

# Smart and connected cities in Pennsylvania: a multi-case study

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## Abstract

The objective of this study is to describe two Pennsylvania cities' unique approaches to smart and connected technology design and implementation around mobility, public safety, and sustainability. Harrisburg and Pittsburgh are emerging leaders implementing their unique smart and connected approach.

These two cities are undergoing a physical, technological, and demographic transformation, which impacts social and economic issues. As a result, many distinct aspects and elements of these cities play an increasingly important role in defining the quality of life of the diverse citizenry.

Cities depend on newer and emerging technologies, such as smart streetlights, autonomous vehicles, electric vehicles, shared mobility, and the Internet of Things (IoT) connected devices to improve health, safety, general welfare, and quality of life for citizens. Moreover, in smart cities, citizens' activities are not limited to their homes. Thus, smart spaces need to connect the smart city to the smart home seamlessly into a smart home concept [1].

The smart and connected cities concept is defined and visualized differently by each city depending on the context, needs and funding. As a result, each city initiates intelligent technology strategies, tools, and partnerships in its approach to developing and implementing the parameters that frame a just, equitable, and inclusive smart city.

This multi-case study describes each city's smart city and connected goals, successes and challenges to answer the research question: How has Pittsburgh and Harrisburg defined and implemented the concept of Smart City to better manage its emergent needs as a result of changing demographics?

**Keywords:** Harrisburg and Pittsburgh Smart Cities

## 1. Introduction

The population of the United States is becoming more diverse while at the same time, it is getting older [2]. Thus, the country is facing the need to address rapid urban demographic changes as well as socio-economic inequality and the high cost of health care. The concept of smart and connected cities in the United States has gained interest as a way to govern more efficiently and effectively, given the growing complexities and needs of an increasingly diverse and unequal urban population.

Smart and connected technology offers one potential way for cities to manage the growing complexities of such a diverse and economically and socially unequal urban population, and improve the mobility, public safety and sustainability of its citizens, especially older citizens, through the integration of smart and connected technology into all aspects of a city's processes and structural environment. Thus, smart and connected cities now offer an increasingly important opportunity to improve the quality of the life of its citizens and is

becoming critical to the success of its social and economic development. While there is no uniform definition of a smart city [3], it is defined by Caragliu, DelBo and Nijkamp as:

“one in which investments in human and social capital and traditional (transport) and modern (based on ICT technologies) infrastructure translate into sustainable economic growth and high quality of life”[4].

Smart and connected cities, regardless of definition, combine the use of IT systems, which allow a city to actively manage different areas of urban activity, with the potential of active engagement of citizens [5]. Caragliu and Del Bo stressed the importance of “space-specific characteristics in shaping the economic effect of smart urban qualities, providing grounding to place-based public policies that account for local characteristics” [6]

This study describes two cases of smart and connected cities, Harrisburg, Pennsylvania and Pittsburgh Pennsylvania in the United States and their smart and connected long-term goals. The study explicates how the use of emerging smart technology is used to better manage each city’s future. The emergence of smart and connected technology in Pennsylvania cities enables this study to use these two cases to assess the current state of smart and connected technology. Additionally, the study seeks to answer a series of questions about the use of smart and connected technology including: (1) what are the values and long-term goals of each smart city in adopting smart and connected technology, (2) what is the extent of the use of smart and connected technology in each city, and (3) what are the challenges to implementing smart technology and connectedness in cities. Further, it asks: How has Pittsburgh and Harrisburg defined and implemented the concept of Smart City to better manage its emergent needs. The study describes each city’s smart and connected long-term goals and successes to illustrate the use of emerging smart technology to better manage their future given their demographic complexities.

The contribution to the literature of this research is twofold. First, the study addresses a void in the academic literature regarding the role of smart and connected technology in meeting the needs of citizens in Pennsylvania cities in terms of mobility, public safety and sustainability. Second, it adds to and updates the research that examined smart and connected cities in the United States by focusing on two older cities, Harrisburg and Pittsburgh. The study provides important information on the use of smart and connected technology in these two older cities.

In reporting this inquiry, this article is organized into five sections: the first section is an introduction of the study, the second section is a review of the relevant literature, the third section is the study design and analysis, the fourth section presents the cases, including: discussion of the Core Values and Ideals pertaining to the smart and connected technology of each city; an overview of smart technology used in each city, and the fifth section is the Discussion and Conclusion.

## 2. The Literature

Cities have “unique cultural and architectural qualities” and “strong forces [as the basis for providing for] social inclusion and economic development” [7], as well as centers of knowledge and sources of growth and innovation” [8]. At the same time, cities face demographic problems such as “social inequality, social exclusion of specific population groups such as the elderly and “a lack of affordable housing and environmental problems”

Citizens need to move freely within the city, and that need is dependent on accessible and available public transportation. This need is especially true for older citizens. Senior mobility increases their access to social and health services as well as their level of civic engagement

There is a strong relationship between smart city governance and the quality of life, and that the identification of strategic drivers aids policymakers in involving all citizens in the sustainable development of the city [9]. Yiticanlar, DeSousa, Butler and Roozkhosh found that the most popular smart city concepts in Australian smart cities are governance, sustainability, and innovation and that the most widely used technologies are in AI and autonomous vehicles [10].

It is critical for a city’s leadership to recognize the social-spatial needs of its citizens in developing its smart city strategy [11]. Yiticanlar et al found that it is critical to integrate policy, technology, and community development to achieve sustainable development for smart cities and that this is the most important in order to be successful. Pierce and Anderson investigated the significant challenges from municipal leaders in implementing smart city initiatives in medium-sized European countries [12]. They conducted interviews in 25 different European cities and found that the significant challenges are lack of awareness of different technologies, economics, need for partnerships, governance issues, and lack of funding for smart city initiatives. Praharaj, Han and Hawken investigated smart cities in India and found that Indian cities need cohesive city financing strategies and policies to achieve smart city initiatives better [13].

The goal of becoming a smart city is to enhance the quality of life for residents by reducing the gap between the demand for needed services and the ability to supply those services [14]. In order to achieve the goal of achieving quality of life demands, many smart cities are focusing on sustainability, mobility, and public safety in areas of health care, transportation, and energy management [15].

In order to be successful, smart and connected cities need good leadership, long-term goals and objectives and to actively engage all citizens in identifying the critical needs [16] that can be addressed in part by the use of technology. The concept of smart and connected cities is based on a high level of social capital, involvement of citizens, and a willingness to engage in cooperation [17]. As such, smart and connected cities need to consider engaging all groups of citizens. The identified critical needs by engaged citizens contribute to the development of sustainable smart and connected cities [18].

### **3. Study Design and Analysis**

The purpose of the study design and analysis is to present two Cases to describe the use of smart technology in the cities of Harrisburg and Pittsburgh Pennsylvania. The design involved the selection of a purposive sample from a list of cities in Pennsylvania who use smart and connected technology. Each government has smart city documents on its website which describe their smart and connected policies and the actions to date to implement the policies. The study primarily relied on documents such as the city's Comprehensive Plan and smart and connected city materials on its websites.

The research question which the study seeks to answer is: How has Pittsburgh and Harrisburg defined and implemented the concept of Smart and Connected City to better manage its emergent needs as a result of changing demographics?

### **4. Smart and Connected Cases**

The Commonwealth of Pennsylvania is the sixth largest state in the United States. The cities of Harrisburg and Pittsburgh are two of the ten largest cities in Pennsylvania to have adopted Smart and Connected technology.

#### **4.1. The City of Harrisburg Case**

The City of Harrisburg has an estimated population of 49,818 [19]. The city's college age (18-24) population is 26.7 percent and retirement (65+) is 10.4 percent. Over half of the population is Black or African American (51.5%). Slightly over one-third (34.9 percent) of the population is White. The City's Asian population increased by 90%, and is currently 5.5% of the population.

Harrisburg initiated its use of Smart and Connected Technology through its Comprehensive Plan. In developing the Comprehensive Plan, the city solicited citizen participation and input into the plan and its development. The next section describes the city's core values and goals.

##### **4.1.1 Core values and goals behind the use of smart and connected technology**

One of Harrisburg's Core Values behind the use of Smart and Connected Technology, as defined in its Comprehensive Plan, is: Harrisburg is a Well-Connected City: to provide a system of well-integrated, frequent, convenient, and accessible transportation options that connect the city's neighborhoods, the region and beyond

Within the core values and long-term goals, Harrisburg has identified: Mobility, Public Safety and Sustainability, as follows:

##### **4.1.2. Mobility**

Mobility is defined by the City of Harrisburg as "the ability to quickly and comfortably travel within the community and region to reach destinations using one or more modes of transportation."

In Harrisburg, mobility refers to “the ease, safety and efficiency by which people travel within the city and surrounding region. A well connected transportation network with a variety of travel options (such as walking, bicycling, transit and on-demand services and the automobile) defines a city with high mobility”

In terms of trends in mobility and access, Harrisburg has identified the following in their Comprehensive Plan:

- “smart vehicles that adjust their speed to mix with pedestrians and cyclists safely when entering urban areas.”
- “Self-directed vehicles that do not require human drivers.”
- Improved Access to a wider variety of transportation options for seniors, persons
- With permanent disabilities, and persons with temporary disabilities.
- Streets are multi-modal and street design should incorporate a range of mobility
- Choices, prioritizing active and sustainable modes of transport. Safe, efficient and
- Comfortable experiences for pedestrians, cyclists, and transit riders support
- Access to critical services and destinations and increase street capacity.”

To that end, the city has developed the following relevant goal, objective and actions :

**Goal MA-6** Promote the use of technology to inform and educate city residents and workers about mobility choices.

**Objective MA-6.1** Identify opportunities to develop mobile device applications that support transit use, walking and biking.

**Actions:**

**MA-1** Establish a mode share goal that supports a shift toward sustainable transportation; collect and monitor data on mode share regularly.

**MA-2.** Develop a local street hierarchy that identifies existing street types within Harrisburg and provide correlating design guidelines that detail appropriate facilities, including elements such as minimum sidewalk widths, type of bicycle facilities and bus stop features.

The core principles that shapes Harrisburg mobility and access includes providing streets that are multimodal and incorporate a range of mobility choices and prioritize active and sustainable modes of transport as well as safe, efficient, and comfortable experiences for pedestrians, cyclists, and transit riders support access to critical services and destinations and increase street capacity. The next focus area is Public Safety, as follows:

### **4.1.3. Public Safety**

“Smart home” and “Internet of Things” technologies promote independence for community dwelling older adults and their families. Such emerging technologies introduce challenges and opportunities in terms of engaging older adults in decision making, making sense of vast amounts of data and promoting effective data visualizations as well as addressing ethical considerations [20].

The city’s focus is on the ability of its citizens to reach major destinations, goods, services and activities by encouraging a mix of land uses within walking distance, and affordable access to jobs and services. Increasing mobility by expanding public transportation, improving walking and biking conditions, embracing new technologies and transportations increases mobility and access. Some examples of smart and connected technologies in Harrisburg are: Placing lighting to allow people to be recognized from 25 feet away, avoid glare, and use a white color that provides better sight ability. The next focus area is complete streets:

### **4.1.4. Complete Streets**

The goal of Complete Streets are to provide streets which meet citizen needs and their design and construction enable safe access for all users. Complete streets are unique and may include sidewalks, bus lanes, bike lanes, comfortable and accessible public transportation stops, frequent and safe crossing opportunities, median islands, accessible pedestrian signals, curb extensions and narrower travel lanes

### **4.1.5. Sustainability**

Sustainability is considered a predominant paradigm and has played a major role in development of smart cities [21]. According to Mohanty, Choppali, and Koungianos [22] social issues, economics and health are sub attributes of sustainability. The sub-attributes of sustainability are interrelated and interdependent .

In Harrisburg, in terms of sustainability, the majority of residential building construction took place prior to 1969. Harrisburg has areas where deferred maintenance and blight have become issues. The city has a large number of vacant housing units. Rental housing is the majority of housing in the city.

Harrisburg has one of the lowest frequencies of home sales in the United States, though recently property in Harrisburg is selling for more and staying on the market less than in the past. The city is developing a strategy of attracting young adults and providing a variety of rental options to this population. This strategy is dependent on:

- A wide variety of quality affordable and smart rental housing
  - Strong sustainable community core
  - A wide range of high-quality smart housing options

The city's sustainable long-term goals are to adopt an inclusive and equitable development strategy to introduce mixed-value housing opportunities in neighborhoods experiencing disinvestment.

In order to become a sustainable smart and connected city, Harrisburg will need to ensure the permanence and sustainability of new housing design and construction include features of smart homes. High quality smart housing should be ADA accessible and provide for smart home construction options.

**Goal H-5:** Incentivize development throughout the city

**Objective: H-5.2.** Attract housing development in many forms.

**Goal H-6:** Develop area plans and targeted redevelopment area plans prior to undertaking significant development efforts.

**Objective:** Adopt citywide design standards for new construction and substantial renovations.

**Actions:**

**H37:** Prepare design guidelines to address quality and sustainability aesthetics and accessibility for building types and open spaces. The next section describes the use of smart and connected technology in Harrisburg.

#### **4.1.6. Use of smart and connected technology in Harrisburg**

Harrisburg implemented smart street lighting in 2016 and smart and connected city technologies such as smart sensors for traffic, air quality, and waste monitoring. In 2016 the city deployed 4,000 connected streetlights, reducing utility bills by 60-70 percent ([www.telensa.com](http://www.telensa.com)). The street lighting system is an end-to-end intelligent street lighting system consisting of wireless nodes connecting individual lights, a dedicated network owned by the city, and a central management application. The system is self-funding through reduced energy and maintenance costs, improved quality of service by automatic fault reporting, and street lighting poles ([www.telensa.com](http://www.telensa.com)).

Other examples of implementation of smart and connected technology in Harrisburg is the monitoring of trash cans to make garbage pick-up routes more efficient. The city also has more detailed electronic monitoring of road temperature to make predictive models more accurate and save money on salt spreading.

The city is now able to connect its sensors and build and monetize its big data platform. The second case is the City of Pittsburgh, Pennsylvania, as follows:

## **4.2. The City of Pittsburgh Case**

The City of Pittsburgh was founded in 1758 and was known for its steel manufacturing. As a result, it earned the nickname of the “Smoky City.” However, the city has moved from its role in steel manufacturing to become a leader in healthcare, education, technology, and financial services. The City of Pittsburgh has an estimated population of 300,286. The population average age is 33. While the City’s Black population is declining, the City’s multiracial population has increased by 10,000. Pittsburgh serves as the County Seat of Allegheny County which has an estimated population of 1.2 million. Pittsburgh serves as the principal city of the Pittsburgh Metropolitan Area, or Greater Pittsburgh. This eight county area has an estimated population of 2.6 million ([www.pittsburgh.gov](http://www.pittsburgh.gov)).

### **4.2.1. Core Values and Goals Behind Use of Smart and Connected Technology**

The City of Pittsburgh is changing from an industrial city to a diverse economy based upon education, healthcare, knowledge and financial services. To that end, the City has defined its smart and connected program, through PLANPGH which expresses its core values and goals, focusing on urban transportation as the basis for economic sustainability. About one fifth of Pittsburgh residents do not own a car. Options such as biking, walking, high quality transportation infrastructure, parking and efficient public transit empowers citizens and visitors to contribute to the economy.

Within its PLAN/MOVEPGH program, Pittsburgh has adapted what it terms “Smart PGH”, which provides the platform for the health, safety and welfare of citizens. This platform is based on the interconnection of information, communications transportation systems and energy and utility information networks and integrates pre-existing and new networks and creates systems-of-systems. The city has developed a uniform system for collection of data and established a consortium which brings together major transportation, energy and communications organizations to work on the next generation of infrastructure).

Pittsburgh is currently working with Spin, a subsidiary of Ford Motor Company, in developing a transit APP under the MOVEPGH platform. Users can plan routes that include multiple modes such as Healthy Ride (bike sharing), Scoobi (e-mopeds) and Spin itself. The City has created 50 “mobility hubs”, which are in-person locations for all modes. In addition, Pittsburgh is also piloting “universal basic mobility,” where 50 low income residents are being given complete access to public transit, bike-sharing and e-scooters.

### **4.2.2. Use of Smart and Connected Technology in Pittsburgh**

The City of Pittsburgh has implemented the following smart technology initiatives:

#### **Smart Loading Zones**

Commercial delivery in Pittsburgh is increasing, leading to increased congestion, emissions and safety hazards. Pre-pandemic estimates showed 35% increase in e-commerce, resulting in increase in use of commercial vehicles. In 2020, e-commerce grew by 44% [23].



Pittsburgh is employing Smart Loading Zones to manage traffic congestion and increase revenue for the benefit of its citizens.

The goals of the Smart Loading Zones are:

- Align parking and loading policies with real-time data
- Decrease emissions from idling and circling
- Reduce parking-caused traffic by 20% and double parking by 60%
- Generate additional revenue from parking and loading
- Increase parking turnover for restaurants and small businesses
- Improve safety for pedestrians, cyclists and other curb users
- Increase delivery efficiency and reduce dwell time
- Autonomous technology is used to analyze real-time curbside activity,
- Automate payment by the minute for the time a vehicle
- Each vehicle is invoiced automatically based on its license plate information.

Smart Loading Zones provides the opportunity for the city to better manage congestion, emissions and safety in ways that benefit citizens, businesses, and fleets. Pittsburgh received a \$100,000 grant by *Autonomous* to create these more efficient and safe curbside loading zones.

### **ATCMTD-Smart Spines**

The City of Pittsburgh has set up an advanced signal system along eight priority corridors or “Smart Spines”. The eight corridors deliver connectivity between the city’s eastern and southern neighborhoods and the downtown central business district. The Smart Spines takes advantage of existing and emerging technologies to create a multi-modal advanced signal system to detect different roadway users and prioritize their movements based on corridor context and real-time traffic patterns. The project Phase 1 began in Spring 2021. The project is divided into two separate phases. Fifth Avenue and Forbes Avenue is to be completed in Phase 1 to allow for new traffic signals along these corridors and to be updated in advance of completion of the Port Authority Bus Rapid Transit Project.

The Smart Spines Project includes a Traffic Management Center to house technology responsible for managing traffic signals across the City of Pittsburgh. The City uses CCTV and video detection feeds to see real time traffic conditions which are displayed on a high resolution video board. The system can remotely adjust traffic signal timing plans in response to incidents or events and adjust corridor modal priority based on real time data and observations.

## 5. Discussion and Conclusion

The use of smart and connected technology in the City of Harrisburg and the City of Pittsburgh reflects the distinct approach by municipal leaders to define the goal and objectives of smart cities based on citizen input in the design and implement smart and connected policies and technologies. These policies take into account both citizen needs and government administrative needs. This approach is especially important given the changing demographics of each city.

Both cities have defined their concept of a smart and connected city through a system of well-integrated, frequent, convenient, and accessible transportation options that connect the city's neighborhoods, the region and beyond and implemented its program through mobility, public safety and sustainability.

The data from each city provided a number of useful insights and policy implications for leadership of older cities with difficulties in setting developing long-term smart technology in the context of rapidly changing demographics. Each city has defined the concept of Smart and Connected City differently. Harrisburg has defined their concept of Smart and Connected City as a system of well-integrated, frequent, convenient, and accessible transportation options that connect the city's neighborhoods, the region and beyond. Pittsburgh has defined its concept of Smart and Connected City through an interconnected urban transportation system as the basis for economic sustainability. Options such as biking, walking, high quality transportation infrastructure, parking and efficient public transit empowers citizens and visitors to contribute to the economy urban transportation as the basis for economic sustainability.

The long-term goals of Harrisburg are to provide a system of well-integrated, frequent, convenient, and accessible transportation options that connect the city's neighborhoods, the region and beyond.

The long-term goals of Pittsburgh are to provide a platform for the interrelation of information, communications transportation systems and energy and utility information networks and integrates pre-existing and new networks and creates systems-of-systems.

The extent of the use of Smart and Connected Technology in Harrisburg is Smart Street Lighting, while the City of Pittsburgh has adopted Smart Loading Zones, Smart Spines and MovePGH, available through the Transit APP.

Challenges to the effective implementation of smart and connected technology are centered primarily on the need of cities such as Harrisburg and Pittsburgh to regularly engage a diversity of participants and include those most impacted by the issues, such as the elderly, that are being addressed through the use of smart and connected technology.

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