RESILIENCE AND LIVABLE CITIES IN A WARMING WORLD

A FESTSCHRIFT IN HONOUR OF

TPL. DR. JOSHUA ADEWUMI ADEBISI FNITP, RTP



EDITED BY

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ISBN: 978-978- 63753-0-4

Published By:

The Nigerian Institute of Town Planners,
Oyo State Chapter,
Quarter 704, Iyaganku GRA, Ibadan.

Supported By:

Center for Sustainable Urban Planning,
Logistics, Infrastructure and Future Transport
3B, Upper Ijesha Road, Taiwo Estate, Iponri, Lagos.

Printed By:
DCrowns Multiventures,
P. O. Box 27796, Ibadan.
oludarebiyi@gmail.com | +234-8053896026

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ISBN: 978-978- 63753-0-4

CHAPTER 08

SMART SOLUTIONS FOR RESILIENT TRANSPORTATION INFRASTRUCTURE AND CITY LIVABILITY: EXAMPLES FROM THE STATE OF CONNECTICUT, UNITED STATES OF AMERICA

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Abstract

City livability is residents' accessibility to effective and resilient infrastructure, sustainable environment, social harmony and economic wellness. Resilient transportation infrastructure has emerged as a critical global imperative, demanding that nations and cities implement smart solutions for designing, constructing, and maintaining roads, bridges, and other transit infrastructure so as to reduce the impacts associated with global warming, or other unexpected shocks. This chapter therefore gave thorough examples of smart solutions for resilient transportation infrastructure and city livability in the State of Connecticut, United States of America (USA) based on three objectives. Livability theory by Veenhoven (2000) and Resilience theory by Holling (1973) served as theoretical guide to this work. Closely related works examined the extent of transit infrastructural influence on livability, transportation infrastructure as a livability constraint, and residents' experiences of how well transport systems satisfy their accessibility and transit needs in Lagos Metropolis. However, they did not give attention to smart solutions for resilient transportation infrastructure and city livability which identified a huge gap in literature. The methodology involved systematic review of peer-reviewed articles, policy documents, and reports. The result revealed that the State of Connecticut, U.S.A. is executing various smart solutions such as the use of intelligent transportation systems (ITS) technologies, multiple modes of transportation and eco-friendly transit initiatives to enhance resilient transportation infrastructure and city livability. The State uses cameras, photologs, sensors, exor and esri to collect and transmit real-time data for better traffic management, safety, control and recovery to ensure city livability. The state offers various routes and public transit options like trains, buses, and bikeways to enhance accessibility, safety and reduce reliance on personal vehicles and single route. Also, the state is investing in the use of electric and other eco-friendly vehicles to reduce emission of greenhouse gases and ensure ecological sustainability. Based on the results, it was recommended that each projects such as Resilience Improvement Plan (RIP), Transportation and Climate Initiative Program (TCI-P), TIME For CT, National Electric Vehicle Infrastructure (NEVI) program should be allotted proper funding for swift implementation of resilient infrastructure; and the government should ensure that electric vehicles are encouraged by providing incentives to motivate the citizens to adopt it so as to ensure environmental sustainability and improved livability.

Keywords: Smart Solutions, Resilient Transportation Infrastructure, City Livability, Sustainability

1.0 Introduction

Livability consists of various facets such as citizens' accessibility to effective infrastructure, sustainable environment, social harmony and economic wellness within a city. In aspect of transportation, livable cities are characterized by proper and efficiently planned transit systems that enhance accessibility, reduces traffic congestion and foster ease in movement (Akanmu et al., 2022). Such cities ensure that the welfare and wellness of residents in areas of tangible and intangible elements such as residence, transit, public services, security, social solidarity and sense of community (Akanmu et al., 2025). For a city to be termed livable, it usually requires an efficient transportation infrastructure to make its various elements of residential, industrial, and professional activities interact successfully (Adeboyejo, 2021).

Transportation infrastructure whether regularly used or not are usually susceptible to the effects of climatic issues, urban expansion and technological proliferation which necessitates the need for resilient infrastructure (Singla, 2024). Resilient transport infrastructure means that the bridges, roads, seaports, rails and airports infrastructure are able to absorb, withstand, and recover from disruptions caused by natural catastrophe, climate situations, human-made catastrophe, technical breakdown and/or unexpected shocks while retaining their critical functions (Lee, 2025; Singla, 2024 & Thomas, 2025). Resilient transport infrastructure is highly vital, as it is integral to overall livability of cities such as ensuring continuity of social cohesion, security, economic stability and health even in intense weather conditions, and the (Lee, 2025 & Thomas, 2025).

As some parts of the world grapples with climatic situations, technological failures and man-made upheavals, the fragility of the transit infrastructure is more at risk than ever. Various cities, particularly those in low-lying coastal areas, are already bearing the brunt of rising sea levels, intense weather conditions and persistent flooding (Igini, 2022; Indrajit et al., 2023; Nicholls et al., 2007 & Pei-Chin et al., 2024). Globally, cities such as Jakarta, Indonesia; Lagos, Nigeria; Miami, New York, New Orleans, and Boston in the USA; Chennai, India; Calais, France; Santander, Spain; Kuala Nerus, Malaysia; and Aberdeen, Scotland are on the crosshairs of an existential environmental catastrophe (Igini, 2022; Nicholls et al., 2007 & Pei-Chin et al., 2024). These cities face infrastructure paralysis, inundation, and saltwater intrusion which result in shoreline erosion that creates long-term displacement risks, endangers residents and affect livability (Igini, 2022; Nicholls et al., 2007; Pei-Chin et al., 2024 & Sheyi, 2023).

The state of Connecticut, USA is also not left out in this global environmental crisis. The state of Connecticut, USA also experiences significant rise in sea levels, persistent flooding, and intense weather conditions as most of the state's population live in vulnerable low-lying coastal environments. Twenty (20) inches of sea-level rise is projected by the year 2050 which could place about thirty-three (33) key transportation infrastructure in the state at risk of twice annual flooding at that time (O'Donnell, 2018). This situation impacts the city's livability. For instance, persistent flooding restricts access to residential areas, schools, and health centers, disrupting daily commutes and

emergency services especially in areas such as Litchfield, Fairfield, and New Haven counties (Lamont, 2024). Furthermore, the rising seas puts at risk residences, key infrastructure and industrial contamination sites. In fact, it is projected that over one hundred and twenty-seven assets in the coastal areas may experience disruptive flooding by the year 2100 (Nunes, 2024). The state also faces the situation of collapsing foundations in some coastal regions, which decreases residents' property values, increases their insurance and maintenance costs and affect their overall livability (Haigh, 2017). Thus, resilient transportation infrastructure is not just a luxury but a key requisite for making sure cities particularly those in low-lying coastal areas in the state of Connecticut are able to thrive and be livable in the face of these vicissitudes (Thomas, 2025).

The major features of a resilient transportation infrastructure include but not limited to – the ability to function in the face of potential natural catastrophe such as earthquakes, climatic conditions and persistent floods (Jean-Paul, 2024); having backup or alternative transit routes to ensure that the failure of one route does not negatively impact the entire transit system for the sole aim of maintaining continuity (Zhang et al., 2025); ability to rapidly restore to normal after a disruption and/or unexpected shock (Leviäkangas & Aapaoja, 2015); ability to adapt or adjust in response to new threats, changing conditions or shocks (Schmitz, 2021); and ability to maintain sustainability, that is, reduce negative ecological impacts while ensuring transit functionality (Lee, 2025). All these features help to make sure the city is livable for residents. However, to achieve the above key features of resilient transportation infrastructure, there is need for smart solutions.

In the context of this chapter, smart solutions for resilient transportation infrastructure and city livability has to do with the use of creative and/or innovative technological methods to create transit structures that can anticipate, respond and adapt to potential catastrophe, climatic situations and man-made crises. These inventive and advanced technological methods involve the integration of smart technologies for live surveillance and dynamic control, fostering multiple modes of transit, and eco-friendly and optimized transit practices investment (Anwar & Oakil, 2024; Lee, 2025). This study therefore sought to explore various examples of smart solutions for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A. based on the following objectives:

i. Examples of integration of smart technologies for live surveillance and dynamic control for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A.;
ii. Examples of fostering multiple modes of transit for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A.; and
iii. Examples of eco-friendly and optimized transit practices investment for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A.

2.0 Literature Review

2.1. Conceptual Review

2.1.1 City Livability

City livability is an attractive, worthwhile, safe urban system that contributes to the overall wellness and personal development of its inhabitants regardless of their gender, age and other socio-demographic characteristics particularly with ease in mobility through various transit options. A livable city is that which improves residents' quality of life through the fostering of sustainable environments, social cohesion, economic welfare and opportunities for education, health, culture, housing, recreation, entertainment and overall environmental quality (Akanmu et al., 2022 & Vaclavik & Macke, 2022). City livability is determined by how much the infrastructures, facilities and services within the city is able to fulfil the needs and aspirations of the residents (Fouladi et al., 2025; Preetha & Tejwant, 2022). The entire surroundings of such cities are deliberately designed and constructed to ensure that the living situations or quality of life of the residents are improved and their basic needs are met or satisfied (Pankaj et al., 2024). A livable city is therefore one that is excellently planned and governed with the sole aim of providing a competitive economy, vibrant, lively, and safe surroundings for the people to dwell, work and have fun (Adewale & Siti, 2024).

2.1.2 Resilient Transportation Infrastructure

Resilient transportation infrastructure refers to the ability of infrastructure used in transportation systems like bridges, roads, airports, and railways to anticipate, prepare for, respond to, and recover from various disruptions caused by natural catastrophe, global warming, technical breakdown, or even human-made incidents. Resilient transportation infrastructure ensures continuity, social functionality and economic protection through its features like absorption, adaptability and redundancy (Jones, 2025). For a transportation infrastructure, resilience is the capability of such infrastructure to timely and efficiently prepare for, absorb, adapt and recover from a disruption or unexpected shocks to an operational level similar to before the disruption. Thus, transportation infrastructure is said to be less resilient if it takes longer time to recover from shocks or disruptions take a deep toll on it (Jean-Paul, 2024; Paulus, 2023).

The four key properties of resilient transportation infrastructure therefore include but not limited to – robustness (ability to withstand expected and unexpected shocks with or without minor decline in transit service); resourcefulness (capability to diagnose problems, emphasise key initiatives and deploy the needed human and material resources for the transit system adaptability and recovery); redundancy (extent at which there are multi modes of transit system that serve as alternatives or backups in order to maintain the integrity of the system without loss of function); and rapidity (timely and efficient recovery of the infrastructure) (Bruneau et al., 2003, as cited in Paulus, 2023).

2.1.3 Smart Solutions for Resilient Transportation Infrastructure and City Livability

Smart solutions for resilient transportation infrastructure and city livability have to do with the usage of smart technologies or digital equipments to ensure safety,

efficiency and ecological sustainability within the transit system (Phalak, 2024; Badidi, 2022; Shiva et al., 2024). These solutions deal with integrating data analytics, and connectivity and advanced technologies such as Internet of Things (IoT), edge computing, blockchain, machine learning, artificial intelligence (AI) and communication systems in the design, planning, construction and maintenance of transit infrastructure so that they are able to timely and efficiently absorb, adapt and recover from various shocks and effects of natural catastrophe in order to improve city livability (Gurleen et al., 2025).

Smart solutions imply that a transportation system is able to analyze, measure, monitor, communicate, and act in line with the data gathered from various sensors. The collected data are used to accurately decide on resource allocation, asset maintainance and disruptive response so as to foster ecological sustainability and livability (Sadiku et al., 2025). Smart solutions therefore involve the use of creative and/or innovative technological methods to create transit structures that can anticipate, respond and adapt to potential catastrophe, climatic situations and man-made crises. These inventive and advanced technological methods involve the integration of smart technologies for live surveillance and dynamic control, fostering multiple modes of transit, and eco-friendly and optimized transit practices investment (Anwar & Oakil, 2024; Lee, 2025).

2.2 Theoretical Review

This studyr was guided by two theories namely Livability theory' by Veenhoven (2000); and Resilience theory' by Holling (1973).

2.2.1 Livability Theory by Veenhoven (2000)

Livability theory is the degree to which institutional structures and environment align with the inherent needs and capabilities of the inhabitants of such community or city. According to livability theory, happiness in humans differ based on how the environment fits or fulfills their needs, that is, when the social and physical structures such as transportation infrastructure effectively meet basic needs of humans, there is subjective happiness among them (Veenhoven, 2000, 2010a, 2014). Basic assumptions of livability theory include:

i. Human beings have inherent needs like water, food, shelter, companionship and safety;
ii. Need gratification shows up in pleasurable experience;
iii. Pleasurable experience determines the degree to which humans judge their lives as happy or not and happiness depends on gratification of their needs;
iv. Gratification of human needs depend on both inner abilities and external living conditions which imply that bad living conditions will decrease human happiness particularly when its demands exceed human capabilities. Since societies are responsible for fulfilling the needs of humans and not all societies fulfil their responsibilities equally well, it means that not all humans are equally happy in various societies; and
v. When the fit between societal institutions and human needs improve, there will be greater happiness among the people (Veenhoven, 2010a, 2014).

This theory is relevant in that it renders support to the role of integrating smart solutions for ensuring resilient transportation infrastructure that makes a city livable and residents of such cities able to meet their needs and gratifications for happiness.

2.2.1 Resilience Theory by Holling (1973)

Resilience theory provides basis for how a system or structure (in this case, transportation infrastructure) is capable of absorbing, adapting, withstanding and recovering amidst disruptions and/or shocks (Holling, 1973 & Moore, 2019). Resilience theory also emphasises the place of anticipatory strategies to reduce risks. These strategies are measures such as forecasting analytics can anticipate likely disturbances like high traffic congestion and weather conditions and permit pro-active transit plan realignments. These strategies may include traffic signal timing, rerouting, notifying travelers about likely circumstances, and reducing the effects of disturbances (Holling, 1973; Lee et al., 2020 & Maroš, 2021). According to resilience theory, the use of strategies or measures like technologies such as sensors help to collect and analyze data thereby creating awareness on the susceptibilities and possible failures in the transit infrastructure or system enabling early and easy detection of congestion and accidents (Holling, 1973 & Maroš, 2021). These technologies also ensure live surveillance of the infrastructure in order to detect early defects, and coordinate timely interventions (Lee et al., 2020 & Maroš, 2021). Resilience theory also emphasizes multi-modal transit system that ensures alternative or backup routes are created to decrease vulnerability of a single route (Grady, 2024; Lee et al., 2020; Maroš, 2021 & Yuchuan et al., 2022). This theory is relevant in that it emphasises the role of strategies, measures or smart solutions such as the integration of technology and creation of multi-modal transit system to ensuring that transportation infrastructure is resilient (robust, redundant and resourceful); able to absorb, withstand and recover from various catastrophe and likely disturbances.

2.3 Empirical Review

Few empirical works closely related to this topic have been carried out. For instance, Akanmu et al. (2022) carried out a work that focused on the nexus between city livability and transportation in Lagos Metropolis, Nigeria. The work emphasized the extent of transit infrastructural influence on livability of Lagos Metropolis. However, the work did not focus on examples of smart solutions for resilient transportation infrastructure and city livability. Akanmu et al. (2025) also carried out a work on livability assessment and socioeconomic impact indicators in Lagos Metropolis, Nigeria. The work emphasised transportation and circulation in aspects of safe streets, transit facilities and pedestrian infrastructure as livability constraints perceived by residents of Lagos State Metropolis, Nigeria. Conversely, this work did not give attention to various strategies for providing solutions for resilience in the transportation infrastructure and city livability which created a gap in literature.

Akanmu and Salisu (2024) examined the effects of environmental peculiarities on transportation infrastructure performance in Lagos Metropolis, Nigeria: residents' experiences. Their work focused on residents' experiences of Lagos state environmental conditions to gauge how well the transport systems meet or satisfy

their accessibility and transit needs but did not give attention to various smart solutions for resilient transportation infrastructure and city livability. This also created a gap in empirical knowledge. This chapter therefore aimed to close the identified gaps in empirical knowledge.

3.0 Materials and Methods

3.1 Study Area

This area of study is the state of Connecticut, USA. Connecticut is one of the original thirteen (13) states and six New England states. The state is located in the northeast region of the country. It is densely populated and lies borders Rhode Island to the east, Massachusetts to the north, New York to the west, and Long Island Sound to the south. The capital of the state is Hartford located in the north-central region. The state is roughly rectangular in shape and takes its name from an Algonquian word which means "land on the long tidal river". The state's greatest east-west length is about 110 miles (180 km), and its maximum north-south extent is about 70 miles (110 km) (Irving, 2026). The state of Connecticut, USA also experiences significant rise in sea levels, persistent flooding, and intense weather conditions as most of the state's population live in vulnerable low-lying coastal environments. Twenty (20) inches of sea-level rise is projected by the year 2050 which could place about thirty-three (33) key transportation infrastructure in the state at risk of twice annual flooding at that time (O'Donnell, 2018).

3.2 Methodology

The methodology adopted for this chapter is a comprehensive literature review that implies blending various perspectives (urban studies, sociology, environmental science, geography, and etcetera) into one cohesive argument. A systematic search strategy was executed across diverse indices, capturing a wide spectrum of academic journals, books, proceedings, institutional reports and databases such as Google Scholar, PubMed, Scopus, and Web of Science. Thus, keywords that were related to smart solutions for resilient transportation infrastructure and city livability were used to ensure that the topic was properly covered. Proper analysis of the literature was conducted for thematic synthesis and gap analysis. Data were thus extracted from relevant studies to provide support and insights into examples of smart solutions for resilient transportation infrastructure and city livability in the state of Connecticut, USA (Okonta & Vladimir, 2024).

4.0 Results and Discussion

Objective One: Examples of integration of smart technologies for live surveillance and dynamic control for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A.

Smart technologies for resilient transportation infrastructure and city livability involve the use of live data gathered and analyzed to monitor and control transit networks, enabling proactive responses to shocks and disruptions so as to improve overall efficiency and safety in states and cities (Guliaeva, 2024; Soubhik, 2025 & Tumminello et al., 2025). Integration of smart technologies is about using cognitive

computing systems to produce better resilient transit networks that are efficient, able to adapt and respond efficiently to likely disturbances and improve city livability. The integration of smart technologies such as sensors, cameras, and connected vehicles can be utilized in gathering useful data on the flow of traffic, incidents, and state of each transit infrastructure which are analyzed and optimized for overall management of traffic, anticipate threats and create ways of overcoming them in a bid to ensuring residents' wellness and stability (Guliaeva, 2024 & Soubhik, 2025).

The State of Connecticut makes use of smart technologies such as cameras to provide visual-based traffic surveillance for early detection of incidents (Lee, 2025). Sensors are embedded in the roads, and other transit infrastructure in order to measure the speed, volume and congestion of traffic (Bayramoglu, 2025 & Guliaeva, 2024). Connected vehicles are also used to wirelessly relay live data such as location, speed and direction of travel and overall traffic situations and/or conditions using vehicle-to-infrastructure (V2I) communication (Bayramoglu, 2025 & Grumert & Tapani, 2017). The live data are used to effectively manage traffic, optimize flow of traffic and improve residents' ease of use of transit system which improves their wellness (Figure 1). Furthermore, by harnessing Intelligent Transportation Systems (ITS) data from smartphones, city planners are able to visually detect traffic patterns and address recurrent bottlenecks (Bayramoglu, 2025; Grumert & Tapani, 2017 & Guliaeva, 2024). Collected data is often synthesized using high-level analytics, including algorithms diagnostics, to detect patterns, preempt potential risks, challenges and overall health of the transit network for ensuring economic and social stability among residents (Anwar & Oakil, 2024; Bayramoglu, 2025 & Guliaeva, 2024).

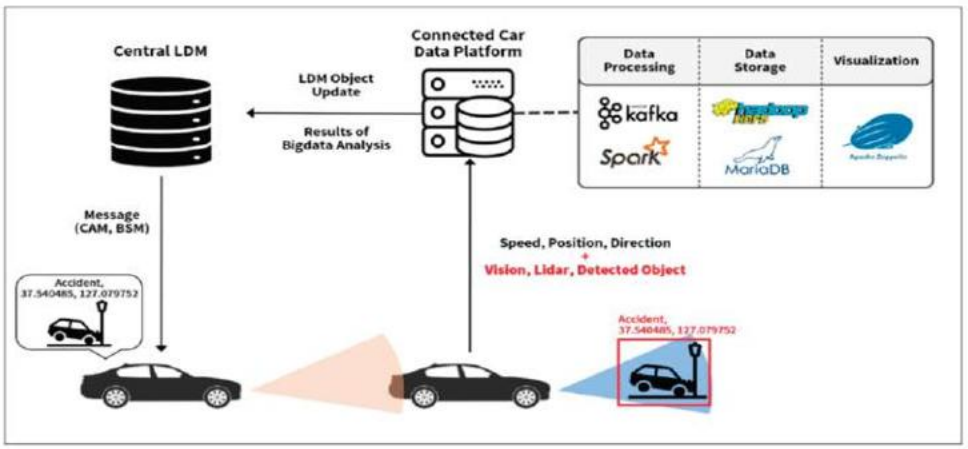


Figure 1: Automated Data Collection Vehicle (ADCVs) equipped with technologies like sensors and cameras to gather data autonomously (*Source:* Bayramoglu, 2025).

Intelligent Transportation Systems (ITS) with its components, software applications and communications technology such as Video and Radar Detection, Wireless, Advanced Traffic Signal Controller, Ethernet, Arterial Pan-Tilt-Zoom Cameras, Fiber Optic Telecommunications, Adaptive Signal Control Technology

(ASCT), Central Traffic Signal System Control Software, Connected Vehicle to Infrastructure (C2I) and Automated Traffic Signal Performance Measures (ATSPM) are vital instruments for enabling timely modifications to the state's traffic signal system (Mohamed et al., 2024 & State of Connecticut, 2025). The above technologies presented in Figure 2 and Figure 3 provide ongoing live traffic data and/or information to those in charge of traffic management resulting to better timing for all transit users on State Roads and thus enhanced safety, increased reliable speed urban sustainability and economic progress (State of Connecticut, 2025).

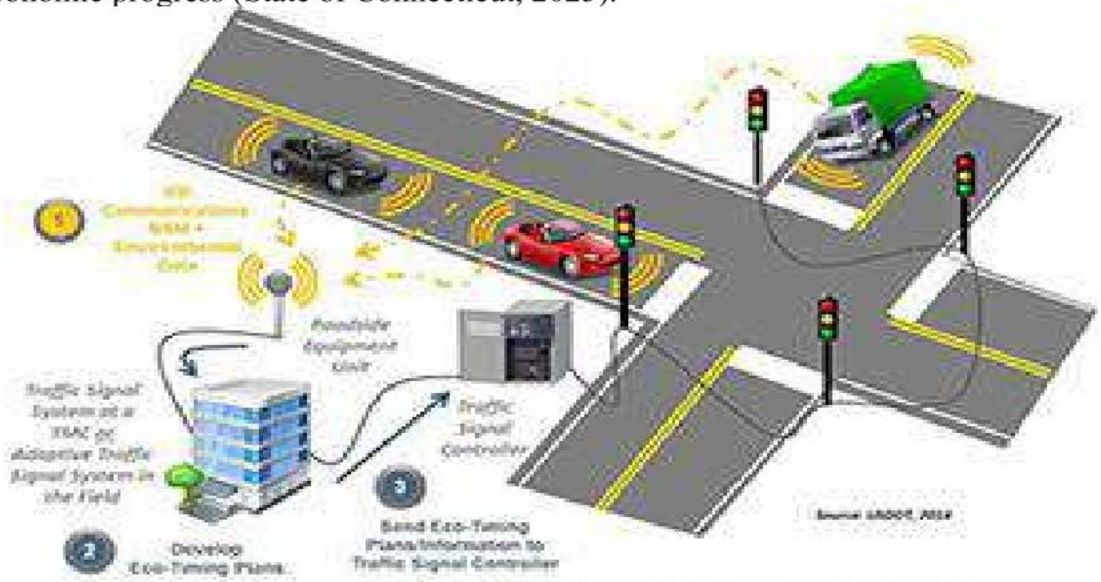


Figure 2: ITS in State of Connecticut (*Source:* State of Connecticut (2025)



Figure .3: *CTDOT* Green Light ITS (*Source:* State of Connecticut, 2022, 2025)

Connecticut Department of Transportation (CTDOT) uses Global Positioning System (GPS) to detect and monitor both ancillary structures and highway constructions within their management framework. The GPS is used to tag each of the assets (ancillary structures and highway constructions) thereby allowing those in charge of inspecting able to record vital information on the conditions, foundation, structure, signs and brightness, and traffic safety devices and features. These assets are subsequently geo-visualized and projected within the Asset Web Application for Live Infrastructure (AWARI). The AWARI is a system designed for live surveillance and asset tracking management (Bayramoglu, 2025 & Connecticut Department of Transportation, 2022). Each highway building's location is denoted by a single GPS point inside the AWARI. AWARI unifies disjointed inventory, performance metrics, proposed improvements, and maintenance log for various asset types such as bridges, traffic signals, and sign supports into a consolidated structure (Bayramoglu, 2025 & Chae et al., 2025).

In the year 2017 to 2018, Connecticut Department of Transportation introduced and implemented a highway building inspection program that allows inspectors and GPS-based data alignment for merging with AWARI/Core-CT and ATLAS 2.0, with forward looking initiatives to execute Infrastructure Management System that automates collection of data with the use of digital work orders, possibly lengthening inspection frequency to ten years to maximize resources and improve the general quality of life for inhabitants (Bayramoglu, 2025 & Connecticut Department of Transportation, 2020, 2022).

Another example of smart solution that the state of Connecticut makes use of for live surveillance and dynamic control for resilient transportation infrastructure and city livability is 'photolog'. Photolog technology is used to shoot and comprehensively record successive roadway pictures or scenes so as to enable transit infrastructure managers to supervise conditions and keeps records current or updated (Figure 4). The state of Connecticut has efficaciously employed this technology to create a statewide sign database, improve accuracy of data and streamline maintenance tracking of infrastructure. This helps to improve the city's livability (Bayramoglu, 2025; Connecticut Department of Transportation, 2022). In the year 2013, the Connecticut Department of Transportation harnessed Photolog to develop a detailed, GPS-track sign documentation, which was transferred from Excel to a comprehensive, cloud-based geospatial platform and Geographic Information System (ArcGIS) to strengthen better visual management and foster roadway infrastructural accuracy (Connecticut Department of Transportation, 2022). Through the use of DigitalHIWAY system that is closely synthesized with Photolog technology, the Connecticut Department of Transportation is able to widen its function via high-resolution visuals to build a thorough visual inventory of state's roadways (Bayramoglu, 2025).



Figure 4: CTDOT's Photolog Van (*Source:* Bayramoglu, 2025)

DigitalHIWAY system records images or visuals at regular intervals and also pairs them with GPS data, delivering accurate geospatial references for each visual thus allowing various CTDOT offices and other state agencies to check-up-to-the-minute road status. DigitalHIWAY distributes these visuals to the offices and agencies via a centralized server-based model, accelerating visual records retrieval to facilitate proactive decision-making by various departments (Connecticut Department of Transportation, 2008). Thus, DigitalHIWAY helps the state of Connecticut to strengthen thorough assessment, evaluation and management of transit infrastructure (Connecticut Department of Transportation, 2008 & Connors, 2008).

A dedicated layer of the Geographic Information Systems (GIS) established in 2019 and regularly updated is used by CTDOT to map and manage roadway illumination assets like electric poles, conduits and cabinets with the aim of ensuring immediate and strategic maintenance, evidence-based allocation of resources and improved sustainability, safety and livability across all its transit network (Connecticut Department of Transportation, 2022, 2023; Glover, 2024 & Truter, 2026). Esri's ArcGIS through Esri Road and Highway solution is also used to guide the management of Connecticut transit assets within their Transportation Asset Management Plan (TAMP) to provide live spatial visualization, analysis, and evidence-based decision-making especially for drainage and signs infrastructure (Bayramoglu, 2025; Connecticut Department of Transportation, 2022 & Rajagopalan, 2025). Esri's ArcGIS platform performs the above function by organizing data on transit infrastructure into separate, digital layers, facilitating live updates and better maintenance surveillance (Bayramoglu, 2025 & U.S. Department of Transportation, 2022).

Exor is another technology or example of smart solution used for road log and linear geocoding by the Connecticut Department of Transportation. Atlas provides location data for road transit infrastructure. Continuing Professional Development (CPD) maintains project records (Figure 5). CAS2 (Collision Analysis System) is utilized for higher statistical modeling of crashes and Esri Data Layers is used for town

boundaries, base maps, legislative districts, and etcetera. Data from these sources is refreshed nightly, ensuring current and trustworthy information for proactive decision-making (Bayramoglu, 2025 & Connecticut Department of Transportation, 2022). The 2022 CTDOT TAMP defines an integrated, risk-informed strategy for managing the state's transit infrastructure, going beyond compulsory National Health Service (NHS) assets to include items like signals and drainage, leveraging whole-life costing and designated capital allocation to ensure a budget-friendly, sustainable state of good repair (Bayramoglu, 2025; Connecticut Department of Transportation, 2022; Giulietti, 2022).



Figure 5: Highway Assets in the CTDOT TAMP (*Source:* Bayramoglu, 2025).

Objective Two: Examples of fostering multiple modes of transit for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A.

Multimodal transit systems blend various travel methods (like road, sea, rail, and air) to maximize efficiency for people and goods. This system helps to reduce transit congestion, lower greenhouse gas emissions, and improve overall transit efficiency for enhanced resilient transportation infrastructure and city livability (Tanwar & Agarwal, 2024). Fostering multiple modes of transit involves encouraging the use of multiple transportation modes under a single contract to move goods or people from origin to destination (Figure 6). This approach aims to optimize efficiency, reduce costs, and enhance resilient transportation infrastructure and city livability by maximizing the benefits of various transit methods (Jingni et al., 2021).

The State of Connecticut is actively fostering multiple modes of transit to better residents' wellness and ecological sustainability, focusing on the incorporation of

public transit, cycling and walking. By zeroing on transit-oriented development (TOD), the state is creating compact, diverse-use communities designed to better accessibility, diversify accommodation options, and foster sustainable transportation (Connecticut Department of Transportation, 2017, 2023; Nasri & Erdoğan, 2025). Connecticut transit-oriented communities such as 616 New Park in West Hartford, Saybrook Station and the Georgetown project in Redding combine housing, leisure spaces and commercial near transit hubs (CTfastrak, Amtrak/CTrail, Metro-North). These transit-oriented communities improve lifestyle quality, connectivity, and foster mixed-use accessibility to amenities among residents thus enhancing livability (Hochul & Baker, 2025; Newton, 2024; Sustainability Directory, 2025 & Walsh, 2025).

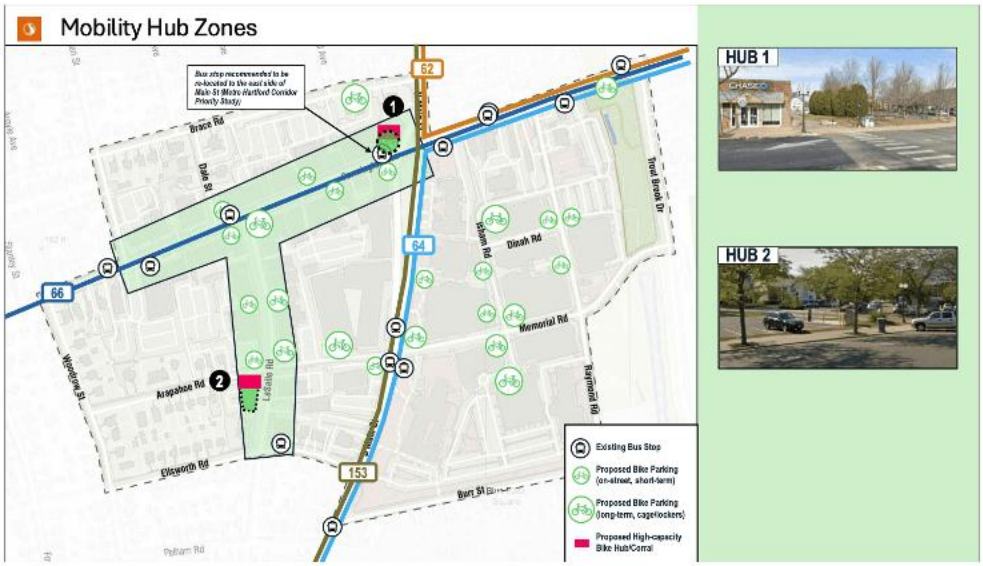


Figure 6: Mobility Hub Zones at West Hartford (Newton, 2024)

The CTfastrak bus rapid transit (BRT) system is a key example of advanced, flexible transportation, serving the Hartford region of Connecticut with a reliable 9.4-mile bus-only guideway (Figure 7). This BRT was constructed on a former rail right-of-way and connects New Britain and Hartford, offering a quick option or alternative to highway traffic (Clark & Hagen, 2016; Connecticut Department of Transportation, 2017, 2023); significant commuter rail expansion on the Metro-North line between New Haven and New York to address bottlenecks on I-95, improve capacity and reduce travel times for commuters; and rail capital improvements identified in the long-range multiple modes of transit plan (Blais, 2024; Clark & Hagen, 2016; Connecticut Department of Transportation, 2017, 2023; Metro-North Railroad, 2025).



Figure 7: Metro-North line, 1-95 (*Source:* Blais, 2024)

CTDOT is also investing in bike and pedestrian infrastructure, such as the rails-with-trail project connecting Hartford to Bloomfield. The State has and is creating protected bikeways, shared-bike systems, and safe bike parking infrastructure to make biking a more practical, safer, and attractive day-to-day transit alternative (Connecticut Department of Transportation, 2025). The State is also developing a statewide Resilience Improvement Plan, investing in Bus Rapid Transit (BRT) and commuter rail improvements, and integrating multi-modal options into regional transportation plans. The Connecticut Department of Transportation (CTDOT) is creating a Resilience Improvement Plan (RIP) to detect climatic susceptibilities and make infrastructural solutions a priority. This strategic move was approved by the Federal Highway Administration in later part of 2025 and helps the state to decrease costs for upcoming infrastructure investments (Connecticut Department of Transportation, 2024). CTDOT and the City of New Haven are creating the Bus Rapid Transit (BRT) on major avenues or corridors such as Dixwell, Grand and Whalley Avenues to improve transit service with new stations, efficient connectivity, and transit signal priority (Jacobs, 2025). The "TIME For CT" plan which means Track Improvement Mobility Enhancement) is a comprehensive infrastructure investment plan that aims to augment rail speeds and foster travel times on the New Haven Line, encompassing rehabilitated infrastructure, aligned and upgraded monitoring and signaling systems (Adam, 2025; Jacobs, 2025 & Lamont, 2021).

The Lower Connecticut River Valley Council of Governments (RiverCOG) is creating a regional, multiple modes of transportation plan centered on fostering connectivity, especially in areas with low vehicle ownership, while the state better's safety through pedestrian-friendly constructions like the Arrigoni Bridge that incorporates biking and walking infrastructure (Lower Connecticut River Valley Council of Governments, 2022). CTDOT also teams up with regional entities like SECOG to finance projects that upgrades transportation options for seniors and people with disabilities, thereby fostering an inclusive and accessible multiple modes of transit

system (SECOG, 2025). There is also the 2022-2026 Connecticut Statewide Freight Plan that ensures that the state's economic competitiveness is fostered by enhancing the swiftness and adaptability of freight movement through strategic investments, such as optimizing road capacity and upgrading rail transit networks to handle accelerating demand (Connecticut Department of Transportation, 2017).

Objective Three: Examples of eco-friendly and optimized transit practices investment for resilient transportation infrastructure and city livability in the State of Connecticut, U.S.A.

Connecticut is speeding up investments in sustainable, resilient transportation by broadening electric vehicle (EV) charging networks, fostering public transit, and initiating a statewide plan to better air quality, fight unfavourable climatic situations, and make sure there is streamlined and modern mobility (Connecticut Department of Transportation, 2024). The CTDOT's Sustainability and Resiliency Unit is committed to fostering and initiating plans to boost sustainable transit system by improving efficient use of energy, reduction in greenhouse gas emission or carbon footprint, and adjusting to the effects of global warming for better wellness among the citizens (Connecticut Department of Energy & Environmental Protection, 2016; Sobczuk & Borucka, 2024).

Connecticut is utilizing up to 52.5 million dollars in federal National Electric Vehicle Infrastructure (NEVI) funding through Fiscal Year 2026 to swiftly broaden its statewide, public direct current fast-charging network for EVs while at the same time transitioning its other public buses and fleet to zero-emission vehicles (Alexander, 2022; Connecticut Department of Transportation, 2022). Connecticut is also investing in key transit upgrades by executing the TIME For CT rail initiative to boost speeds, switching to a battery-electric bus fleet, and advancing New Haven bus rapid transit (BRT) routes with better infrastructure, fostering comprehensive connectivity and efficiency (Bureau of Engineering and Construction, Chief Engineer's Office, 2023; Connecticut Department of Transportation, 2022; State of Connecticut: Governor Ned Lamont, 2021). Also, the Connecticut Department of Transportation (CTDOT) is developing a Resilience Improvement Plan (RIP) to address climate-related vulnerabilities in the transportation network. This Resilience Improvement Plan will help to detect susceptibilities in the transportation assets owned by the state and develop a properly structured budget-project plan to ensure continuity of transit operations and swift recovery during intense weather and climatic conditions (Bureau of Engineering and Construction, Chief Engineer's Office, 2023; Connecticut Department of Transportation, 2022, 2024; CIRCA Resilience Roundup, 2024).

Connecticut is committed to ensuring equitable access to transportation options, particularly for low-income communities and those disproportionately affected by transportation pollution (Department of Energy and Environmental Protection State of Connecticut, 2024; State of Connecticut: Governor Ned Lamont, 2020). The Transportation and Climate Initiative Program (TCI-P) includes a commitment to invest at least 50% of program proceeds to assist overburdened and underserved communities (Department of Energy and Environmental Protection, 2021). The State is also working

to ensure that electric vehicle infrastructure and incentives are accessible to all residents, including those in rural areas (Department of Energy and Environmental Protection, 2022; Larson, 2024). The University of Connecticut has also invested in resilient infrastructure on their Storrs Main Campus. From their paved parking lot which absorbs water (thereby preventing flooding, cracking and potholes), to their interlocking blocks used on sidewalks and catch basins to channel stormwater, the University is at the forefront of various Low Impact Development (LID) that will cause minimal disruptions to the environment and are easy to maintain (Figure 8). The institution even has a green roof - a building where plants are grown on the roof like a garden to maintain a balanced ecosystem (Miller, 2013).



Figure 8: Plaque at the top of the Green Roof Building, Storrs Hall, University of Connecticut at Storrs. (*Source:* Author's Fieldwork, 2024)

5.0 Conclusion and Recommendations

This chapter has shown that the State of Connecticut has and is implementing several smart solutions for resilient transportation infrastructure in a bid to mitigating the adverse effects of global warming, natural catastrophe and other unexpected shocks. The State through the use of several smart technologies like cameras, sensors, GPS, connected vehicles and Intelligent Transportation Systems (ITS) are able to gather data on traffic flow, incidents, and infrastructure conditions so as to properly optimize traffic management, predict potential issues, and enhance incident response. Further, through the advancement of initiatives such as transportation-oriented communities, mobility centers, and investments in rail and bus rapid transit, the State of Connecticut has been able to lower congestion and emissions with improvement in transit efficiency.

In addition, the Connecticut Department of Transportation (CTDOT) is developing a Resilience Improvement Plan (RIP) to identify vulnerabilities and prioritize solutions across all transportation modes. Lastly, the State of Connecticut, U.S.A. is actively investing in sustainable and efficient transportation infrastructure such as expanding electric vehicle charging infrastructure, improving public transit, and developing a statewide resilience plan to foster resilient transportation infrastructure. By incorporating resilience into long-range planning, the State of Connecticut is

positioning itself to secure federal funding and enhance its ability to adjust to natural catastrophe, changing climate, and other unexpected shocks. On the basis of the above conclusion, the following recommendations were therefore proffered:

i. Awareness: For any project implemented by the government to succeed, there is need for partnership and cooperation between the government and the citizens. Hence, the government through various Departments and Units should ensure that the citizens are aware of all the smart projects and their aims/objectives so the people can contribute their quota in making sure they are successful. Through bulletins, newspapers, magazines, reports, social media and other platforms, the ongoing projects such as Resilience Improvement Plan (RIP), Transportation and Climate Initiative Program (TCI-P), TIME For CT, National Electric Vehicle Infrastructure (NEVI) program, and etcetera should be made known to the public.

ii. Funding: For resilient infrastructural development, there is need for huge financial investments. The State of Connecticut should also ensure that funding is not only promised but provided, accessed and properly utilized for the right purposes. Each project such as Resilience Improvement Plan (RIP), Transportation and Climate Initiative Program (TCI-P), TIME For CT, National Electric Vehicle Infrastructure (NEVI) program should be allotted the right amount of money required for their implementation and each of the Department responsible for these projects should ensure transparency and accountability. The bottlenecks should be fished out and removed. The State of Connecticut should also explore smart technologies that other States such as Texas, California and etcetera are using to effectively implement resilient transportation infrastructure and ensure they add them to their existing smart technologies.

iii. Incentives: To effectively ensure sustainability in transportation, there is need to improve energy efficiency, reduce the carbon footprint or GHG emissions, and adjust to the effects of global warming and various climatic conditions. Several ways of ensuring these are done is making sure vehicles used for transportation are emission free such as electric vehicles. Hence, the government should ensure that electric vehicles are encouraged by providing incentives to motivate the citizens to adopt it (Olaleye et al., 2025).

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