layer is created with this network dataset.

Step 21: Click Next. Click Yes to set up directions

Step 22: Click OK to return to the New Network Dataset wizard.

Step 23: Click Next. A summary of all the settings is displayed for your review. Click Finish.

Step 24: Click Yes. The Build Network Dataset progress bar opens; it will disappear when the build process is finished.

Step 25: The new network dataset, Public transportation _ND, is added to ArcCatalog along with the system junctions feature class, Public transportation _ND_Junctions.

Step 26: Preview the network dataset by clicking its name and clicking the Preview tab.

Step 27: Close ArcCatalog. Now you can add the network dataset to ArcMap and use it to create network analysis layers.
Exercise 2: Identification of service area

In this exercise, you will create a series of polygons that represent the distance (The distance required is 500m) that can be reached from a facility. These polygons are known as service area polygons.

Data required:
- Street network data (Network dataset created under exercise 1)
- Public transport stops

Step 1: Open ArcMap and add the network data created under Exercise 1 and add the data to be used for this exercise.

Step 2: To enable the Network Analyst extension, click Customize > Extensions. The Extensions dialog box opens. Check Network Analyst and Click Close.
If the *Network Analyst* toolbar is not displayed, you need to add it by clicking Customize > Toolbars > Network Analyst. The *Network Analyst* toolbar is added to ArcMap.

**Step 3:** To create the service areas, click New Service Area on the Network Analyst toolbar.

The service area analysis layer is added to the *Network Analyst* window showing the network analysis classes, which are *Facilities, Polygons, Lines, Point Barriers, Line Barriers, and Polygon*...
Barriers). It is also added to the Table of Contents window.
Step 4: The next step is to add the Public stops as facilities for which the service area polygons will be generated. On the Network Analyst window, right-click **Facilities** and choose **load locations**.

![Network Analyst window with Facilities and Load Locations options](image)

Step 5: The load location dialogue box opens. From the drop-down list, Choose **Public stops** and click **Ok**.

![Load Locations dialogue box](image)
The facilities are displayed in the map

**Step 6:** Next will be to specify the impedance of the service area to be calculated. The service area will be calculated based on walking distance (using meters). On the Network Analyst window, click the **Analysis Layer properties** button to open the **service area properties** dialog box.

![Service Area Properties dialog box](image)

**Step 7:** Click the Analysis Settings tab and set the **Impedance** to use distance (meters). In the **Default Breaks** text box, type 500, 1000. Under **Direction**, click **Towards Facility**. At **Junctions** drop-down list choose **Not allowed**. Leave **Ignore Invalid Locations** checked and Check **One-way** in the **Restrictions** list. The Analysis settings tab should look like this:

![Analysis settings tab](image)
Step 8: Click the Polygon Generation tab. Make sure that Generate polygons is checked. Under polygon type, click Generalized. Next, click Overlapping for the Multiple Facilities Options (This results in individual polygons for each facility. A polygon from one facility might overlap with a polygon from another, nearby facility). Click the Line Generation tab and leave Generate Lines unchecked and Click Ok. The Polygon Generation tab should look like this:

![Polygon Generation Tab](image)

Step 9: Click the Solve button on the Network Analyst toolbar. The service area polygons appear on the map and on the Network Analyst window.
Exercise 3: Identification of population served

Data Required
- Public transport stops
- Service areas
- Population data (census tracts with population figures, and any other socio-demographic data).

Demo Data:
- Census tracts for San Francisco, California USA

Once the service areas are constructed, the next step is to overlay the socio-demographic data.

Step 1: Add the socio-demographic data to the workspace. The socio-demographic data becomes the analysis zones.

Step 2: Right click the socio-demographic layer (San Francisco Census_2010) and Select, Open attribute table to view the data contained in the layer. The selected column contains the total population for each census tract. The other columns have data disaggregated using various variables such as, sex, age, race, etc.

The next step is to label the census tract layer to ease identification of population figures

Step 3: Right click the socio-demographic layer (San Francisco Census_2010) to open the properties. Go to Labels Tab. Check the label features in this layer box. Set the Label field to field that contains the data required (DP0010001). Click OK to close the properties dialog box.
Step 4: To identify the population served by the public transport service, the following should be noted. A service buffer (denoted as $i$) intersects, either fully or partially, with more than one analysis zone $j$ ($j=1...n$). The population served by the public transport buffer $i$, $P_i$ is thus equal to the sum of the population in each of the intersecting area, $P_{ij}$. Hence

$$P_i = \sum_{j=1}^{n} P_{ij}$$

Where, $P_{ij}$ is estimated based on the amount of interaction between service buffer $i$ and analysis zone $j$. In estimating $P_{ij}$, we will assume that the population is uniformly distributed within the analysis zone.

Step 5: Hence, to calculate the population served, Select the individual service area and record the total population served.

The total population served by *Union Bus terminal buffer* is:

$i = 4503467083$

$P_{ij} = 2598+3833+3073+2408+5164+3286+3143+1783+1500+4578$

Total = 17,163

Repeat the process for all the service areas and analysis zones.

*Tip: Label the service areas for easy identification.*
Step 6: Finally, the population with access to public transport out of the entire city population is computed as follows:

\[
\text{\% with access to Public transport} = \frac{\text{population with convenient access to Public transport}}{\text{City Population}}
\]

Examples:

<table>
<thead>
<tr>
<th>Service Area Id.</th>
<th>Population Served</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intersect 1</td>
<td>Intersect 2</td>
</tr>
<tr>
<td>4625148978</td>
<td>3376</td>
<td>4044</td>
</tr>
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</tr>
<tr>
<td>4557135186</td>
<td>3264</td>
<td>3218</td>
</tr>
<tr>
<td>309821157</td>
<td>6577</td>
<td>5171</td>
</tr>
<tr>
<td>4586346893</td>
<td>4711</td>
<td>3034</td>
</tr>
</tbody>
</table>

| Total Population with convenient access to public transport | 151,311 |

Total Population with convenient access to public transport = \(151,311\)

County Population = \(691,893\)

\[
\% \text{ With access to Public Transport} = \frac{151,311}{691,893} \times 100
\]

= \(22\%\)

In total, \(22\%\) of the total population of the DeKalb County has convenient access to public transport.
### GENERAL LIMITATIONS

<table>
<thead>
<tr>
<th>Data Limitations</th>
<th>Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The methodology described above covers public transport service solely based on proximity analysis to transport stops. It does not incorporate temporal dimension associated with the availability of public transport.</td>
<td>• The temporal aspect is important in measures of accessibility, as a service within walking distance is not necessarily considered as available if waiting time goes beyond a certain threshold level that is required. Additional data is required to determine how quality impacts on use and access to public transport</td>
</tr>
<tr>
<td>Factors such as affordability, safety and universal accessibility may influence the usage of public means of transport.</td>
<td></td>
</tr>
<tr>
<td>Harmonized global/local data on urban transport does not exist, nor are they comparable at the world level.</td>
<td>• An open source software platform for measuring accessibility, the Open Trip Planner Analyst (OPTA) accessibility tool, will be available to government officials and all urban transport practitioners. • Expert Group Meeting to harmonize the tools and existing data to ensure a more uniform and standard format for reporting on this indicator.</td>
</tr>
<tr>
<td>The road segments should include attributes allowing for a selection of streets accessible to pedestrians; however, road network is not incorporated in the measurement of the target.</td>
<td>• To be able to quantify the ease of access stops; a comprehensive road network is needed. Additionally, calculating how easily people can walk to a public stop is important. • The walking distance could be calculated using a street network taking into account the density of the street network and obstacles such as rivers, steep slopes, highways or railroads, which cannot easily be crossed by walking.</td>
</tr>
</tbody>
</table>
References

10. Tracking the SDG Targets: An Issue Based Alliance for Transport.
1. How important are good public transport systems to urban and social development?

Answer: Good public transport systems are an essential part of safe, clean and affordable transport for development. Public transport is often the only means of transport for disadvantaged populations; without it, they would be able to look for opportunities only within walking distance of their homes. Public transport is therefore likely to improve their livelihood opportunities. Public transport is also the main means of mobility for the elderly, people with disabilities and children. It gives greater access to education, health and recreation facilities.

2. What are key elements of sustainable public systems?

Answer: A good transport system must be easy and convenient to use, fast, safe, clean and affordable. A key feature is that they integrate multiple technologies such as metro rail, light rail, bus rapid transit making it easy for passengers to transfer from one mode to another.

3. Can you give examples of cities that have elements of sustainable public transport system?

Answer: Seoul, Singapore, Hong Kong.

4. What are the barriers to sustainable public transport?

Answer: Having many small operators that allows for low-cost services, yet the quality is poor. While single publicly owned entities may offer higher quality of services, their costs tend to be high and the quantity of their services is often inadequate.