Current Situation of Smart Transport Component and a Strategic Overview Within The Scope of The Turkey's Smart City Maturity Assessment Model

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Abstract—**This paper summarizes the capabilities and application of smart transportation component addressed within the scope of Smart City Maturity Assessment Model developed in the chaos of Turkish 2020-2023 National Smart City Strategy and Action Plan which is the 4th national smart city strategy in the world. There are many smart city maturity assessment models which enable cities to be evaluated together. In these models, standards and etc., different structures for different purposes are given over different concepts with different understandings. These found to be insufficient in terms of developing a national strategy by associating all smart city components under the smart city roof with each other. In addition, it has been determined that they do not meet the need to take into account the conditions and opportunities specific to Turkey. In this context, the need for Turkey-specific smart city maturity assessment model considering the current situation and future strategies of smart transportation component, which is defined in line with the Smart City Maturity Assessment Model, is emphasized. As a result, development of the Turkey specific maturity assessment model development and the Model itself became the backbone in analysis of the current situation and establishment of strategic view activities of the National Strategy and Action Plan.**

Keywords-smart transportation; smart cities; smart city maturity assessment model; maturity model; smart city components.

I. INTRODUCTION

There are many maturity assessment models that enable cities to feed each other and evaluate them together by comparing the smart city maturity of the cities in a systematic and structured way with a common understanding. When smart city maturity assessment models are examined, generally vertical assessment dimensions consisting of smart city components are used in models. As transportation services are the most used and needed service among city services, digitization in transportation services has become more important than other city services. In this context, many models such as [UNECE-ITU Smart and Sustainable City Indicators [1], Morgenstadt Framework Model [2], European Union (EU)-European Mid-Sized Cities Smart City Ranking Model [3], European Commission - Cultural and Creative City Monitoring Model [4] and ISO 37120 Sustainable Development of Communities-Indicators

For City Services and Quality of Life, Smart Transportation, Smart Mobility and Logistics Management [5] are among the vertical dimensions mentioned in the evaluation of transportation services. These are evaluated in detail and found out that they have different structures with different concepts representing different understandings serving for different purposes. Moreover, they are evaluated as insufficient in terms associating all smart city components under the smart city roof with each other. At last, it has been determined that they do not meet the need to take into account the conditions and opportunities specific to Turkey.

With this approach, in Turkey within the scope of the 2020-2023 National Smart Cities Strategy and Action Plan [6] Project, Smart City Maturity Assessment Model [7] has been developed by TÜBİTAK BİLGEM Software Technologies Research Institute, which forms a common language and systematic structure guaranteeing simultaneous smart city maturity development. With the Model, the Smart City maturity level is determined by assessing smart city capabilities of a city and solutions are proposed for improvement of the maturity level. The developed model specific-to Turkey, is compatible with the country's current policy and takes sources and experience related to international examples into account.

The Smart City Maturity Assessment Model has been developed in the structure of displaying the current state of the city related to smart city transformation through status indicators, assessment of readiness in activity areas in division of competence-component-capability, and maturity level of efficiency dimensions, and display of the impact of smart city studies on the city through impact indicators. Smart City Capability is the skills that cities need / will need to perform smart city studies for a specific purpose or that they can / will acquire through smart city studies. Smart City Components are groups of capabilities that serve the same value. Smart City Competence is a group of consisting components based on sectorial expertise or service areas.

The Smart Transportation component is among the smart city components defined in the model. The existence of Smart Transportation applications in the cities, which are included in the breakdown of capabilities defined within the scope of the Smart Transportation component in the model, the state of intelligence creation based on the data and expertise obtained with these applications, and the use of this

intelligence in order to predict the improvement of the services provided by the use of these applications are evaluated. By determining the indicators used in measuring the current situation regarding smart transportation and the impact created by the smart city studies, the maturity level of the smart transportation component and its impact are evaluated.

There are four section in this paper. In first section, the case of addressing the smart transportation component to smart city maturity assessment models is described, the need for smart city maturity assessment model is evaluated, and, the structure of the model developed specific-to Turkey to meet this need is expressed. Section II describes the smart transportation component defined in scopes of 2020-2023 National Smart City Strategy and Action Plan Project and the Maturity Assessment Model work and the component capabilities and applications are included in this section. Section III provides information related to current state of smart transportation component in Turkey through the smart city maturity assessment model structure and the policies and indicators defined in this direction. In final section, the effects of studies to be conducted over the structure defined by developed model, on defined smart city policies are emphasized.

II. SMART TRANSPORTATION

The preparation studies of 2020-2023 National Smart Cities Strategy and Action Plan, analysis and examinations which adopted deductive and inductive approaches, were carried out in a way that feed each other and feed from each other iteratively and have become an integrated structure named Smart City Maturity Assessment Model. In smart city current state analysis studies, needs and problems were determined by

- focus group studies,
- strategy and legislation analysis,
- local government survey,
- examination of standards, framework models, sample applications developed both in Turkey and other countries.

With the knowledge conceptualization and modeling studies, capabilities and applications were defined within the scope of smart city components and components included in the maturity assessment model.

Among these components, the smart transportation component; developed for purposes such as reducing travel times, increasing traffic safety, optimum use of existing road capacities, increasing mobility, contributing to the national economy by providing energy efficiency and reducing the damage to the environment, is defined as sustainable integration of ICT-supported integrated systems, which include trams, buses, trains, subways, cars, bicycles and pedestrians using one or more modes of transportation, multi-directional data exchange between user-vehicle-infrastructure-center and monitoring, measurement, analysis and control, safe practices [6].

The capabilities identified within the scope of the smart transportation component are summarized below:

- Next generation vehicles: These are environmentally friendly vehicles with high fuel performance, low or no air pollutant emission.
- Next generation transportation models: These are models that adopt innovative approaches as well as the combined use of different transportation modes developed as an alternative to conventional transportation methods.
- Emergency management: It is the management of unexpected events that require emergency intervention in transportation.
- Accessibility management in transportation: It is the ease of people and commercial activities to reach the desired goods, facilities and activities in the transportation network.
- Transportation infrastructure: It consists of lines such as canals, waterways, airlines, railways and roads, as well as facilities such as terminals, ports, refueling depots, warehouses, bus stations, train stations and airports.
- Transportation governance: It consists of transportation planning, operation and maintenance, improvement and change management, continuity and integrated management.
- Logistics management: It is the supply chain management that provides the forward and backward flow of goods, services and related information between the production points and consumption points in line with the needs.
- Traffic management: It is the management of activities aimed at regulating urban traffic and ensuring its safety.
- Public transport management: Providing quality service for city residents using public transportation and managing vehicles and drivers in a holistic manner.
- Railway management: It is the management of the necessary activities for the safe and quality of railway safety and transportation.
- Park management: These are the activities required for the innovative, effective and efficient use of parking lots.
- Payment management: It is the establishment and management of the necessary infrastructures to make payment safe and easy in transportation.

The applications and application areas within the scope of smart transportation capabilities determined in line with the research conducted within the scope of model development activities are summarized in the following figure.

Figure 1. Capabilities and Applications of Smart Transportation Component.

As seen in Figure 1, within the scope of each smart transportation capability, the applications and application areas that cities should have in accordance with their smart city maturity levels are defined. Capability of next generation vehicles includes electric transportation vehicles, hybrid vehicles, autonomous vehicles, connected vehicles and capability of next generation transportation modes include car and bike sharing, multimode public transport, transport tunnels, demand responsive transport, multimode city transport traffic, targeted combination of different transport modes applications and etc. Capability of traffic management includes traffic intensity detector sensor, smart intersection solution center, real time and dynamic intersection management system, traffic measurement system, variable message system, intelligent guidance system, virtual twin and simulation in transportation, traffic light analysis, traffic analysis, trip planning, traffic jam assistant, lane warning system applications. Capability of public transport management includes smart stop, indoor mapping in transport, pedestrian access incentive implementation after public transport stops, common electronic ticket system in public transport, capability of

payment management includes city box office management, pricing for special cases, single card payment system applications. Parking management capability includes smart parking management and payment solutions, online parking reservation system, parking lot management and guidance system, vertical parking lots, park and use public transport system, parking lot dynamic pricing, parking lot occupancy applications. Railway management consists of train control system, railway safety monitoring system, railway infrastructure, intercity and high speed transport applications. Logistics management includes intelligent freight transport, special transport infrastructure for cargo systems, logistics data portal, freight mobility, logistics infrastructure applications. Accessibility in transport capability includes talking pedestrian button for disabled, personalized transportation information, pedestrianized zone, barrier-free accessible pedestrian routes, barrier-free traffic signaling, barrier-free public transport, standards for pedestrian roads and sidewalks. Capability of emergency management includes traffic light prioritization, emergency vehicle priority (evp) management, vehicle location detection, snow and ice fighting, preferential paths. And capability of transport governance includes data based transportation management, integrated traffic management, optimum route planning, traffic congestion based pricing, test evaluation center, traffic control center, urban network management, transport inventory database, passenger mobility , planning and implementation, operation and maintenance, monitoring evaluation and change management, sustainability, organization, resource management, service management, interoperability and coordination among stakeholders.

III. SMART TRANSPORTATION COMPONENT:CURRENT SITUATION AND STRATEGIC VIEW

Within the scope of 2020-2023 National Smart Cities Strategy and Action Plan [6] and Maturity Assessment Model [7] development studies, analyzing the current situation in terms of smart city components and defining expectations and solution suggestions for the future and identifying policies and strategies that will shape / affect the smart city area, the target view has been determined and a strategic perspective has been established. Within the scope of these studies, the Smart Transportation component has also been addressed.

The survey [8] conducted electronically by local governments is important in terms of determining the current status of smart transportation components in Turkey. 327 local governments (22 Metropolitan, 34 Provinces, 271 Districts) participated in the survey [8]. The structure of the smart transportation component in the smart city maturity assessment model was used in the questionnaire. An analysis was made with the answers given regarding the life cycle-based availability of 41 applications within the scope of the Smart Transportation component.

As part of the local government survey [8], in the area of smart transportation;

- 7% of cities have "Next Generation Vehicle and Transportation Modes" capability,
- 8,9% of cities have "Smart Traffic Managements" capability,
- 5,5% of cities have "Smart Parking" capability,
- 12,7% of cities have "Accessibility in Transportation" capability,
- 7,5% of cities have "Emergency Management" capability,
- 6,6% of cities have "İnfrastructure Management, Public Transport Management, Payment Management, Railway Management, Transportation Governance and Logistic Management" capabilities

have been found that the foregoing considerations exist at different stages of the life cycle. Thus;

- 8% of cities have "Electric vehicles/Buses" applications,
- 4% of cities have "Hybrid vehicles" applications,
- 9% of cities have the "Maintenance Repair Assistance" applications
- 7% of cities have "Parking Assistance" applications,
- 5% of cities have "Traffic Jam Assistance" applications,
- 4% of cities have "Vehicle Sharing" applications,
- 10% of cities have "Bike Sharing" applications,
- 7% of cities have "Multi-Mode Public Transport" applications,
- 5% of cities have "Emergency Change Management" applications
- 10% of cities have "Traffic Light Prioritization" applications,
- 5% of cities have "Vehicle Priority Management" applications,
- 11% of cities have " Talking Pedestrian Buttons for Disabled Persons" applications,
- 5% of cities have "Personalized Transportation Information" applications,
- 22% of cities have "Pedestrianized Zone" applications,
- 1% of cities have "Smart Vehicle Highway Systems" applications,
- 4% of cities have "Lane Warning System" applications,
- 5% of cities have "Lane Management Arrangement" applications,
- 5% of cities have "Car Park Dynamic Pricing" applications,
- 8% of cities have "Car Park Occupancy Determination" applications,
- 7% of cities have "Parking Management and Routing System" applications,
- 2% of cities have "Online Parking Reservation System" applications,
- 4% of cities have "Intensity Density Sensors" applications,
- 6% of cities have "Smart Solution Center" applications,

- 8% of all cities have "Real-time and Dynamic Junction Management Systems" applications,
- 8% of all cities have "Light Analyses" applications,
- 14% of cities have of "High Speed Transport" applications,
- 8% of cities have "Commuting to Work and Regional Transportation" applications,
- 7% of cities have "Trip Planning" applications,
- 5% of cities have "Demand Based Transportation" applications,
- 1% of cities have "Traffic Jam Based Pricing" applications,
- 9% of cities have "Traffic Analyses" applications,
- 4% of cities have "City Ticket Office Management" applications,
- 12% of cities have "Determination of Vehicle Routes with GPRS Data" applications,
- 7% of cities have "Smart Routing Center" applications,
- 13 % of cities have "Traffic Monitoring System" applications,
- 9% of cities have "Traffic Measurement System" applications,
- 9% of cities have "Traffic Violation Systems" applications,
- 8% of cities have "Variable Messaging System" applications,
- 5% of cities have "Integrated Traffic Management" applications,
- 2% of cities have "Connected Traffic Cloud" applications,
- 9% of cities have "Urban Traffic Management Systems" applications

have been found that the foregoing considerations exist at different stages of the life cycle.

In this context, policies developed are as follows:

- The need to evaluate the use of the next generation efficient and low carbon release vehicles, a next generation transportation models and reduced traffic and increased user comfort has been determined as a policy area. The dissemination of new generation environmentally friendly (with alternative power system) means of transportation will be ensured. In addition to the combined use of different transportation modes developed as an alternative to classical transportation methods, the widespread use of next-generation transportation models addressing innovative approaches will be ensured.
- The need for efficient management of traffic based on data, optimizing the time spent in traffic, facilitating the lives of city residents and providing safe travel has been determined as a policy area. In this context, there is a need to improve the transportation infrastructure and expand the application / application areas within the scope of transport infrastructure, public transport management, railway management, payment management, parking management and governance capabilities.

- There is a need to develop transportation infrastructure and extend applications/application areas. Infrastructure that supports smart transportation systems will be deployed.
- There is a need to develop transportation infrastructure and extend applications/application areas. Activities intended for transportation governance will be conducted at the national, regional and local level for organization, resource management, planning and implementation, operational maintenance, monitoring evaluation, sustainability, interoperability, service management and coordination among stakeholders.
- In smart transportation area, it is needed to provide emergency transportation management and provide transportation without interruption by vehicle priority in case of emergency and disasters. Within the scope of emergency transportation management, the widespread use of information systems that provide traffic light routing and automatic detection of cases will be ensured in order to provide the rapid transportation of priority vehicles in traffic as required.
- There is a need for talking pedestrian buttons for disabled people, unobstructed pedestrian paths, unobstructed accessible traffic signalization and the use of personalized transportation information through unobstructed accessible public transportation applications to ensure accessibility in transportation. To ensure accessibility in transit, all segments on the transportation network will be foreseen for smooth and easy use, as well as advance notification of transportation options and widespread use of applications for disabled people.
- By building a Smart haulage infrastructure, the development of the logistics data portal and the provision of logistics management are required. Data-driven logistics management will be undertaken, based on needs that embraces the generation supply chains that provide forward and reverse flows of goods, services and related information between production point and consumption points.
- There is a need to provide inclusive transport services that improve the quality of life of city residents and ensure safe mobility of drivers, pedestrians and passengers.

The indicators determined in order to measure the effect of the policies developed for the smart transportation component on the current situation are as follows:

- Status Indicators
  - The number of public transport trips per person per year
  - The number of personal cars per person
  - Percentage of people who use a travel mode other than a personal vehicle
  - The number of vehicles with two wheels per person

- o Percentage of cycle paths and lanes per 100000 people
- o The number of deaths in transportation per 100000 people
- o Real-time traffic information presentation rate
- o Measurement status of the amount of renewable energy used in transportation
- o Existence of the physical infrastructure provided for the sharing of electric vehicles
- Impact Indicators
  - o The number of cities with increasing Smart Transportation Maturity of the Component
  - o National Smart Transportation maturity level increasing status
  - o Increasing status for the length of the high capacity public transportation system per 100000 people
  - o Increasing status for of the length of the light passenger public transportation system per 100000 people
  - o Increasing status for commercial air connection (the number of continuous commercial air destinations)
  - o Increasing status of the amount of renewable energy used in transportation.

IV. CONCLUSION

Since the smart city is a complex concept, it is necessary to give a structure for the concept. Smart city maturity assessment models are used to meet this need. With this approach, Turkey specific maturity assessment model has been developed and the model have been used in analysis of the current situation and establishment of strategic view activities within the scope of the National Strategy and Action Plan development. In this context, the current situation was determined in a structural, related and systematic way through the architecture of the model defined and the strategies, namely the target view, were expressed over the same structure. Within the scope of the model, the smart transportation component, its capabilities and applications were determined and the needs definition studies and target view determination studies for the smart transportation component were shaped through this structure.

To summarize, for the future the implementation of adopted policies will be ensured by measuring the development and impact of the smart city studies carried out in the city with city-based model implementation. On the other hand, new solutions are constantly added to smart transportation solutions, and some of them are not preferred because they do not create the desired value in practice. Therefore, it is necessary to reflect these changes to the model continuously, and there is a need to address such a large number of city-based solutions in line with the priorities defined in the city smart city strategy (possibility, condition, need and current smart transportation maturity).

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