



Smart Mobility Hubs (SMH) System Requirements

for the Smart Columbus
Demonstration Program

FINAL REPORT | November 15, 2018



Produced by City of Columbus

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Chapter 1. Introduction

This Systems Requirements Specification (SyRS) is intended to communicate the Requirements of the Smart Columbus Smart Mobility Hubs (SMH) project to the technical community who will specify and build the system. The SyRS is a “black-box” description of what the SMH must do, but not how it will do it. The document contains descriptions of inputs, outputs, and required relationships between inputs and outputs.

1.1. DOCUMENT PURPOSE

This System Requirement Specification (SyRS) serves as the second in a series of engineering documents intended to describe the SMH, building upon the Concept of Operations (ConOps) document. The SyRS describes a set of Requirements that, when realized, will satisfy the expressed needs on the SMH. This document includes the identification, organization, presentation, and modification of the Requirements for the SMH. These Requirements are derived from the User Needs, constraints and interfaces that the SMH facilities are expected to implement. This SyRS addresses conditions for incorporating operational concepts, design constraints, and design configuration Requirements as well as the necessary characteristics and qualities of individual Requirements and the set of all Requirements.

This document was developed based on 1233-1998 Institute of Electrical and Electronics Engineers (IEEE) Guidance for Developing System Requirements Specifications and contains the following sections:

- **Chapter 1. Introduction** provides an overview of the SMH project and key elements that guide the development of this SyRS document, including an overview of the project, the Stakeholders, Requirements development process, and referenced materials.
- **Chapter 2. System Description** focuses on describing and extending the system concepts established in the Concept of Operations, including any system capabilities, conditions, constraints, and decomposing the system into its Functional Groups (FGs) for establishing Requirements.
- **Chapter 3. System Requirements** contains the Requirements for each FG that make up the system.
- **Chapter 4. Engineering Principles** provides a description of engineering principles applied to the system and Requirements definition process.

1.2. PROJECT SCOPE

In 2016, the U.S. Department of Transportation (USDOT) awarded \$40 million to the City of Columbus, Ohio, as the winner of the Smart City Challenge. With this funding, Columbus intends to address the most pressing community-centric transportation problems by integrating an ecosystem of advanced and innovative technologies, apps and services to bridge the sociotechnical gap and meet the needs of residents of all ages and abilities. In conjunction with the Smart City Challenge, Columbus was also awarded a \$10 million grant from Paul G. Allen Philanthropies to accelerate the transition to an electrified, low-emissions transportation system.

With the award, the city established a strategic Smart Columbus program with the following vision and mission:

- **Smart Columbus Vision:** Empower residents to live their best lives through responsive, innovative, and safe mobility solutions
- **Smart Columbus Mission:** Demonstrate how Intelligent Transportation Systems (ITS) and equitable access to transportation can have positive impacts of every day challenges faced by cities.

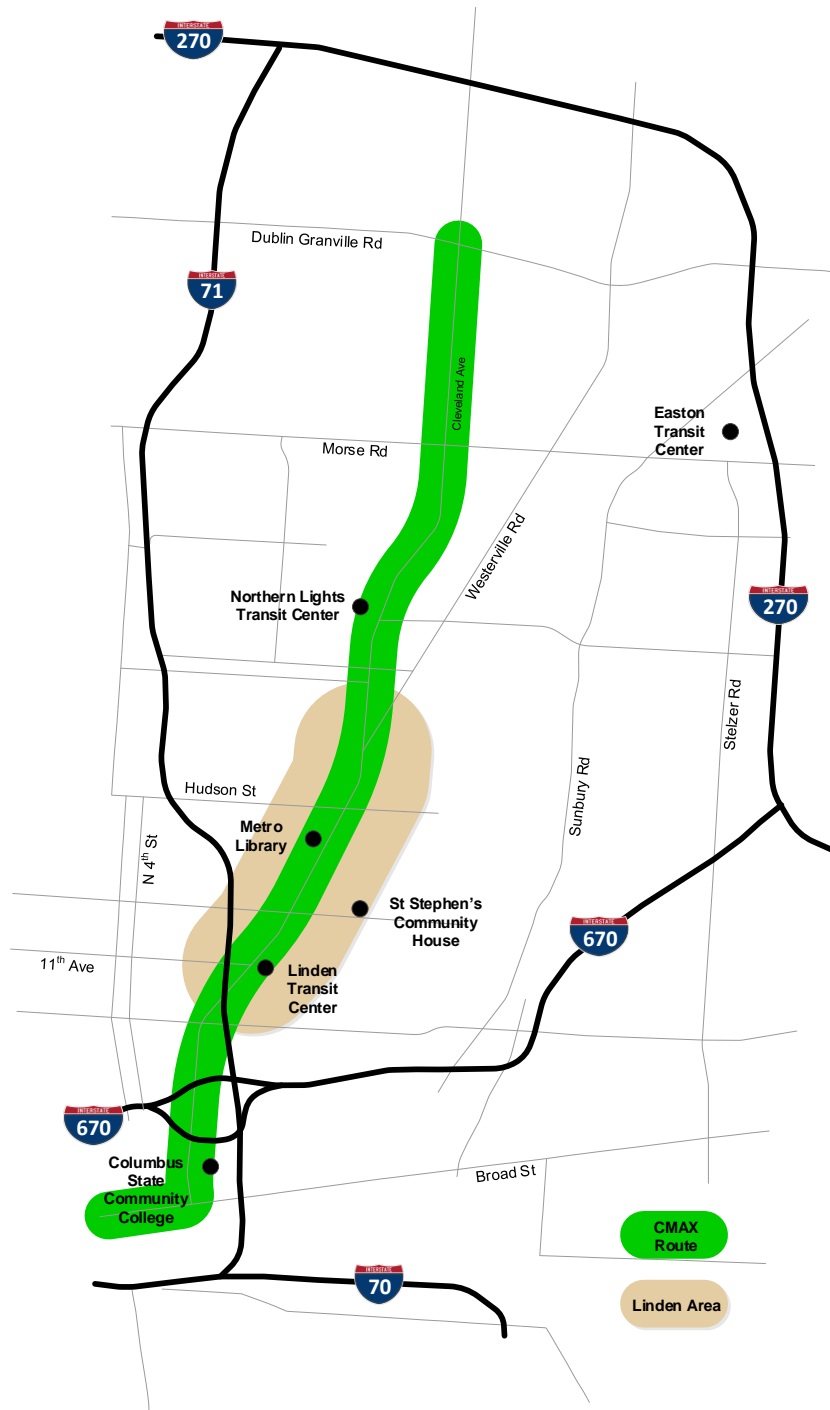
To enable these new capabilities, the Smart Columbus program is organized into three focus areas addressing unique User Needs: enabling technologies, emerging technologies, and enhanced human services. Deployment of the SMH primarily addresses needs within the enhanced human services program focus area.

The SMH project is one of the nine projects in the Smart Columbus program and is considered the future of consolidated transportation centers. The purpose of the SMH project is to deploy transportation facilities that provide Travelers with consolidated transportation amenities such as Interactive Kiosks (IKs), provide access to Comprehensive Trip Planning (CTP) tools [via Multimodal Trip Planning Application (MMTPA)/Common Payment System (CPS)] and real-time transportation information, and are designed to accommodate multiple modes of transportation from a single location including bike- and car-sharing and Mobility Providers. These services are particularly useful in the completion of first-mile/last-mile (FMLM) and multimodal trip options. Benefits of a SMH system include enhanced integration and connectivity of the transportation system across and between modes, improved efficiency of the surface transportation system, and increased accessibility and mobility of Travelers.

The geographic scope of the proposed SMH project deployment includes the Cleveland Avenue corridor coinciding with COTA's bus rapid transit (BRT) service (CMAX) and the Easton commercial district, providing those in the Linden area better access to jobs and services in the Easton and Downtown Columbus Commercial districts.

Six initial SMH deployment locations, shown in **Figure 1: Cleveland Avenue Corridor** were selected based on User feedback and surveys:

- St. Stephen's Community House
- Linden Transit Center
- Columbus State Community College
- Northern Lights Park and Ride
- Easton Transit Center
- Metro Library – Linden Branch

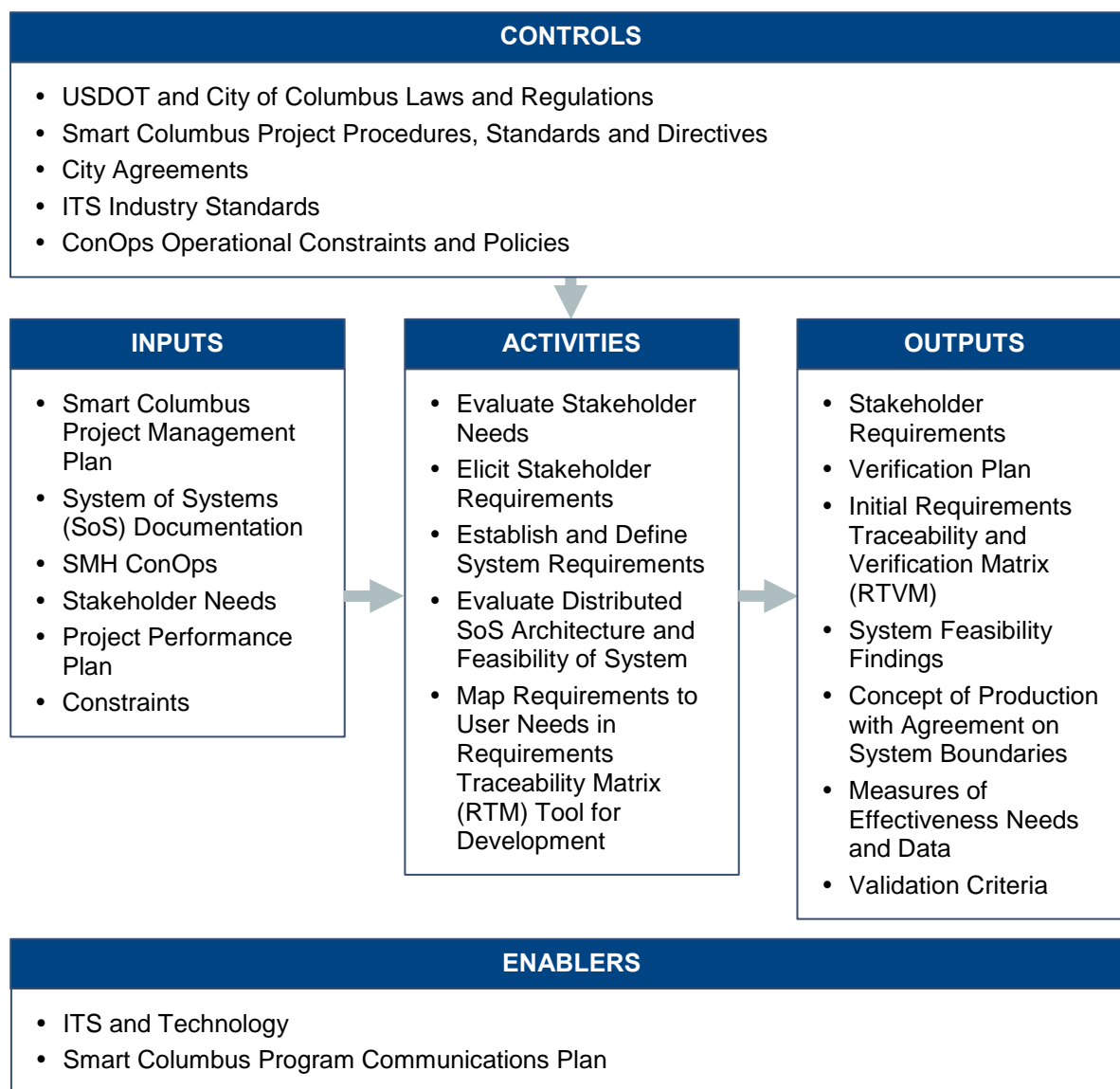


Source: City of Columbus

Figure 1: Cleveland Avenue Corridor

1.3. REQUIREMENTS PROCESS

The Requirements established for this project will govern the SMH system's development cycle and are an essential factor in further defining and clarifying the scope and feasibility of development for the system. This process will also provide the basis for the technical description of deliverables in the form of a system-level specification and defined interfaces at the system boundaries. **Figure 2: Smart Mobility Hubs Stakeholder Requirements Definition Process** provides a high-level view of the project's Stakeholder Requirements definition process.



Source: City of Columbus

Figure 2: Smart Mobility Hubs Stakeholder Requirements Definition Process

After the project's Requirements are established, they will be formally placed under configuration control using Helix ALM software developed by Perforce. This software will enable the program to centrally capture, relate, reuse and decompose Requirements across projects and map them to User Needs. The tools enable the City and project leads to perform reviews, view the approval status of Requirements and track and manage changes throughout the app life cycle.

1.4. REFERENCES

Table 1: References contains documents, literature and working group sessions used to gather input for this document.

Table 1: References

Document Number	Title	Revision	Publication Date
FHWA-JPO-17-518	Smart Columbus Systems Engineering Management Plan (SEMP) for Smart Columbus Demonstration Program https://rosap.ntl.bts.gov/view/dot/34764	–	January 16, 2018
–	Beyond Traffic: The Smart City Challenge – Phase 2 – Volume 1: Technical Application https://www.columbus.gov/WorkArea/DownloadAsset.aspx?id=2147487896	–	May 24, 2016
1233-1998	IEEE Guidance for Developing System Requirements Specifications	–	1998
INCOSE-TP-2003-002-03.2.2	INCOSE Systems Engineering Handbook	3.2.2	2011
–	Systems Engineering Guidebook for Intelligent Transportation Systems	3.0	2009
FHWA-JPO-17-523	Concept of Operations for the Multimodal Trip Planning Application/Common Payment System for the Smart Columbus Demonstration Program https://smart.columbus.gov/uploadedFiles/Projects/MMTP-CPS%20ConOps%208.30.18.pdf	2.0	August 10, 2018
N/A	Smart Columbus Operating System https://www.smartcolumbusos.com	N/A	N/A
FHWA-JPO-17-528	Concept of Operations for Smart Mobility Hubs for Smart Columbus Demonstration Program https://smart.columbus.gov/uploadedFiles/Projects/Smart%20Columbus%20Smart%20Mobility%20Hubs%20ConOps%202018-07-30_v2.pdf	1.0	7/30/2018
N/A	Draft Data Management Plan (DMP) for the Smart Columbus Demonstration Program	N/A	9/28/2018

Document Number	Title	Revision	Publication Date
N/A	<i>Draft Data Privacy Plan (DPP) for the Smart Columbus Demonstration Program</i>	N/A	9/24/2018

Source: City of Columbus

Chapter 2. System Description

2.1. SYSTEM CONTEXT

The Smart Columbus program will deploy SMH facilities at six different geographic locations. The SMH facility is the physical site that consolidates some or all the amenities of the SMH System, which includes IKs, real-time information displays, pickup/drop-off areas, dockless devices zones, bike-share docks, bike racks, and parking spaces for Mobility Providers, park and rides, and car-shares. Individual SMH facilities will vary in size, configuration and available services since the goal of the sites is to incorporate the amenities within the existing physical constraints. The following are descriptions of components that may be available at a SMH facility:

2.1.1. Interactive Kiosk

Traveler IKs will be installed on free standing pylons at SMH facilities. The IKs will display real-time travel related information and provide an embedded touch-screen display to serve as a direct interface between Travelers and the MMTPA/CPS, providing the Traveler the ability to plan, schedule and pay for trips using multimodal options available at the SMH facility, along with additional information and instruction such as directing the Traveler to a Transportation Network Company (TNC) pickup location.

2.1.2. Wi-Fi

SMH facilities will be equipped with public Wi-Fi that will allow a Traveler to access the MMTPA/CPS and other transportation information on his or her personal wireless device.

2.1.3. Park and Ride

Designated parking spaces will be available at select SMH locations and allow a Traveler the option to complete a segment of his or her trip using a personal vehicle and parking at SMH facility, where he or she can utilize the SMH amenities to continue his or her trip using alternate modes of transportation.

2.1.4. USB Charging

The SMH locations will have powered Universal Serial Bus (USB) ports for Travelers to recharge personal electronic devices like cellular phones, tablets and other wireless devices while planning a trip or waiting for transportation services. The USB charging ports will be integrally installed on the IK.

2.1.5. Emergency Call Button

An Emergency Call Button (ECB) will be available that when activated, will send notification of the help request directly to the 911 emergency call center operated by the City of Columbus and initiate an audio connection between the distressed Traveler and an operator at the emergency call center. The ECB will be a physical push button integrally installed on the IK.

2.1.6. Interactive Voice Response

The IK will include capability to connect to an Interactive Voice Response (IVR) system that will allow Travelers to interact with the MMTPA and trip-planning tools through use of voice commands. The IVR system is a function of the MMTPA project and where it is described in greater detail.

2.1.7. Real-Time Data Display

Real-Time Data Displays post current transit information, public notifications and other information at COTA CMAX bus stops and transit centers. These devices will be accessible to passengers at some SMH locations.

2.1.8. Personal Wireless Device

A personal wireless device such as a cell phone or tablet may be used at SMH facilities to access the MMTPA via public Wi-Fi or through a personal data plan. Wi-Fi access may include the development of a SMH home webpage that displays or provides links to real-time information that will be displayed on IK screens at the SMH facility. Additionally, trip confirmation codes and other trip information may be sent to the personal wireless device upon Traveler request and used to gain access to TNCs or to unlock bikes at bike-sharing docks.

2.1.9. Designated Passenger Pickup/Drop-Off Zones

Loading zones will be available at SMH locations in the form of pull-off lanes and/or parking spaces located away from travel lanes that allow the safe transfer of passengers between modes of transportation. These zones will primarily be used for Mobility Providers and will be clearly marked with signage and pavement markings.

2.1.10. Dockless Device Parking Zones

Designated zones will be established for parking dockless devices such as scooters and ebikes to prevent interference between this rapidly increasing mode of transportation and other services offered at the SMH facilities.

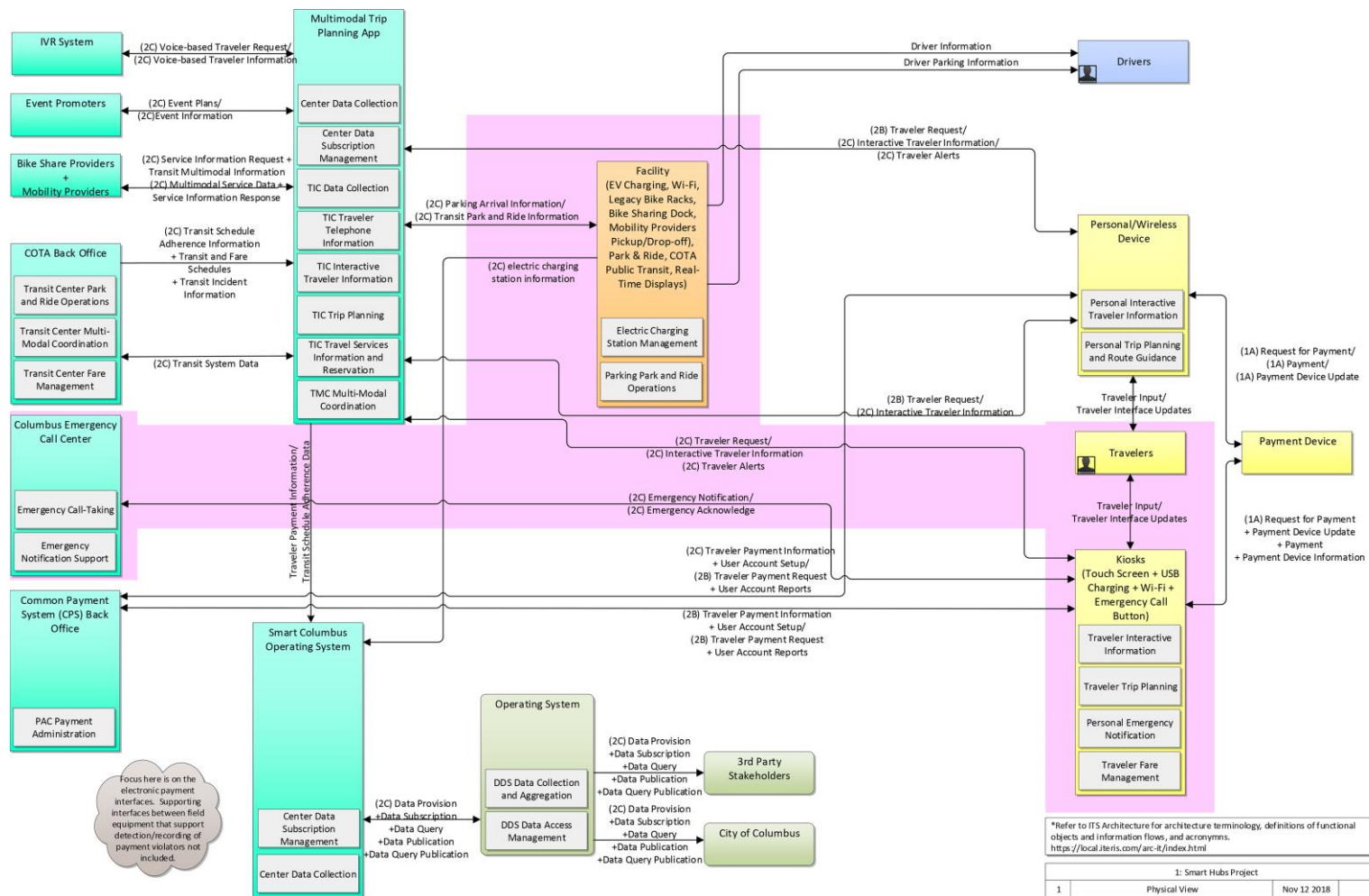
2.1.11. Bike-Share Docks

Privately operated bike-share docking stations will be installed at SMH locations and will allow passengers to continue his or her trip from the SMH using a rented bike.

2.1.12. Bike Racks

SMH facilities will include the installation of bike racks enabling passengers to use a personal bike to access the SMH continue their trip.

Figure 3: Smart Mobility Hubs Context Diagram shows a context diagram for the new SMH system.



Source: City of Columbus

Figure 3: Smart Mobility Hubs Context Diagram

Table 2: System Functional Groups provides FGs resulting from the proposed system diagram deconstructed into its major components/functionality.

Table 2: System Functional Groups

Ref No.	FG	High-Level Functionality
CTP	Comprehensive Trip Planning	CTP features will be made available to Travelers at SMH by providing access to the MMTPA/CPS functions, which include providing the Traveler the ability to plan, schedule and pay for trips using multimodal options available at the SMH facility.
ECB	Emergency Call Button	When activated, the ECB will send notification of the help request directly to the 911 emergency call center operated by the City of Columbus and initiate an audio connection between the distressed Traveler and an operator at the emergency call center.
DOCKLESS	Dockless Device Zone	Designated zones will be established for parking dockless devices such as scooters and ebikes.
IK	Interactive Kiosk	The IK will provide an embedded touch-screen display to serve as a direct interface between Travelers and the MMTPA/CPS, providing the Traveler the ability to plan, schedule, and pay for multimodal trip options available at the SMH facility. The IK will display additional information and instructions such as directing the Traveler to a TNC pickup location.
PARKRD	Park and Ride	PARKRD will designate physical space at a SMH facility for park and ride vehicle parking spaces.
RACKS	Bike Racks	RACKS will provide physical bike racks at a SMH facility for Travelers to park and secure privately owned bikes.
BIKESHARE	Bike-Sharing	BIKESHARE will install docking stations for bike-share operations at the SMH facility
CARSHARE	Car-Sharing	CARSHARE will designate physical space at a SMH facility for car-sharing vehicle parking spaces.
RIDESHARE	Ride-Sharing	RIDESHARE will designate physical space at a SMH facility for passenger pickup and drop off by TNCs.
USB	USB Charging	Powered USB ports will be available at the SMH facility to allow Travelers to recharge personal electronic devices like cellular phones, tablets, and other wireless devices while planning a trip or waiting for transportation services.

Ref No.	FG	High-Level Functionality
WIFI	Wi-Fi Enabled	SMH facilities will be equipped with public Wi-Fi that will allow a Traveler to access the MMTPA/CPS and other transportation information using a personal wireless device. Some SMH Stakeholders will provide Wi-Fi with their own equipment and the IK provided Wi-Fi will available at other SMH locations.

Source: City of Columbus

Table 3: Expected Interfaces summarizes the interfaces, facilities, communications and messages used in the system. The reader should reference these figures and table throughout this section to foster a better understanding of the system concept.

Table 3: Expected Interfaces

Interface ID (FROM HELIX)	Source Element	Destination Element	Data Flow	Communication Media
SMH-IX2431-v01	IK Touch Screen	MMTPA/CPS Application	Request for trip- planning services (car- share, ride-share, bike-share, paratransit, account information and payment request data	Application Programming Interface (API), Secured Internet Browser over Wi-Fi

Interface ID (FROM HELIX)	Source Element	Destination Element	Data Flow	Communication Media
SMH-IX2432-v01	MMTPA/CPS Application	IK Touch Screen	Real-time trip-planning data associated with mode of transport (public transportation, ride-sharing services, bike-sharing, etc.), payment authorization, and confirmations	API, Secured Internet Browser over Wi-Fi

Interface ID (FROM HELIX)	Source Element	Destination Element	Data Flow	Communication Media
SMH-IX2433-v01	ECB	Columbus Emergency Call Center (CECC)	Request for emergency services, voice and location data	Telephone
SMH-IX2434-v01	CECC	ECB	Emergency response service, notifications, and voice data	Telephone

Interface ID (FROM HELIX)	Source Element	Destination Element	Data Flow	Communication Media
SMH-IX2435-v01	IK System	Personal Wireless Device	Wireless Internet Access for IK system and public use	Wireless Network Interface Card
SMH-IX2436-v01	Personal Wireless Device	MMTPA/CPS Application	Request for trip- planning services (car- , ride- and bike-share; paratransit; account information; and payment request data)	Wireless Ethernet
SMH-IX2437-v01	IK System	USB Charging	Power only (no signal) for electronic device charging	USB
SMH-IX2438-v01	IK Touch Screen	IVR System	Request for information accessibility, voice data	IVR

Source: City of Columbus

2.2. SYSTEM MODES AND STATES

Table 4: New SMH System Modes of Operation defines the modes of operations for the new SMH system.

Table 4: New SMH System Modes of Operation

Mode	Definition
Normal Operation	Normal operation mode occurs while IKs are online, Wi-Fi is fully accessible, and Users can utilize the MMTPA/CPS to evaluate real time transportation conditions throughout the corridor to make decisions on modal choices, book, and pay for the trip. Buses, TNCs, cars (car-sharing), and bikes are readily available to User with minimal delay.

Mode	Definition
Degraded Conditions	Degraded mode refers to a localized or systemic event that results in diminished access to a component of the MMTPA/CPS resulting in trip disruption to Users; or when appropriate travel options are not readily available to Users within a reasonable amount of time; or when full corridor travel is not possible or permitted due to system unrelated event such as a traffic incident or other emergency event.
Failure Conditions	Failure mode results in the complete systemic disruption of the User's ability to access the MMTPA/CPS or transportation modes. This may be due to a network or other system equipment problem, or physical lack of bus, TNC, bike service, etc.
Maintenance	Maintenance mode occurs when system components are taken offline to restore, repair, or replace. These are planned events and should occur during off peak hours to minimally impact Users, and proper notification should be given to potential Users in advance of the event when practical.

Source: City of Columbus

2.3. MAJOR SYSTEM CHARACTERISTICS

2.3.1. System Capabilities

The SMH system will be created by providing physical amenities and network connectivity that will give Travelers more transportation options, real-time transportation information, and improved access to trip-planning services offered through use of the MMTPA/CPS. This system will improve accessibility to first/last mile trip options and is expected to increase ridership of the CMAX BRT service that is currently operated by COTA within the SMH project limits. Trip data involving SMH features will be collected and used by City and COTA officials to improve transportation planning decision making and services.

2.3.2. System Conditions

The SMH is generally expected to perform under most conditions, providing Travelers with area transportation information and access to trip-planning tools and modes of transportation. Situations that may result in degraded or no performance include:

- **Loss of Communications** – The loss of network connectivity at the IK will result in failure to use trip-planning tools like MMTPA/CPS. Travelers would be limited to using personal wireless devices and data plans to use these features. Trip data will also be unavailable to the Operating System (OS) during a communications loss event.
- **Severe weather events or incidents impacting roadway network in vicinity of SMH** – Temporary unavailability of some modes of transportation may result if transit, vehicles and/or bikes are not able to physically access the SMH facility or experience significant delays traveling to the site.

2.4. USER CHARACTERISTICS

This section defines the Stakeholders, User classes, and their roles and responsibilities for the SMH system. Stakeholders refers to an individual or organization affected by the activities, inputs and outputs of the system being developed. They may have a direct or indirect interest in the system and their level of participation may vary. This includes public agencies, private organizations or the traveling public (End Users) with a vested interest, or a “stake” in one or more aspect of the SMH as identified in **Table 5: Smart Mobility Hubs Stakeholders and User Classes**. User Classes are based on the perception of the system and the needs identified. Some key personnel may serve in multiple roles based on the User Needs and functions.

Table 5: Smart Mobility Hubs Stakeholders and User Classes

User Classes	Description
City of Columbus	The City, through Smart Columbus, will provide the project deployment functions necessary to establish the operational system and provide testing and verification. The City also will maintain the OS, the MMTPA and data dashboards to analyze the use of the SMH.
COTA	As the public transit provider in central Ohio and Columbus, Central Ohio Transit Authority (COTA) is central to the design and implementation of the SMH. It is envisioned that COTA will serve as the backbone of the transportation system, tying into the SMH facilities and linking Travelers to multimodal options for FMLM connections.
Third Party	Typically, a public or private transportation provider or planning agency utilizing data from the Smart Columbus project to improve the efficiency and accuracy of its services or a developer that uses data to create reports or improve mobility within the City.
Travelers	Travelers are End Users who utilize the features of SMHs to begin, pass through or complete their trips. Travelers interact with SMHs in the following ways: <ul style="list-style-type: none"> • They use the physical SMH facility to transfer or connect between modes of transportation; for example, a User may transfer from a ride-sharing service to a COTA fixed route bus, or from COTA fixed route bus to a bike-sharing service. • They use the IK or Wi-Fi connectivity provided at the SMH facility to interact with the MMTPA/CPS to plan, reserve and pay for one or more components required to complete their trip. • They activate the ECB feature for emergency services during an incident.
Mobility Providers	Mobility Providers are private businesses, nonprofits, and quasi-governmental agencies that offer one or more modes of transportation for use by Travelers in exchange for payment. These include car-sharing services, ride-sharing services, ride-hailing companies, bike-sharing services and private car/van pools from ride matching services. A bike-sharing service may maintain a physical space at the SMH where Travelers can pick up or drop off a bicycle when transitioning to or from a COTA bus.
Property Owners/Stakeholders	Agencies partnering with the City to permit the deployment of a SMH facility within the limits of their property. Agreements between these agencies and the City will be made to address operating and maintenance expectations of the SMH facility and equipment.

User Classes	Description
City of Columbus Emergency Dispatch Center	The Emergency Dispatch Center will interact with Travelers and other Users of the IKs to intake emergency call information and deploy the appropriate resources to respond to the emergency.

Source: City of Columbus

2.5. ASSUMPTIONS AND DEPENDENCIES

Table 6: Assumptions and Dependencies lists the known assumptions and dependencies that represent a risk to the SMH project and can affect the ability to meet the desired functionality, maintain the project schedule or meet performance goals.

Table 6: Assumptions and Dependencies

Assumption	Corresponding Risk	Dependency	Degree
Stakeholder/City agreements will be in place prior to SMH deployment	Installation of equipment on Stakeholder property cannot begin unless agreements are executed	All physical SMH improvements at respective Stakeholder site	Critical

Source: City of Columbus

2.6. SYSTEM CONSTRAINTS

Table 7: System Constraints defines the system constraints in the new SMH system.

Table 7: System Constraints

Constraint ID	Reference	Constraint
SMH-CN2424-V01	Constraint 1	TNCs must respect existing COTA infrastructure and agreements. Additional registration/agreements with Townships are needed.
SMH-CN2425-V01	Constraint 2	Effective distance of Wi-Fi coverage (COTA is working with vendors to improve).
SMH-CN2426-V01	Constraint 3	The City is evaluating whether advertisement material may be permitted to be posted on infrastructure such as IKs within right of way or on City property.
SMH-CN2427-V01	Constraint 4	Physical right of way and existing infrastructure may limit the features that a specific transit center facility can offer.
SMH-CN2428-V01	Constraint 5	City does not desire to be an Internet Service Provider (ISP); however, COTA is willing to be an ISP for their buses and stops.
SMH-CN2429-V01	Constraint 6	The system shall adhere to the current guidelines and principles set forth in the National ITS Architecture developed by the USDOT ITS Joint Program Office.

Constraint ID	Reference	Constraint
SMH-CN2430-V01	Constraint 7	The availability of Wi-Fi and accessibility to internet content is determined by operational policy set forth by COTA, who functions as the ISP for Users of the SMH system. The intent of the Wi-Fi service is to provide Users access to trip-planning apps and information systems. For example, changes to the policies in place that might provide Users with access to internet content outside of the intended use, such as social media or video streaming, will greatly reduce available bandwidth of the communications network and may present security concerns as well.
SMH-CN3056-V01	Constraint 8	The City and/or Property Owner may designate parking areas or restrict car parking within certain areas of the SMH.

Source: City of Columbus

2.7. METHODS OF VERIFICATION

The software and hardware components that make up the SMH will be individually verified, then integrated to produce top-level assemblies and microservices. These assemblies will also be individually verified before being integrated with others to produce larger, evolving assemblies until the complete system has been integrated and verified. Throughout this process, the Smart Columbus program will utilize the Helix Requirements Management tool to capture, track and trace Requirements starting with the User Needs defined in the ConOps through development, testing and deployment. This approach and software tool will be instrumental through the design and development phases of the project.

The Requirements also maintain a verification method, which details the plan for verifying the Requirement based on its stated definition. For each Requirement, one of the verification methods listed in **Table 8: Methods of Verification** is assigned. Using the Requirements defined in the previous section.

Table 8: Methods of Verification

Type	Description
Inspection	Verification through a visual, auditory, olfactory or tactile comparison.
Demonstration	Verification that exercises the system software or hardware as it is designed to be used, without external influence, to verify the results are specified by the Requirement.
Test	Verification using controlled and predefined inputs and other external elements (e.g. data, triggers, etc.) that influence or induce the system to produce the output specified by the Requirement.
Analyze	Verification through indirect and logical conclusion using mathematical analysis, models, calculations, testing equipment and derived outputs based on validated data sets.

Source: City of Columbus

2.8. OPERATIONAL SCENARIOS

Chapter 6 of the *Concept of Operations for the Smart Mobility Hubs Project for the Smart Columbus Demonstration Program* captures and documents the operational scenarios.

Chapter 3. System Requirements

This section of the document lists the identified System Requirements for the SMH project. The Requirements are organized first by type, then by system and services (i.e. Functional Requirements (FNs) for FG 1, then FNs for FG 2, etc.). Each Requirement type has a Requirement ID (Req. ID) (see **Appendix A. Document Terminology and Conventions**) along with a description, a reference number that identifies traceability to User Needs; User Scenarios; and/or policies and constraints. Each Requirement also has a verification method (see **Section 2.7 Methods of Verification** for method definitions).

Table 9: List of Requirement Types describes the classifications of Requirement types in this document.

Table 9: List of Requirement Types

Requirement Type	Description
Functional (FN)	FN Requirements specify actionable and qualitative behaviors (e.g. functions, tasks) of the core system of interest.
Performance (PR)	PR Requirements specify quantifiable characteristics of operations that define the extent, or how well, and under what conditions a function or task is to be performed (e.g. rates, velocities).
Interfaces (IF)	IF Requirements define how the system will interact, communicate, or exchange data with external systems (External IF) and how core system elements interact with other parts of the system (Internal IF).
Data (DR)	DRs define the data collected, transformed, and stored from various sources as well as identifies new data that is expected to be generated.
Security (SR)	SRs specify what is necessary to protect the integrity and operability of the system, its microservices, connections, and data. This includes physical security as well as cyber prevention, detection, identification, response and recovery Requirements.
Non-Functional (NF)	NF Requirements define the characteristics of the overall operation of the system.
Physical (PY)	PY Requirements specify the construction, durability, adaptability and environmental characteristics of the system.
Availability and Recovery (AR)	AR Requirements define the times of day, days of year, and overall percentage the system can be used, when it will not be available for use, and recovery point and time objectives.
Maintainability (MT)	MT Requirements specify the level of effort required to locate and correct an error during operation.
Storage and Transport (ST)	ST Requirements specify the physical location and environment for the system, including designated storage facility, installation site, repair facility, Requirements for transporting equipment, etc.
Disposal (DP)	DP Requirements specify the items related to the disposal of project/system components, due to either failure replacements, removal, end-of-life upgrade, or retirement.

Requirement Type	Description
Enabling (EN)	EN Requirements specify details concerning the management of information as well as the production of the system and its life-cycle sustainability.
Information Management (IM)	IM Requirements specify the acquisition, management, and ownership of information from one or more sources, the custodianship and the distribution of that information to those who need it.
Life-Cycle Sustainability (LC)	LC Sustainability Requirements define what items the project or system will review, measure, and analyze as part of its commitment to quality during the life cycle of the system including development, integration, verification, validation and training.
Policy and Regulation (RG)	RG Requirements specify relevant and applicable organizational policies or regulations that affect the development, operation or performance of the system (e.g. information technology (IT) and labor policies, reports to regulatory agencies, health or safety criteria, etc.). This section also includes new policy and regulation imposed to realize the system.

Source: City of Columbus

3.1. FUNCTIONAL REQUIREMENTS

Table 10: Functional Requirements organizes by FG the SMH FN Requirements, which are related to the User Needs the SMH ConOps identified.

Table 10: Functional Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN3071-V01	Bike Racks	Racks	The bike racks shall support a bicycle in a stable upright position.	SMH-UN001-V01	Inspection
SMH-FN2290-V02	Bike-Sharing	Docking Station	Bike-share docking station shall be installed at SMH locations.	SMH-UN005-V01 SMH-UN011-V01 SMH-CN2427-V01	Inspection
SMH-FN2291-V02	Bike-Sharing	Docking Station	The docking station shall accept a secure code generated (through verified payment via MMTPA and CPS) for unlocking the bikes.	SMH-UN011-V01	Demonstration
SMH-FN2293-V01	Bike-Sharing	Docking Station	The docking station shall be solar powered.	SMH-UN011-V01	Inspection
SMH-FN2294-V02	Bike-Sharing	Docking Station	The docking station shall report the number of bikes currently docked to the OS.	SMH-UN011-V01 SMH-UN001-V01	Demonstration
SMH-FN2296-V01	Bike-Sharing	Docking Station	The docking station shall track the date and time when a bike is unlocked.	SMH-UN001-V01 SMH-UN011-V01	Test
SMH-FN2297-V01	Bike-Sharing	Docking Station	The docking station shall track the date and time when a bike is locked.	SMH-UN001-V01 SMH-UN011-V01	Test
SMH-FN2298-V02	Bike-Sharing	Docking Station	The docking station shall report the operational status of the docking station to the OS.	SMH-UN001-V01 SMH-UN011-V01	Demonstration
SMH-FN3070-V01	Bike-Sharing	Docking Station	The docking station shall support a bicycle in a stable upright position.	SMH-UN001-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN3057-V01	Car-Sharing	Car-Sharing System	Car-sharing provider utilizing SMH facility shall report the number of available shared vehicles located at each SMH location to the OS.	SMH-UN014-V01	Inspection
SMH-FN2310-V02	Car-Sharing	Parking Lot	The SMH facility shall provide designated parking spaces for car-share vehicles.	SMH-UN005-V01 SMH-CN2424-V01 SMH-CN2427-V01	Inspection
SMH-FN2442-V01	Dockless Device Zone	Dockless Parking Zone Facility	Designated paved area shall be made available for dockless devices such as scooters and ebikes at the SMH facility.	SMH-UN005-V01	Inspection
SMH-FN2443-V01	Dockless Device Zone	Dockless Parking Zone Facility	Boundaries, symbols and/or text description of designated area for dockless devices shall be clearly outlined on pavement with paint.	SMH-UN005-V01	Inspection
SMH-FN2322-V02	ECB	ECB System	The ECB system shall be capable of two-way voice communications and transmitting Global Positioning System (GPS) location coordinates to the CECC.	SMH-UN015-V01 SMH-IX2433-V01 SMH-IX2434-V01	Test
SMH-FN2323-V02	ECB	ECB System	When an ECB alarm is triggered, the ECB system shall perform the following functions: <ul style="list-style-type: none"> Establish a bidirectional voice-enabled communication medium from the IK to the CECC Activate the IK camera and record video to local digital video recorder (DVR) 	SMH-UN007-V01 SMH-UN015-V01 SMH-IX2433-V01 SMH-IX2434-V01	Test
SMH-FN3061-V01	IK	Camera	The IK shall include an integrated security camera and DVR.	SMH-UN007-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN2292-V02	IK	IK System	The IK shall allow the User to enter trip feedback such as the operational status of the just docked bike. The operational status could include the need for preventative and repair maintenance.	SMH-UN003-V01 SMH-UN011-V01	Demonstration
SMH-FN2335-V02	IK	IK System	The IK system shall support multiple languages. At a minimum, English and Spanish shall be supported.	SMH-UN012-V01	Inspection
SMH-FN2441-V01	IK	IK System	The IK system shall reset back to the default language at the end of a User session or after a maximum two minutes of inactivity.	SMH-UN003-V01	Demonstration
SMH-FN3058-V01	IK	IK System	The IK system shall maintain English as its default language setting and provide Users the ability to select a language of choice.	SMH-UN012-V01	Inspection
SMH-FN2336-V01	IK	IK System Administration	<p>The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following:</p> <ul style="list-style-type: none"> • Inability to communicate through an interface • Inability to send/receive data • Service requests and queries extend longer than 10 seconds • Invalid or missing data has been detected. 	SMH-UN001-V01 SMH-UN002-V01 SMH-UN003-V01 SMH-UN004-V01 SMH-UN006-V01 SMH-UN008-V01 SMH-UN010-V01	Test

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN2337-V02	IK	IK System Administration	The IK system software shall be capable of the automatic resolution of system abnormalities, security incidents, faults, and errors (to the extent possible).	SMH-UN002-V01	Test
SMH-FN2338-V01	IK	IK System Environment	All IK communications links shall utilize Transmission Control Protocol/Internet Protocol (TCP/IP) and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.	SMH-UN003-V01 SMH-UN004-V01 SMH-UN006-V01 SMH-UN007-V01 SMH-UN008-V01 SMH-UN010-V01	Test
SMH-FN2339-V02	IK	IK System Monitoring	All IK system errors, warnings, and self-correcting actions shall be stored locally in ASCII text formatted log files at the IK for a minimum of 24 hours and sent to the OS at regularly scheduled intervals to ensure there are no gaps in log file data.	SMH-UN002-V01	Demonstration
SMH-FN2449-V01	IK	IK System Monitoring	IK system files shall be “revolving” or self-appending so that old data is continually overwritten, and system data does not reach capacity of available memory.	SMH-UN003-V01	Demonstration
SMH-FN2340-V02	IK	IK System Redundancy	The IK system shall reboot following a power loss.	SMH-UN003-V01 SMH-UN004-V01 SMH-UN006-V01 SMH-UN007-V01 SMH-UN008-V01 SMH-UN010-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN2341-V02	IK	IK System Security	The IK system shall limit the use of internet to the approved apps, services and features offered through the interactive display, including trip-planning and payment via the MMTPA/CPS.	SMH-UN003-V01	Demonstration
SMH-FN2342-V01	IK	IK Display	The IK system shall be designed for unattended operation under normal circumstances, exclusive of manual data entry, public User access, and routine administrative functions.	SMH-UN002-V01 SMH-UN003-V01	Demonstration
SMH-FN2343-V02	IK	Operating System	The IK system shall send SMH location, trip mode, and timestamp data to OS for all trips generated at the respective IK.	SMH-UN003-V01	Demonstration
SMH-FN2344-V02	IK	Touch-Screen Interface	The IK touch-screen content shall be configurable for services offered at each location.	SMH-UN001-V01 SMH-UN003-V01 SMH-UN006-V01 SMH-UN010-V01	Demonstration
SMH-FN2345-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall prohibit unauthorized Users from accessing the OS or any Graphical User Interface (GUI), IK or network controls or settings, as outlined in the DMP and DPP.	SMH-UN002-V01 DMP DPP	Test
SMH-FN2346-V01	IK	Touch-Screen Interface	The IK touch-screen interface and its controls shall conform to the applicable accessibility requirements of the Americans with Disabilities Act (ADA).	SMH-UN008-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN2347-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall be designed to withstand intentional or unintentional misuse (e.g. repeated tapping of keys) without system malfunction.	SMH-UN002-V01	Demonstration
SMH-FN2348-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall maintain a unique identifier for each IK to diagnose system malfunctions, provide information to the ECB service, as well as customize content per SMH location (location awareness).	SMH-UN002-V01	Test
SMH-FN2349-V02	IK	Touch-Screen Interface	The IK touch-screen interface shall not permit access to data deemed to be confidential or inappropriate for public use, as outlined in the DMP and DPP.	SMH-UN002-V01 DMP DPP	Test
SMH-FN2350-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall utilize a commercial off-the-shelf Kiosk Operating System (KOS) that resides on top of the OS (latest version of Windows, Linux, or Raspberry Pi), in accordance with the software requirements outlined in this SyRS.	SMH-UN002-V01	Inspection
SMH-FN2351-V01	IK	Touch-Screen Interface	Where source data is not available in real time, the touch screen shall utilize PDF and/or service board websites in the short term such as transit route maps, location-specific services or tourism information, etc.	SMH-UN003-V01 SMH-UN006-V01 SMH-UN008-V01 SMH-UN010-V01 SMH-CN2426-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN2448-V01	IK	Touch-Screen Interface	Current transit route maps, location-specific services or tourism information, etc., shall be saved on the KOS, so data is available to be displayed even during periods of communication failure.	SMH-UN003-V01	Demonstration
SMH-FN2352-V02	IK	Touch-Screen Menu	The IK touch screen may incorporate a demonstration of the use of the screen, general information, and/or animation while in standby mode.	SMH-UN003-V01 SMH-UN013-V01 SMH-FN3059-V01	Demonstration
SMH-FN2353-V02	IK	Touch-Screen Menu	The IK touch screen shall support a standby mode that displays a static or animated screen or series of screens.	SMH-UN003-V01 SMH-UN013-V01 SMH-CN2426-V01 SMH-FN3059-V01	Demonstration
SMH-FN2354-V01	IK	Touch-Screen Menu	Users shall exit standby mode by touching the screen or activating any other IK controls. When standby mode is exited, the system shall display an initial start page with links to various submenus and content pages that allow the User to reach all information contained within the system.	SMH-UN003-V01 SMH-UN013-V01 SMH-FN3059-V01	Test
SMH-FN3059-V01	IK	Touch-Screen Menu	The IK touch-screen display shall enter standby mode after a configurable period (default is one minute) of inactivity.	SMH-FN2352-V02 SMH-FN2353-V02 SMH-FN2354-V01	Test
SMH-FN2388-V02	Ride-Sharing	Parking Lot	Curb space shall be designated for pickup from ride-share and taxi services.	SMH-UN005-V01 SMH-UN014-V01 SMH-CN2424-V01 SMH-CN2427-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-FN2394-V01	USB Charging	USB General	USB charging outlets shall be USB Type A 3.0 standard.	SMH-UN009-V01	Inspection
SMH-FN2395-V02	USB Charging	USB General	The USB charging service shall deliver free charging for Travelers to charge mobile devices.	SMH-UN009-V01	Inspection
SMH-FN2403-V02	Wi-Fi Enabled	Wi-Fi Core Functionality	SMH shall permit electronic devices equipped with internet capabilities (phone, tablet, computer) to connect to the internet via Wi-Fi.	SMH-UN004-V01 SMH-CN2428-V01 SMH-CN2430-V01	Demonstration
SMH-FN2405-V01	Wi-Fi Enabled	Wi-Fi Standards	SMH may consider IEEE 802.11ai to enable Fast Initial Link Setup (FILS) methods to enhance End-User experience in high-density Wireless Local Area Network (WLAN) environments.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration
SMH-FN2406-V01	Wi-Fi Enabled	Wi-Fi Standards	Wi-Fi technologies shall follow IEEE 802.11 b/g/n standards to enable multi-gigabit throughput in the 2.4 GHz, 5GHz and 60GHz spectrum bands.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration
SMH-FN2407-V01	Wi-Fi Enabled	Wi-Fi Usage	An active session with internet access shall be provisioned for the User when that User accepts the terms and conditions of service.	SMH-UN004-V01 SMH-CN2428-V01 SMH-CN2430-V01	Test
SMH-FN2408-V01	Wi-Fi Enabled	Wi-Fi Usage	An active session with internet access shall not be provisioned for the User when that User declines the terms and conditions of service.	SMH-UN004-V01 SMH-CN2428-V01 SMH-CN2430-V01	Test

Source: City of Columbus

3.2. PERFORMANCE REQUIREMENTS

SMH PR Requirements specify the performance of the system of interest, or what the system will do. **Table 11: Performance Requirements** organizes by FG the PR Requirements, which are related to the User Needs the SMH ConOps identified.

Table 11: Performance Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-PR2275-V01	Bike Racks	Racks	The placement of bike racks shall not impede flow of vehicle or pedestrian traffic.	EPM-CN1677-V01 SMH-UN011-V01 SMH-UN005-V01	Inspection
SMH-PR2301-V02	Bike-Sharing	Bike-Sharing System	The bike-share docking station shall not impede flow of vehicle or pedestrian traffic.	SMH-UN005-V01 SMH-UN011-V01 SMH-CN2427-V01	Demonstration
SMH-PR2302-V02	Bike-Sharing	Bike-Sharing System	Bikes that are parked in violation of City codes or are vandalized or inoperable shall be reported by SMH owning agency to bike-share company.	SMH-UN005-V01 SMH-UN011-V01	Demonstration
SMH-PR2450-V02	Dockless Device Zone	Dockless Parking Zone Facility	The dockless parking zone shall not be laid out in a manner which impedes the flow of vehicle or pedestrian traffic.	SMH-UN005-V01	Inspection
SMH-PR2452-V01	IK	Touch-Screen Interface	IK touch-screen displays shall meet City outdoor advertisement brightness standards and be capable of adjusting brightness based on varying outside light conditions, according to Columbus Ordinance 3377.08 – Illumination and Special Effects .	SMH-UN004-V01 Columbus Ordinance 3377.08 – Illumination and Special Effects	Demonstration
SMH-PR3062-V01	IK	Touch-Screen Interface	The IK touch-screen interface display shall be at least 55" diagonal.	SMH-UN003-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-PR2382-V02	Park and Ride	Park-and-Ride Facility	The park and ride parking spaces shall allow 24/7 public access to the vehicles.	SMH-UN005-V01 SMH-UN014-V01	Demonstration
SMH-PR2383-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall allow parked vehicles to maintain unimpeded access to roadway/driveway entrances and exits.	SMH-CN2427-V01 SMH-UN005-V01 SMH-UN014-V01	Demonstration
SMH-PR2384-V02	Park and Ride	Park-and-Ride Facility	The park and ride designated parking spaces shall be located in locations that do not impede the regular flow of travel in the public right of way.	SMH-UN005-V01 SMH-UN014-V01 SMH-CN2427-V01	Demonstration
SMH-PR2385-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall ensure the vehicles not be parked in a way that impedes the 5 feet clearance on sidewalks needed for ADA compliance.	SMH-UN005-V01 SMH-UN014-V01	Demonstration
SMH-PR2392-V02	Ride-Sharing	Parking Lot	The City and Property Owner may designate parking areas or restrict car parking within certain areas.	SMH-UN005-V01 SMH-UN014-V01 SMH-CN2427-V01	Demonstration
SMH-PR2411-V02	Wi-Fi Enabled	Wi-Fi Capacity	Wi-Fi technologies shall support a minimum of 10 simultaneously connected Users.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration
SMH-PR3063-V01	Wi-Fi Enabled	Wi-Fi Monitoring	The upload and download speed on each Wi-Fi access point shall be tracked, monitored, and changed, as necessary.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration
SMH-PR3064-V01	Wi-Fi Enabled	Wi-Fi Monitoring	The load on each Wi-Fi access point shall be monitored and flagged when there is an overloading issue associated with the access point.	SMH-UN004-V01 SMH-CN2428-V01	Test

Source: City of Columbus

3.3. INTERFACE REQUIREMENTS

SMH IF Requirements allow dynamic and configurable functionality between internal components of the Smart Columbus System of Systems (SoS) and external systems that provide data or some other stated functionality as per the User Needs for SMH. **Table 12: Interface Requirements** organizes by FG the IF Requirements, which are related to the User Needs the SMH ConOps identified.

Table 12: Interface Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-IF2315-V01	Comprehensive Trip Planning	CPS Integration	The CPS app shall be deployed and available for use at the IK display through the MMTPA app.	SMH-UN003-V01 SMH-IX2431-V01	Demonstration
SMH-IF2316-V01	Comprehensive Trip Planning	IK System Integration	The MMTPA app shall be deployed and available for use at the IK display.	SMH-UN003-V01 SMH-IX2432-V01	Demonstration
SMH-IF2325-V01	ECB	IK System Integration	An ECB interface shall be designed for public Users to alert the CECC officials in an emergency situation.	SMH-UN007-V01 SMH-UN015-V01 SMH-IX2433-V01	Test
SMH-IF2355-V02	IK	IK Display Interface	The IK shall provide a secured, direct-connect interface to facilities for operational administration.	SMH-UN003-V01 SMH-IX2435-V01	Test
SMH-IF2356-V02	IK	MMTPA Integration	The IK system shall provide access to a web- or app-based interface with the MMTPA/CPS system to provide CTP and trip-booking services and disseminate information regarding Mobility Providers, parking providers, and availability of various modes of transportation to the traveling public.	SMH-UN003-V01 SMH-IX2431-V01	Demonstration
SMH-IF2357-V01	IK	MMTPA Integration	The interface to other SMH services offered at the SMH facility (e.g. car-, bike- and ride-sharing) shall be provided through the MMTPA/CPS interface, which provides CTP services for the SMH Traveler.	SMH-UN003-V01 SMH-IX2432-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-IF2359-V02	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to display any current alerts that describe events having a significant impact on transportation services.	SMH-UN010-V01 SMH-IX2431-V01	Demonstration
SMH-IF2360-V01	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to the COTA Real-Time Display.	SMH-UN006-V01 SMH-IX2431-V01	Test
SMH-IF2361-V02	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to various static maps within the SMH demonstration area.	SMH-UN003-V01 SMH-UN006-V01 SMH-IX2431-V01	Demonstration
SMH-IF2362-V01	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to Visitor Information, which includes location-aware content.	SMH-UN010-V01 SMH-IX2431-V01	Demonstration
SMH-IF2363-V01	IK	USB Integration	The IK should include a minimum of four USB ports for charging mobile devices to SMH Travelers.	SMH-UN009-V01 SMH-IX2437-V01	Demonstration
SMH-IF2389-V01	Ride-Sharing	MMTPA Integration	The ride-sharing service shall be provided through the MMTPA app.	SMH-UN014-V01 SMH-IX2432-V01	Demonstration
SMH-IF2409-V01	Wi-Fi Enabled	Wi-Fi Enabled	Wi-Fi services shall be provided through the IK.	SMH-UN004-V01 SMH-IX2438-V01	Test

Source: City of Columbus

3.4. DATA REQUIREMENTS

SMH DR Requirements define the data collected, transformed and stored from various sources and identifies new data that is expected to be generated. **Table 13: Data Requirements** organizes by FG the DR Requirements, which are related to the User Needs the SMH ConOps identified.

Table 13: Data Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-DR2283-V02	Bike-Sharing	Bike-Sharing System	The SMH shall provide an interface to the bike-share company.	SMH-UN001-V01	Demonstration
SMH-DR2284-V01	Bike-Sharing	Bike-Sharing System	The bike-share company shall maintain and share monthly with the City a list of deployed bikes at the SMH, listed by unique identifiers.	SMH-UN001-V01	Demonstration
SMH-DR2285-V01	Bike-Sharing	Bike-Sharing System	The bike-share company shall maintain and share monthly with the City a list of lost, stolen and vandalized bikes.	SMH-UN002-V01 SMH-UN002-V01	Demonstration
SMH-DR2286-V01	Bike-Sharing	Bike-Sharing System	The bike-share company shall maintain and share monthly with the City a record of maintenance activities including but not limited to identification number and maintenance performed.	SMH-UN002-V01	Demonstration
SMH-DR2320-V01	ECB	ECB Data	ECB shall record the time, date, and location upon activation.	SMH-UN007-V01 SMH-UN015-V01	Test
SMH-DR2321-V02	ECB	ECB Data	The street address and GPS coordinates of the SMH facility shall be sent to the CECC to notify dispatchers of location of the help request.	SMH-UN015-V01 SMH-UN007-V01 SMH-IX2433-V01	Test
SMH-DR2328-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning and real-time service information, transit bulletins and maps.	SMH-UN001-V01 SMH-UN003-V01 SMH-UN006-V01 SMH-UN009-V01 SMH-UN010-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-DR2329-V01	IK	Touch-Screen Interface	The IK touch-screen interface content shall include static and real-time Traveler information to the extent that each data element is available from the OS retrieved through the General Transit Feed Specification (GTFS) real-time data feed. The screen should display arrivals in the next hour for that location.	SMH-UN001-V01 SMH-UN013-V01	Demonstration
SMH-DR2400-V01	Wi-Fi Enabled	Wi-Fi Data Collection	SMH Wi-Fi enabled technologies shall track number of clients per access point.	SMH-UN004-V01	Demonstration
SMH-DR2401-V01	Wi-Fi Enabled	Wi-Fi Data Collection	SMH Wi-Fi technologies shall log User connection time stamp, IP, Media Access Control (MAC) address, OS, device manufacturer, sites visited, and connection status and length.	SMH-UN004-V01	Test

Source: City of Columbus

3.5. SECURITY REQUIREMENTS

SMH SR Requirements specify what is necessary to protect the integrity and operability of the system, and its microservices, connections and data. This includes physical security as well as cyber prevention, detection, identification, response and recovery requirements. **Table 14: Security Requirements** organizes by FG the SR Requirements, which are related to the User Needs the SMH ConOps identified.

Table 14: Security Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-SR2308-V01	Bike-Sharing	Docking Station	The docking station shall permit the locking of the bicycle frame and one wheel to the rack	SMH-UN011-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-SR2376-V01	IK	IK System	The IK system components shall be protected by firewalls and equipped with security detection, prevention, and response mechanisms to guard against intentional and unintentional threats to the integrity of the system arising from unauthorized access, computer viruses and worms, system abnormalities or faults, and other sources of potential harm.	SMH-UN003-V01	Demonstration
SMH-SR2377-V01	IK	IK System	The IK system shall accommodate multiple tiers of User data security to allow distinct privileges to access data based on User roles (e.g. public User, administrator, service accounts, City and COTA personnel, data miner, external agency, etc.).	SMH-UN001-V01 SMH-UN002-V01 SMH-UN003-V01	Demonstration
SMH-SR2378-V01	IK	IK System	The IK system shall be designed to preserve the privacy of individual public Users of the system and provide data protection, such as encrypting login credentials, payment information, and other sensitive data captured through the IK and transmitted over Wi-Fi or fiber.	SMH-UN003-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-SR2379-V01	IK	IK System Administration	<p>The IK system shall detect and automatically alert the IK system administrator when it detects a security incident such as the following:</p> <ul style="list-style-type: none"> • IK access door has been opened • Cybersecurity alert has been logged by the unified threat management software (anti-virus, malware detection, etc.) • Misuse of IK features such as recreational web browsing or attempts to intercept communications between interfaces 	SMH-UN002-V01	Test
SMH-SR2380-V01	IK	IK System Security	The integrity of IK system apps, communications and network links shall be secured through mechanisms such as password authentication.	SMH-UN003-V01	Demonstration
SMH-SR2453-V02	IK	IK System Software	All IK software and security systems shall be reviewed quarterly by IK administrator for updates or as updated as new versions become available.	SMH-UN003-V01	Inspection
SMH-SR2416-V01	Wi-Fi Enabled	Wi-Fi Monitoring	A timer shall be implemented to track the length of time a Wi-Fi connection has been active.	SMH-UN004-V01 SMH-CN2428-V01	Test
SMH-SR2419-V01	Wi-Fi Enabled	Wi-Fi Monitoring	Usage shall be tracked on all Wi-Fi technologies, per device, to validate proper usage of public wireless as per COTA internet usage policy.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-SR2421-V01	Wi-Fi Enabled	Wi-Fi Security	<p>Wi-Fi technologies shall terminate a connection if either of the following conditions have been met:</p> <ul style="list-style-type: none"> • A violation of Wi-Fi technology usage has been identified • A connection has extended beyond 15 minutes 	<p>SMH-UN004-V01</p> <p>SMH-CN2428-V01</p> <p>DMP</p> <p>DPP</p>	Test

Source: City of Columbus

3.6. NON-FUNCTIONAL REQUIREMENTS

SMH NF Requirements specify the characteristics of the overall operation of the system such as availability, maintainability, reliability, safety, environmental, human factors and ergonomics.

3.6.1. Physical Requirements

SMH PY Requirements specify the construction, durability, adaptability and environmental characteristics of the system such as installation location, device weight limits, dimension and volume limitations, temperature regulations, layout, access for maintenance, and growth and expansion characteristics. **Table 15: Physical Requirements** organizes by FG the PY Requirements, which are related to the User Needs the SMH ConOps identified.

Table 15: Physical Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-PY2305-V01	Bike Racks	Docking Station	The bike-share docking station shall be located on paved or pervious surface with a slope of less than 3 percent.	SMH-UN011-V01	Inspection
SMH-PY2278-V01	Bike Racks	Racks	The bike racks shall be located on paved or pervious surface with a slope no greater than 3 percent.	SMH-UN011-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-PY2279-V01	Bike Racks	Racks	The bike racks shall have a vertical clearance of at least 6 feet.	SMH-UN011-V01	Inspection
SMH-PY2280-V01	Bike Racks	Racks	The bike racks shall have an access aisle with a minimum width of 5 feet.	SMH-UN011-V01	Inspection
SMH-PY2306-V01	Bike-Sharing	Docking Station	The bike-share docking station shall have a vertical clearance of at least 6 feet.	SMH-UN011-V01	Inspection
SMH-PY2307-V01	Bike-Sharing	Docking Station	The bike-share docking station shall have an access aisle with a minimum width of 5 feet.	SMH-UN011-V01	Inspection
SMH-PY2312-V01	Car-Sharing	Parking Lot	The car-share parking lots shall have a vertical clearance of at least 12 feet.	SMH-UN005-V01 SMH-UN014-V01	Inspection
SMH-PY2313-V01	Car-Sharing	Parking Lot	The car-share parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.	SMH-UN005-V01 SMH-UN014-V01	Inspection
SMH-PY2369-V01	IK	IK System Environment	All portions of the IK hardware and communications system shall be locked and secured to minimize the risk of tampering or damage by unauthorized individuals.	SMH-UN002-V01	Inspection
SMH-PY2370-V01	IK	IK System Environment	IK equipment shall be oriented and ventilated in a manner consistent with applicable workplace safety, ergonomics, and operated within the environmental parameters recommended by the equipment manufacturers.	SMH-UN002-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-PY2372-V01	IK	IK System Power	The IK system power supply shall be installed in accordance with national and local electrical codes and all central hardware shall be provided with an adequate supply of continuous AC power (i.e., protected from spikes and surges).	SMH-UN002-V01	Inspection
SMH-PY3066-V01	IK	Kiosk Construction	The IK unit shall be a UL certified device.		Inspection
SMH-PY3067-V01	IK	Kiosk Construction	The IK unit shall be capable of withstanding wind loads of $v_{asd} = 80$ mph and $v_{ult} = 105$ mph for up to three seconds.		Inspection
SMH-PY3065-V01	IK	Touch-Screen Construction	The IK touch-screen interface shall be physically robust to withstand intentional or unintentional impacts normally expected for a commercial grade display accessible to the public.		Inspection
SMH-PY2386-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall have a vertical clearance of at least 12 feet.	SMH-UN005-V01 SMH-UN014-V01	Inspection
SMH-PY2387-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall have an access aisle with a minimum width of 5 feet.	SMH-UN005-V01 SMH-UN014-V01	Inspection
SMH-PY2454-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.	SMH-UN005-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-PY2398-V01	USB Charging	USB Environment	The USB hardware shall withstand indoor and outdoor environmental conditions such as high and low temperatures, humidity, rain, snow, etc.	SMH-UN009-V01	Demonstration
SMH-PY2412-V01	Wi-Fi Enabled	Wi-Fi Construction	Wi-Fi equipment shall withstand indoor and outdoor environmental conditions such as high and low temperatures, humidity, rain, snow, etc.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration

Source: City of Columbus

3.6.2. Availability and Recoverability Requirements

SMH AR Requirements define the times of day, days of year, and the overall percentage of time the system can be used and when it will not be available for use. It also specifies the recovery time objective of the system, or the time frame permitted for a system to become operational; the recovery point objective, which specifies up till what point in time shall the data be restored; and how the system is expected to restore services (e.g. failover, backups, etc.) in an event of a failure. The ability to recover quickly from a system failure or disaster depends on a blend of technologies and having a predefined plan for recovering the data on new hardware, when appropriate. **Table 16: Availability and Recovery Requirements** organizes by FG the AR Requirements, which are related to the User Needs the SMH ConOps identified.

Table 16: Availability and Recovery Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-AR2274-V02	Bike Racks	Racks	The minimum number of bike racks per SMH location should be equal to 5% of the total number of parking spaces.	SMH-UN011-V01	Inspection
SMH-AR2282-V01	Bike-Sharing	Docking Station	The docking station shall be designed for persistent always-on availability, maintaining continuous operation 24 hours a day, seven days a week, 365 days a year.	SMH-UN011-V01	Analyze

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-AR2318-V01	ECB	ECB Availability	The ECB service shall be made available 24 hours a day, seven days a week, 365 days a year.	SMH-UN007-V01 SMH-UN015-V01	Analyze
SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.	SMH-UN003-V01 SMH-UN004-V01 SMH-UN006-V01 SMH-UN007-V01 SMH-UN008-V01 SMH-UN010-V01	Analyze
SMH-AR2381-V02	Park and Ride	Park-and-Ride Facility	At least one ADA-compliant parking space shall be available at each of the SMH locations for every 25 spaces. One out of six of the ADA-compliant spaces must be van accessible. An accessible car parking space must be a minimum of 96 inches wide, and a van space must be a minimum of 132 inches wide (a van space may be 96 inches if the access aisle is 96 inches or wider).	SMH-UN005-V01 SMH-UN014-V01	Inspection
SMH-AR2399-V01	Wi-Fi Enabled	Wi-Fi Network Availability	The Wi-Fi network shall be fault tolerant and maintain continuous network uptime outside of the scheduled maintenance, 24 hours per day, 365 days per year.	SMH-UN004-V01	Analyze

Source: City of Columbus

3.6.3. Maintainability Requirements

SMH MT Requirements specify the level of effort required to locate and correct an error during operation, establishing a quantitative requirement for planned and unplanned support (e.g. mean and maximum times to repair or resolve issues, number of people and levels of skills required, support equipment necessary, maintenance staff hours, time and frequency of preventative maintenance, etc.). **Table 17: Maintainability Requirements** organizes by FG the MT Requirements, which are related to the User Needs the SMH ConOps identified.

Table 17: Maintainability Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-MT2367-V01	IK	IK System Administration	The IK system shall be designed such that administrative and maintenance activities that require the system to be taken off line can occur at periods of lowest public utilization (e.g. overnight) to maintain maximum system availability for public Users.	SMH-UN002-V01	Demonstration
SMH-MT2368-V01	IK	IK System Maintenance	The vendor shall maintain the IK and back-office IK system.	SMH-UN002-V01	Demonstration
SMH-MT2391-V01	Ride-Sharing	Vehicles	Each vehicle shall have a unique identifier that is visible to the User.	SMH-UN014-V01	Inspection
SMH-MT2397-V02	USB Charging	USB Maintenance	The IK system contractor shall perform maintenance, replacement, and annual functional testing for all USB charging ports available for public use.	SMH-UN002-V01 SMH-UN009-V01	Demonstration
SMH-MT2410-V01	Wi-Fi Enabled	Wi-Fi Network Maintenance	IK based Wi-Fi devices shall be managed and maintained by IK vendor.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration
SMH-MT3068-V01	Wi-Fi Enabled	Wi-Fi Network Maintenance	Stakeholder agency owned Wi-Fi devices shall be managed and maintained by Stakeholder agency.	SMH-UN004-V01 SMH-CN2428-V01	Demonstration

Source: City of Columbus

3.6.4. Storage and Transport Requirements

SMH ST Requirements specify the physical location and environment for the system, including designated storage facility, installation site, repair facility and requirements for transporting equipment. **Table 18: Storage and Transport Requirements** organizes by FG the ST Requirements, which are related to the User Needs the SMH ConOps identified.

Table 18: Storage and Transport Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-ST3072-V01	IK	IK System Hardware	IK hardware shall be protected from environmental perils during transport, storage, installation and operation such as moisture, humidity, weather, dust, smoke, heat, static electricity, magnetic fields and vibration.	SMH-UN002-V01	Inspection

Source: City of Columbus

3.6.5. Disposal Requirements

SMH DP Requirements specify the items related to the disposal of project/system components, due to either failure replacements, removal, end-of-life upgrade or retirement. **Table 19: Disposal Requirements** organizes by FG the DP Requirements, which are related to the User Needs the SMH ConOps identified.

Table 19: Disposal Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-DP2327-V01	IK	IK System Maintenance	Replacement and disposal of damaged parts on IK shall be performed by vendor.	SMH-UN003-V01	Demonstration

Source: City of Columbus

3.7. ENABLING REQUIREMENTS

SMH EN Requirements specify details concerning the management of information as well as the production of the system and its life-cycle sustainability, including development, integration, verification, validation and training. **Table 20: Enabling Requirements** organizes by FG the EN Requirements, which are related to the User Needs the SMH ConOps identified.

Table 20: Enabling Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-EN2317-V01	ECB	ECB Monitoring	The ECB service shall undergo end-to-end testing by vendor on an annual basis.	SMH-UN007-V01 SMH-UN015-V01	Demonstration
SMH-EN2330-V01	IK	IK System	<p>The IK system shall contain the minimum required system components for IK touch-screen products including the following:</p> <ul style="list-style-type: none"> • IK display strategically installed at six SMH locations as outlined in Chapter 2. System Description • IK software installed over an existing OS (latest version of Windows, Linux, or Raspberry Pi) as outlined by the product's system requirements • Back-office app server • Back-office database • Back-office storage drives • Back-office backup drives 	SMH-UN003-V01	Demonstration
SMH-EN2331-V02	IK	IK System Integration	<p>All hardware shall undergo testing procedures and shall include the following:</p> <ul style="list-style-type: none"> • Factory acceptance testing • Installation testing • Performance testing 	SMH-UN002-V01	Test

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-EN2332-V02	IK	IK System Scalability	The IK system shall be designed with an open architecture intended to facilitate expansion of the functionality and/or scale of the IK system as new data sources, apps, features, standards and/or technologies emerge in the future.	SMH-UN003-V01 SMH-UN008-V01 SMH-UN010-V01	Inspection
SMH-EN2333-V01	IK	Touch-Screen Interface	The IK touch-screen interface design elements and page renderings shall be flexible to enable future enhancements as information and data quantity and quality improves/evolves over time, including modular graphics, design templates controlling color schemes, fonts, backgrounds, etc., and implementation of web-development best practices, version control, notation and documentation.	SMH-UN002-V01	Demonstration

Source: City of Columbus

3.7.1. Information Management Requirements

SMH IM Requirements specify the acquisition, management and ownership of information from one or more sources, the custodianship and the distribution of that information to those who need it, and its ultimate disposition through archiving or deletion. **Table 21: Information Management Requirements** organizes by FG the IM Requirements, which are related to the User Needs the SMH ConOps identified.

Table 21: Information Management Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-IM2364-V01	IK	Data Management	The IK system shall perform daily background verification of all external web links and provide immediate notification to the IK system administrator if any link fails verification.	SMH-UN003-V01 SMH-UN006-V01 SMH-UN010-V01	Demonstration
SMH-IM2365-V01	IK	IK System Software	The IK system backup files (server clone snapshot and data backups) shall be tested quarterly for recoverability integrity.	SMH-UN002-V01 SMH-UN003-V01	Demonstration
SMH-IM3069-V01	IK	IK System Software	All IK software and security systems shall be reviewed quarterly for updates or as updated as new versions become available.	SMH-UN003-V01	Inspection
SMH-IM2366-V01	IK	Information Management	The IK system shall capture and log all data entered through the touch-screen interface for further analysis at the back office for purposes of enhancing location aware services and improving safety at each designated location.	SMH-UN001-V01 SMH-UN003-V01	Demonstration

Source: City of Columbus

3.7.2. Life-Cycle Sustainability Requirements

SMH LC Sustainability Requirements define what items the project or system will review, measure and analyze as part of its commitment to quality during the life cycle of the system. The capacity to change or enhance the product and life-cycle processes can be designed into the system

architecture to enable the cost-effective sustainment of the system throughout its life cycle. This design attribute should be established early in the system's development to provide a basis for planning each incremental development effort. **Table 22: Life-Cycle Sustainability Requirements** organizes by FG the LC Sustainability Requirements, which are related to the User Needs the SMH ConOps identified.

Table 22: Life-Cycle Sustainability Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-LC2456-V01	Bike Racks	Scalability	Bike racks should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.	SMH-UN003-V01 SMH-UN011-V01	Inspection
SMH-LC2457-V01	Bike-Sharing	Scalability	Docking stations should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.	SMH-UN003-V01 SMH-UN011-V01	Inspection
SMH-LC2458-V02	Car-Sharing	Scalability	Addition of parking spaces should be investigated if warranted by increased demand for car sharing services.	SMH-UN011-V01 SMH-UN014-V01	Inspection
SMH-LC2445-V02	Dockless Device Zone	Scalability	Additional space for dockless equipment zone should be made available by Stakeholder agency if warranted by increased demand for this service.	SMH-UN011-V01 SMH-UN014-V01	Inspection
SMH-LC2460-V02	IK	Touch-Screen Interface	The IK touch-screen interface shall be designed with flexibility to allow future expansion such as the addition of new software tools, data sources, or other needs that may emerge in the future.	SMH-UN002-V01	Demonstration

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-LC2455-V01	Park and Ride	Scalability	Additional parking spaces should be made available if warranted by increased demand for park-and-ride services.	SMH-UN011-V01 SMH-UN014-V01	Inspection
SMH-LC2459-V01	Ride-Sharing	Scalability	Additional space for pickup/drop-off zone should be made available if warranted by increased demand for ride-sharing services.	SMH-UN011-V01 SMH-UN014-V01	Inspection

Source: City of Columbus

3.8. POLICY AND REGULATION REQUIREMENTS

SMH RG Requirements specify relevant and applicable organizational policies and regulations that affect the development, operation or performance of the system (e.g. IT and labor policies, reports to regulatory agencies, health or safety criteria, etc.). This section also includes new policy and regulation imposed to realize the system. **Table 23: Policy and Regulation Requirements** are organized by FG the RG Requirements which are related to the User Needs the SMH ConOps identified.

Table 23: Policy and Regulation Requirements

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-RG2276-V01	Bike Racks	Racks	The City or Property Owner shall approve the locations of the bike racks.	SMH-UN011-V01 SMH-CN2427-V01 SMH-UN005-V01	Demonstration
SMH-RG2303-V01	Bike-Sharing	Bike-Sharing System	The docking stations shall be primarily located within the public right of way, along public streets and sidewalks, parks, trails, parking lots/garages, events venues, etc., or be located on private property, provided that the Property Owner agrees to allow 24/7 public access to the docking station.	SMH-UN005-V01 SMH-UN011-V01 SMH-CN2427-V01	Inspection

Req. ID	FG	Sub-Component	Description	References	Verification Method
SMH-RG2461-V02	Bike-Sharing	Bike-Sharing System	The City and Property Owner shall approve the locations of the docking stations.	SMH-UN005-V01 SMH-UN011-V01	Inspection
SMH-RG2447-V01	Dockless Device Zone	Dockless Parking Zone Facility	The City and Property Owner shall approve the locations of the dockless device zones.	SMH-UN005-V01	Inspection
SMH-RG2373-V01	IK	IK System Environment	Installation of IK in the City shall comply with building and construction city codes of Columbus, OH.	SMH-UN002-V01 SMH-UN003-V01	Inspection
SMH-RG2374-V02	IK	IK System Scalability	The IK system shall adhere to object-oriented design principles to facilitate replacement or modification of individual components of the IK system without impacting the overall system.	SMH-UN003-V01 SMH-UN008-V01 SMH-UN010-V01	Inspection
SMH-RG2393-V01	Ride-Sharing	Parking Lot	The locations of the ride-share parking lots shall be approved by the City and Property Owner.	SMH-UN005-V01 SMH-UN014-V01 SMH-CN2427-V01	Demonstration
SMH-RG2413-V02	Wi-Fi Enabled	Wi-Fi Usage	Property Owner shall regulate use of all SMH Wi-Fi technologies.	SMH-UN004-V01 SMH-CN2428-V01 SMH-IX2436-V01 DMP DPP	Demonstration
SMH-RG2415-V01	Wi-Fi Enabled	Wi-Fi Usage	Wi-Fi technologies shall present the User with a terms of use page designated by vendor or Property Owner to display the free Wi-Fi terms and conditions of service and prompt the User to accept.	SMH-UN004-V01 SMH-CN2428-V01	Test

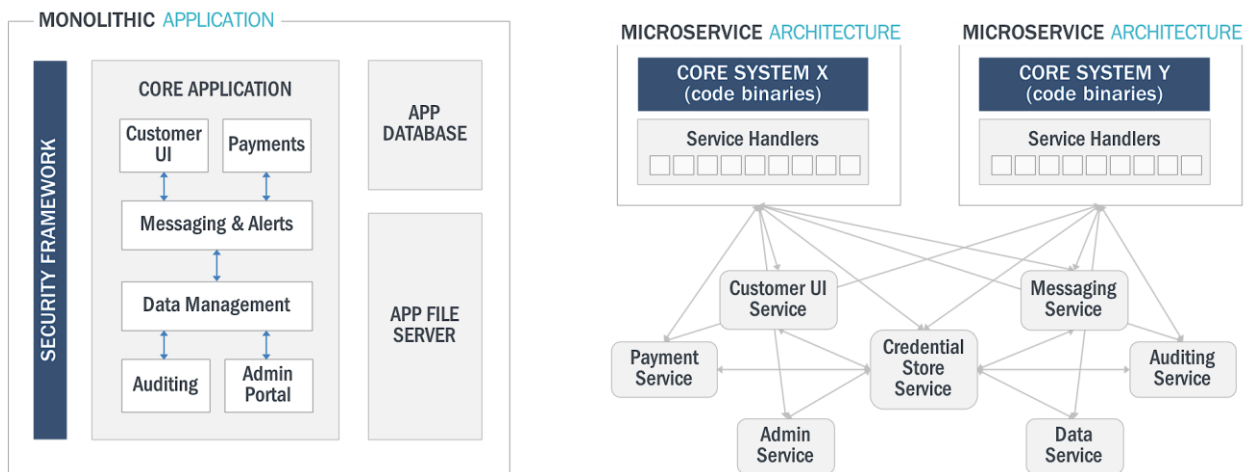
Source: City of Columbus

Chapter 4. Engineering Principles

This section describes engineering principles that guide composition of the SMH.

4.1. REFERENCE ARCHITECTURE

Historically, software systems have been developed as a single, monolithic unit constructed from a blend of hand-built custom technologies. The more features added, the more complicated the system becomes to work with contributing to high-risk, high-maintenance dependencies and a software structure that resembles spaghetti code, making software exceedingly difficult and costly to manage over time. The architecture of the Smart Columbus program breaks apart this model by designing a set of small, discrete, independent and standardized processes (i.e., FGs) that produce a service and can be plugged in for a cleaner, more efficient build. **Figure 4: Monolithic Versus Microservice Reference Architecture** provides an illustration of the reference architecture for monolithic versus services by FG.



Source: City of Columbus

Figure 4: Monolithic Versus Microservice Reference Architecture

As **Figure 4: Monolithic Versus Microservice Reference Architecture** depicts, system features in a monolithic application are hard-wired into the app and cannot be used otherwise. In theory, the entire system would need to be cloned. On the other hand, a modular design allows services to operate independently, making plug and play features easy and quick to configure, deploy and scale.

The SMH system is mindfully designed to leverage this model to create an SoS targeted for performance, agility and scalability in a manageable way. Each API establishes a set of rules and principles for how the prepackaged FG microservice will integrate. The communications bus will be built over hardware infrastructure and governed by software, which will enable FG microservices to communicate securely while operating independently.

Appendix A. Document Terminology and Conventions

A.1 REFERENCE CONVENTIONS

The following conventions are used through this document:

- Titles of externally referenced documents or sources are underlined.
- Titles of internally referenced exhibits, sections, etc., are *italicized*.

A.1.1 Requirement Numbering Convention

Each requirement contains a unique ID for traceability and configuration management. Requirements for all projects in the Smart Columbus program will follow the same convention. This identifier contains six elements partitioned into three segments, each representing an identifiable attribute of the requirement. The convention is as follows:

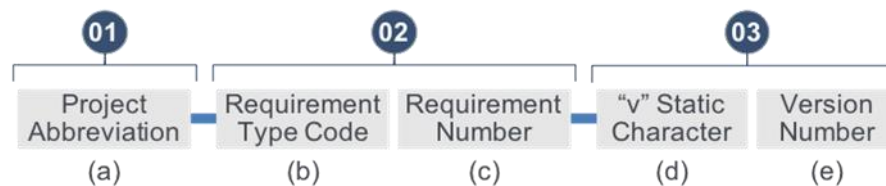


Table 24: Requirements Numbering Convention

	Description	Data Type, Casing	Number of Characters/Digits
Project Abbreviation	The designated Smart Columbus project acronym (e.g. Connected Vehicle Environment = CVE; Smart Mobility Hub = SMH; etc.)	String, upper case	Variable

	Description	Data Type, Casing	Number of Characters/Digits
Requirement Type Code	FN: Functional PR: Performance IF: Interface DR: Data SR: Security RG: Policy and Regulation PY: Physical AR: Availability and Recovery MT: Maintainability ST: Storage and Transport DP: Disposal IM: Information Management LC: Life-Cycle Sustainability CN: Constraints	String, upper case	2
Requirement Number	An integer incrementing by one, indicating the number of requirements established.	Integer	4
"v" Static Character	Static letter "v" represents the requirement version.	Character	1
Version Number	An integer incrementing by one, indicating the number of revisions made to the requirement.	Integer	2

Source: City of Columbus

An example of a FN Requirement for the Transit Pedestrian Indicator app under the CVE would be "SMH-SR2353-v01" in which the following applies:

- "SMH" is the Project Abbreviation.
- "SR2353" is the requirement type code coupled with the 4-digit Requirement Number.
- "v01" is the static "v" coupled with the 2-digit version number.

A.1.2 Requirements Table Headings

The columns in the requirements tables throughout this document have the following definitions:

- **Req. ID:** A unique identifier providing a reference to a specific requirement.
- **Description:** Statement of the business function or conditions the system must meet.
- **Reference:** Additional requirement(s), documents, standards, etc., relating to the function or condition the system must meet.

A.1.3 Conformance

Requirements listed in this document use the following terminology:

- **SHALL:** indicates the definition is an absolute requirement of the specification.

- **SHALL NOT:** Indicates the definition is an absolute prohibition of the specification.
- **SHOULD (RECOMMENDED):** Indicates there may exist valid reasons or circumstances to omit a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- **SHOULD NOT (NOT RECOMMENDED):** Indicates there may exist valid reasons or circumstances when a particular function or condition is acceptable or even useful, but the full implications should be understood, and the case carefully weighed before implementing any function or condition described with this label.
- **MAY (OPTIONAL):** Indicates an item is truly optional. Some vendors may choose to include or implement Optional Requirements to add value or enhance their overall product while other vendors may omit the same Optional Requirement to reduce cost, increase time to market, etc., An implementation which does not include an Optional Requirement **SHALL** be interoperable with implementations which does include the Optional Requirement, though perhaps with reduced functionality. In the same vein an implementation which does include an Optional Requirement **SHALL** be interoperable with an implementation which does not include the Optional Requirement (with the exception for the feature the option provides).

Appendix B. Requirements by System Function Groups

Table 25: Requirements Organized by Functional Groups organizes requirements defined in **Chapter 3. System Requirements** into their FGs. This organization is intended for ease of use and quick reference during system design.

Table 25: Requirements Organized by Functional Groups

FG	Req. ID	Description
Bike Racks	SMH-AR2274-V02	The minimum number of bike racks per SMH location should be equal to 5% of the total number of parking spaces.
Bike Racks	SMH-PR2275-V01	The placement of bike racks shall not impede flow of vehicle or pedestrian traffic.
Bike Racks	SMH-RG2276-V01	The City or Property Owner shall approve the locations of the bike racks.
Bike Racks	SMH-PY2278-V01	The bike racks shall be located on paved or pervious surface with a slope no greater than 3 percent.
Bike Racks	SMH-PY2279-V01	The bike racks shall have a vertical clearance of at least 6 feet.
Bike Racks	SMH-PY2280-V01	The bike racks shall have an access aisle with a minimum width of 5 feet.
Bike-Sharing	SMH-AR2282-V01	The docking station shall be designed for persistent always-on availability, maintaining continuous operation 24 hours a day, seven days a week, 365 days a year.
Bike-Sharing	SMH-DR2283-V02	The SMH shall provide an interface to the bike-share company.
Bike-Sharing	SMH-DR2284-V01	The bike-share company shall maintain and share monthly with the City a list of deployed bikes at the SMH, listed by unique identifiers.
Bike-Sharing	SMH-DR2285-V01	The bike-share company shall maintain and share month with the City a list of lost, stolen and vandalized bikes.
Bike-Sharing	SMH-DR2286-V01	The bike-share company shall maintain and share monthly with the City a record of maintenance activities including but not limited to identification number and maintenance performed.
Bike-Sharing	SMH-FN2290-V02	Bike-share docking station shall be installed at SMH locations.
Bike-Sharing	SMH-FN2291-V02	The docking station shall accept a secure code generated (through verified payment via MMTA and CPS) for unlocking the bikes.

FG	Req. ID	Description
IK	SMH-FN2292-V02	The IK shall allow the User to enter trip feedback such as the operational status of the just docked bike. The operational status could include the need for preventative and repair maintenance.
Bike-Sharing	SMH-FN2293-V01	The docking station shall be solar powered.
Bike-Sharing	SMH-FN2294-V02	The docking station shall report the number of bikes currently docked to the OS.
Bike-Sharing	SMH-FN2296-V01	The docking station shall track the date and time when a bike is unlocked.
Bike-Sharing	SMH-FN2297-V01	The docking station shall track the date and time when a bike is locked.
Bike-Sharing	SMH-FN2298-V02	The docking station shall report the operational status of the docking station to the OS.
Bike-Sharing	SMH-PR2301-V02	The bike-share docking station shall not impede flow of vehicle or pedestrian traffic.
Bike-Sharing	SMH-PR2302-V02	Bikes that are parked in violation of City codes or are vandalized or inoperable shall be reported by SMH owning agency to bike-share company.
Bike-Sharing	SMH-RG2303-V01	The docking stations shall be primarily located within the public right of way, along public streets and sidewalks, parks, trails, parking lots/garages, events venues, etc., or be located on private property, provided that the Property Owner agrees to allow 24/7 public access to the docking station.
Bike Racks	SMH-PY2305-V01	The bike-share docking station shall be located on paved or pervious surface with a slope of less than three percent (3%).
Bike-Sharing	SMH-PY2306-V01	The bike-share docking station shall have a vertical clearance of at least 6 feet.
Bike-Sharing	SMH-PY2307-V01	The bike-share docking station shall have an access aisle with a minimum width of 5 feet.
Bike-Sharing	SMH-SR2308-V01	The docking station shall permit the locking of the bicycle frame and one wheel to the rack.
Car-Sharing	SMH-FN2310-V02	The SMH facility shall provide designated parking spaces for car-share vehicles.
Car-Sharing	SMH-PY2312-V01	The car-share parking lots shall have a vertical clearance of at least 12 feet.
Car-Sharing	SMH-PY2313-V01	The car-share parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.
Comprehensive Trip Planning	SMH-IF2315-V01	The CPS app shall be deployed and available for use at the IK display through the MMTPA app.
Comprehensive Trip Planning	SMH-IF2316-V01	The MMTPA app shall be deployed and available for use at the IK display.

FG	Req. ID	Description
ECB	SMH-EN2317-V01	The ECB service shall undergo end-to-end testing by vendor on an annual basis.
ECB	SMH-AR2318-V01	The ECB service shall be made available 24 hours a day, seven days a week, 365 days a year.
ECB	SMH-DR2320-V01	ECB shall record the time, date, and location upon activation.
ECB	SMH-DR2321-V02	The street address and GPS coordinates of the SMH facility shall be sent to the CECC to notify dispatchers of location of the help request.
ECB	SMH-FN2322-V02	The ECB system shall be capable of two-way voice communications and transmitting GPS location coordinates to the CECC.
ECB	SMH-FN2323-V02	When an ECB alarm is triggered, the ECB system shall perform the following functions: <ul style="list-style-type: none"> • Establish a bidirectional voice-enabled communication medium from the IK to the CECC • Activate the IK camera and record video to local DVR
ECB	SMH-IF2325-V01	An ECB interface shall be designed for public Users to alert the CECC officials in an emergency situation.
IK	SMH-AR2326-V02	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.
IK	SMH-DP2327-V01	Replacement and disposal of damaged parts on IK shall be performed by vendor.
IK	SMH-DR2328-V01	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning information, real-time service information, transit bulletins and maps.
IK	SMH-DR2329-V01	The IK touch-screen interface content shall include static and real-time Traveler information to the extent that each data element is available from the OS retrieved through the GTFS real-time data feed. The screen should display arrivals in the next hour for that location.

FG	Req. ID	Description
IK	SMH-EN2330-V01	<p>The IK system shall contain the minimum required system components for IK touch-screen products including the following:</p> <ul style="list-style-type: none"> • IK display strategically installed at six SMH locations as outlined in Chapter 2. System Description • IK software installed over an existing OS (latest version of Windows, Linux, or Raspberry Pi) as outlined by the product's system requirements • Back-office app server • Back-office database • Back-office storage drives • Back-office backup drives
IK	SMH-EN2331-V02	<p>All hardware shall undergo testing procedures and shall include the following:</p> <ul style="list-style-type: none"> • Factory acceptance testing • Installation testing • Performance testing
IK	SMH-EN2332-V02	<p>The IK system shall be designed with an open architecture intended to facilitate expansion of the functionality and/or scale of the IK system as new data sources, apps, features, standards and/or technologies emerge in the future.</p>
IK	SMH-EN2333-V01	<p>The IK touch-screen interface design elements and page renderings shall be flexible to enable future enhancements as information and data quantity and quality improves/evolves over time, including modular graphics, design templates controlling color schemes, fonts, backgrounds, etc., and implementation of web-development best practices, version control, notation, and documentation.</p>
IK	SMH-FN2335-V02	<p>The IK system shall support multiple languages. At a minimum, it shall support English and Spanish languages.</p>
IK	SMH-FN2336-V01	<p>The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following:</p> <ul style="list-style-type: none"> • Inability to communicate through an interface • Inability to send/receive data • Service requests and queries extend longer than 10 seconds • Invalid or missing data has been detected
IK	SMH-FN2337-V02	<p>The IK system software shall be capable of the automatic resolution of system abnormalities, security incidents, faults, and errors (to the extent possible).</p>

FG	Req. ID	Description
IK	SMH-FN2338-V01	All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.
IK	SMH-FN2339-V02	All IK system errors, warnings, and self-correcting actions shall be stored locally in ASCII text formatted log files at the IK for a minimum of 24 hours and sent to the OS at regularly scheduled intervals to ensure there are no gaps in log file data.
IK	SMH-FN2340-V02	The IK system shall reboot following a power loss.
IK	SMH-FN2341-V02	The IK system shall limit the use of internet to the approved apps, services and features offered through the interactive display, including trip-planning and payment via the MMTPA/CPS.
IK	SMH-FN2342-V01	The IK system shall be designed for unattended operation under normal circumstances, exclusive of manual data entry, public User access, and routine administrative functions.
IK	SMH-FN2343-V02	The IK system shall send SMH location, trip mode, and timestamp data to OS for all trips generated at the respective IK.
IK	SMH-FN2344-V02	The IK touch-screen content shall be configurable for services offered at each location.
IK	SMH-FN2345-V01	The IK touch-screen interface shall prohibit unauthorized Users from accessing the OS or any GUI, IK, or network controls or settings, as outlined in the DMP and DPP.
IK	SMH-FN2346-V01	The IK touch-screen interface and its controls shall conform to the applicable accessibility requirements of the ADA.
IK	SMH-FN2347-V01	The IK touch-screen interface shall be designed to withstand intentional or unintentional misuse (e.g. repeated tapping of keys) without system malfunction.
IK	SMH-FN2348-V01	The IK touch-screen interface shall maintain a unique identifier for each IK to diagnose system malfunctions, provide information to the ECB service, as well as customize content per SMH location (location awareness).
IK	SMH-FN2349-V02	The IK touch-screen interface shall not permit access to data deemed to be confidential or inappropriate for public use, as outlined in the DMP and DPP.
IK	SMH-FN2350-V01	The IK touch-screen interface shall utilize a commercial off-the-shelf KOS that resides on top of the OS (latest version of Windows, Linux, or Raspberry Pi), in accordance with the software requirements outlined in this SyRS.

FG	Req. ID	Description
IK	SMH-FN2351-V01	Where source data is not available in real time, the touch screen shall utilize PDF and/or service board websites in the short term such as transit route maps, location-specific services or tourism information, etc.
IK	SMH-FN2352-V02	The IK touch screen may incorporate a demonstration of the use of the screen, general information, and/or animation while in standby mode.
IK	SMH-FN2353-V02	The IK touch screen shall support a standby mode that displays a static or animated screen or series of screens.
IK	SMH-FN2354-V01	Users shall exit standby mode by touching the screen or activating any other IK controls. When standby mode is exited, the system shall display an initial start page with links to various submenus and content pages that allow the User to reach all information contained within the system.
IK	SMH-IF2355-V02	The IK shall provide a secured, direct-connect interface to facilities for operational administration.
IK	SMH-IF2356-V02	The IK system shall provide access to a web- or app-based interface with the MMTPA/CPS system to provide CTP and trip-booking services and disseminate information regarding Mobility Providers, parking providers, and availability of various modes of transportation to the traveling public.
IK	SMH-IF2357-V01	The interface to other SMH services offered at the SMH facility (e.g. car-, bike- and ride-sharing) shall be provided through the MMTPA/CPS interface, which provides CTP services for the SMH Traveler.
IK	SMH-IF2359-V02	The IK touch screen shall provide Users with a link to display any current alerts that describe events having a significant impact on transportation services.
IK	SMH-IF2360-V01	The IK touch screen shall provide Users with a link to the COTA Real-Time Display.
IK	SMH-IF2361-V02	The IK touch screen shall provide Users with a link to various static maps within the SMH demonstration area.
IK	SMH-IF2362-V01	The IK touch screen shall provide Users with a link to Visitor Information, which includes location-aware content.
IK	SMH-IF2363-V01	The IK should include a minimum of four USB ports for charging mobile devices to SMH Travelers.
IK	SMH-IM2364-V01	The IK system shall perform daily background verification of all external web links and provide immediate notification to the IK system administrator if any link fails verification.

FG	Req. ID	Description
IK	SMH-IM2365-V01	The IK system backup files (server clone snapshot and data backups) shall be tested quarterly for recoverability integrity.
IK	SMH-IM2366-V01	The IK system shall capture and log all data entered through the touch-screen interface for further analysis at the back office for purposes of enhancing location aware services and improving safety at each designated location.
IK	SMH-MT2367-V01	The IK system shall be designed such that administrative and maintenance activities that require the system to be taken off line can occur at periods of lowest public utilization (e.g. overnight) to maintain maximum system availability for public Users.
IK	SMH-MT2368-V01	The vendor shall maintain the IK and back-office IK system.
IK	SMH-PY2369-V01	All portions of the IK hardware and communications system shall be locked and secured to minimize the risk of tampering or damage by unauthorized individuals.
IK	SMH-PY2370-V01	IK equipment shall be oriented and ventilated in a manner consistent with applicable workplace safety, ergonomics, and operated within the environmental parameters recommended by the equipment manufacturers.
IK	SMH-PY2372-V01	The IK system power supply shall be installed in accordance with national and local electrical codes and all central hardware shall be provided with an adequate supply of continuous AC power (i.e., protected from spikes and surges).
IK	SMH-RG2373-V01	Installation of IK in the City shall comply with building and construction city codes of Columbus, OH
IK	SMH-RG2374-V02	The IK system shall adhere to object-oriented design principles to facilitate replacement or modification of individual components of the IK system without impacting the overall system.
IK	SMH-SR2376-V01	The IK system components shall be protected by firewalls and equipped with security detection, prevention, and response mechanisms to guard against intentional and unintentional threats to the integrity of the system arising from unauthorized access, computer viruses and worms, system abnormalities or faults, and other sources of potential harm.
IK	SMH-SR2377-V01	The IK system shall accommodate multiple tiers of User data security to allow distinct privileges to access data based on User roles (e.g. public User, administrator, service accounts, City and COTA personnel, data miner, external agency, etc.)

FG	Req. ID	Description
IK	SMH-SR2378-V01	The IK system shall be designed to preserve the privacy of individual public Users of the system and provide data protection, such as encrypting login credentials, payment information, and other sensitive data captured through the IK and transmitted over Wi-Fi or fiber.
IK	SMH-SR2379-V01	The IK system shall detect and automatically alert the IK system administrator when it detects a security incident such as the following: <ul style="list-style-type: none"> • IK access door has been opened • Cybersecurity alert has been logged by the unified threat management software (anti-virus, malware detection, etc.) • Misuse of IK features such as recreational web browsing or attempts to intercept communications between interfaces
IK	SMH-SR2380-V01	The integrity of IK system apps, communications and network links shall be secured through mechanisms such as password authentication.
Park and Ride	SMH-AR2381-V02	At least one ADA-compliant parking space shall be available at each of the SMH locations for every 25 spaces. One out of six of the ADA-compliant spaces must be van accessible. An accessible car parking space must be a minimum of 96 inches wide, and a van space must be a minimum of 132 inches wide (a van space may be 96 inches if the access aisle is 96 inches or wider).
Park and Ride	SMH-PR2382-V02	The park and ride parking spaces shall allow 24/7 public access to the vehicles.
Park and Ride	SMH-PR2383-V01	The park-and-ride facility shall allow parked vehicles to maintain unimpeded access to roadway/driveway entrances and exits.
Park and Ride	SMH-PR2384-V02	The park and ride designated parking spaces shall be located in locations that do not impede the regular flow of travel in the public right of way.
Park and Ride	SMH-PR2385-V01	The park-and-ride facility shall ensure the vehicles not be parked in a way that impedes the 5 feet clearance on sidewalks needed for ADA compliance.
Park and Ride	SMH-PY2386-V01	The park-and-ride facility shall have a vertical clearance of at least 12 feet.
Park and Ride	SMH-PY2387-V01	The park-and-ride facility shall have an access aisle with a minimum width of 5 feet
Ride-Sharing	SMH-FN2388-V02	Curb space shall be designated for pickup from ride-share and taxi services.
Ride-Sharing	SMH-IF2389-V01	The ride-sharing service shall be provided through the MMTA app.

FG	Req. ID	Description
Ride-Sharing	SMH-MT2391-V01	Each vehicle shall have a unique identifier that is visible to the User.
Ride-Sharing	SMH-PR2392-V02	The City and Property Owner may designate parking areas or restrict car parking within certain areas.
Ride-Sharing	SMH-RG2393-V01	The locations of the ride-share parking lots shall be approved by the City and Property Owner.
USB Charging	SMH-FN2394-V01	USB charging outlets shall be USB Type A 3.X standard.
USB Charging	SMH-FN2395-V02	The USB charging service shall deliver free charging for Travelers to charge mobile devices.
USB Charging	SMH-MT2397-V02	The IK system contractor shall perform maintenance, replacement, and annual functional testing for all USB charging ports available for public use.
USB Charging	SMH-PY2398-V01	The USB hardware shall withstand indoor and outdoor environmental conditions such as high and low temperatures, humidity, rain, snow, etc.
Wi-Fi Enabled	SMH-AR2399-V01	The Wi-Fi network shall be fault tolerant and maintain continuous network uptime outside of the scheduled maintenance, 24 hours per day, 365 days per year.
Wi-Fi Enabled	SMH-DR2400-V01	SMH Wi-Fi enabled technologies shall track number of clients per access point.
Wi-Fi Enabled	SMH-DR2401-V01	SMH Wi-Fi technologies shall log User connection time stamp, IP, MAC address, OS, device manufacturer, sites visited, and connection status and length.
Wi-Fi Enabled	SMH-FN2403-V02	SMH shall permit electronic devices equipped with internet capabilities (phone, tablet, computer) to connect to the internet via Wi-Fi.
Wi-Fi Enabled	SMH-FN2405-V01	SMH may consider IEEE 802.11ai to enable FILS methods to enhance End-User experience in high-density WLAN environments.
Wi-Fi Enabled	SMH-FN2406-V01	Wi-Fi technologies shall follow IEEE 802.11 b/g/n standards to enable multi-gigabit throughput in the 2.4 GHz, 5GHz and 60GHz spectrum bands.
Wi-Fi Enabled	SMH-FN2407-V01	An active session with internet access shall be provisioned for the User when that User accepts the terms and conditions of service.
Wi-Fi Enabled	SMH-FN2408-V01	An active session with internet access shall not be provisioned for the User when that User declines the terms and conditions of service.
Wi-Fi Enabled	SMH-IF2409-V01	Wi-Fi services shall be provided through the IK.
Wi-Fi Enabled	SMH-MT2410-V01	IK based Wi-Fi devices shall be managed and maintained by IK vendor.
Wi-Fi Enabled	SMH-PR2411-V02	Wi-Fi technologies shall support a minimum of 10 simultaneously connected Users.

FG	Req. ID	Description
Wi-Fi Enabled	SMH-PY2412-V01	Wi-Fi equipment shall withstand indoor and outdoor environmental conditions such as high and low temperatures, humidity, rain, snow, etc.
Wi-Fi Enabled	SMH-RG2413-V02	Property Owner shall regulate use of all SMH Wi-Fi technologies.
Wi-Fi Enabled	SMH-RG2414-V01	Users may be redirected to a landing page designated by vendor or Property Owner when connecting to Wi-Fi technologies once the User accepts the terms and conditions of service.
Wi-Fi Enabled	SMH-RG2415-V01	Wi-Fi technologies shall present the User with a terms of use page designated by vendor or Property Owner to display the free Wi-Fi terms and conditions of service and prompt the User to accept.
Wi-Fi Enabled	SMH-SR2416-V01	A timer shall be implemented to track the length of time a Wi-Fi connection has been active.
Wi-Fi Enabled	SMH-SR2419-V01	Usage shall be tracked on all Wi-Fi technologies, per device, to validate proper usage of public wireless as per COTA internet usage policy.
Wi-Fi Enabled	SMH-SR2421-V01	Wi-Fi technologies shall terminate a connection if either of the following conditions have been met: <ul style="list-style-type: none"> • A violation of Wi-Fi technology usage has been identified • A connection has extended beyond 15 minutes
IK	SMH-FN2441-V01	The IK system shall reset back to the default language at the end of a User session or after a maximum two minutes of inactivity.
Dockless Device Zone	SMH-FN2442-V01	Designated paved area shall be made available for dockless devices such as scooters and ebikes at the SMH facility.
Dockless Device Zone	SMH-FN2443-V01	Boundaries, symbols and/or text description of designated area for dockless devices shall be clearly outlined on pavement with paint.
Dockless Device Zone	SMH-LC2445-V02	Additional space for dockless equipment zone should be made available by Stakeholder agency if warranted by increased demand for this service.
Dockless Device Zone	SMH-RG2447-V01	The City and Property Owner shall approve the locations of the dockless device zones.
IK	SMH-FN2448-V01	Current transit route maps, location-specific services or tourism information, etc., shall be saved on the KOS, so data is available to be displayed even during periods of communication failure.
IK	SMH-FN2449-V01	IK system files shall be “revolving” or self-appending so that old data is continually overwritten, and system data does not reach capacity of available memory.

FG	Req. ID	Description
Dockless Device Zone	SMH-PR2450-V02	The dockless parking zone shall not be laid out in a manner which impedes the flow of vehicle or pedestrian traffic.
IK	SMH-PR2452-V01	IK displays shall meet City outdoor advertisement brightness standards and be capable of adjusting brightness based on varying outside light conditions, according to <u>Columbus Ordinance 3377.08 – Illumination and Special Effects</u> .
IK	SMH-SR2453-V02	All IK software and security systems shall be reviewed by IK administrator quarterly for updates or as updated as new versions become available.
Park and Ride	SMH-PY2454-V01	The park-and-ride facility parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.
Park and Ride	SMH-LC2455-V01	Additional parking spaces should be made available if warranted by increased demand for park-and-ride services.
Bike Racks	SMH-LC2456-V01	Bike racks should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.
Bike-Sharing	SMH-LC2457-V01	Docking stations should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.
Car-Sharing	SMH-LC2458-V02	Addition of parking spaces should be investigated if warranted by increased demand for car sharing services.
Ride-Sharing	SMH-LC2459-V01	Additional space for pickup/drop-off zone should be made available if warranted by increased demand for ride-sharing services.
IK	SMH-LC2460-V02	The IK touch-screen interface shall be designed with flexibility to allow future expansion such as the addition of new software tools, data sources, or other needs that may emerge in the future.
Bike-Sharing	SMH-RG2461-V02	The City and Property Owner shall approve the locations of the docking stations.
Car-Sharing	SMH-FN3057-V01	Car-sharing provider utilizing SMH facility shall report the number of available shared vehicles located at each SMH location to the OS.
IK	SMH-FN3058-V01	The IK system shall maintain English as its default language setting and provide Users the ability to select a language of choice.
IK	SMH-FN3059-V01	The IK touch-screen display shall enter standby mode after a configurable period of time (default one minute) of inactivity.
IK	SMH-FN3061-V01	The IK shall include an integrated security camera and DVR.

FG	Req. ID	Description
IK	SMH-PR3062-V01	The interface display shall be at least 55" diagonal.
Wi-Fi Enabled	SMH-PR3063-V01	The upload and download speed on each Wi-Fi access point shall be tracked, monitored, and changed, as necessary.
Wi-Fi Enabled	SMH-PR3064-V01	The load on each Wi-Fi access point shall be monitored and flagged when there is an overloading issue associated with the access point.
IK	SMH-PY3065-V01	The IK touch-screen interface shall be physically robust to withstand intentional or unintentional impacts normally expected for a commercial grade display accessible to the public.
IK	SMH-PY3066-V01	The IK unit shall be a UL certified device.
IK	SMH-PY3067-V01	The IK unit shall be capable of withstanding wind loads of $v_{asd} = 80\text{mph}$ and $v_{ult} = 105\text{mph}$ for up to 3 seconds.
Wi-Fi Enabled	SMH-MT3068-V01	Stakeholder agency owned Wi-Fi devices shall be managed and maintained by Stakeholder agency.
IK	SMH-IM3069-V01	All IK software and security systems shall be reviewed quarterly for updates or as updated as new versions become available.
Bike-Sharing	SMH-FN3070-V01	The docking station shall support a bicycle in a stable upright position.
Bike Racks	SMH-FN3071-V01	The bike racks shall support a bicycle in a stable upright position.
IK	SMH-ST3072-V01	IK hardware shall be protected from environmental perils during transport, storage, installation and operation such as moisture, humidity, weather, dust, smoke, heat, static electricity, magnetic fields and vibration.

Source: City of Columbus

Appendix C. Relationship Matrices

Table 26: User Needs Mapped to Requirements, Constraints and System Interfaces contains a preliminary list of project specific data elements identified as required for the proper functionality of the system. The list is not meant to be exhaustive at this time given the evolutionary nature of agile projects, rather provides insight into where the data may be retrieved.

Table 26: User Needs Mapped to Requirements, Constraints and System Interfaces

USER NEED: SMH-UN001-V01		USER: CITY		
Title:	Data Collection			
Description:	The City lacks the ability to collect detailed travel data to make informed and effective planning decisions.			
Priority:	Essential			
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
DR	SMH-DR2283-V02	Bike-Sharing	Bike-Sharing System	The SMH shall provide an interface to the bike-share company.
DR	SMH-DR2284-V01	Bike-Sharing	Bike-Sharing System	The bike-share company shall maintain and share monthly with the City a list of deployed bikes at the SMH, listed by unique identifiers.
DR	SMH-DR2328-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning information, real-time service information, transit bulletins and maps.
DR	SMH-DR2329-V01	IK	Touch-Screen Interface	The IK touch-screen interface content shall include static and real-time Traveler information to the extent that each data element is available from the OS retrieved through the GTFS real-time data feed. The screen should display arrivals in the next hour for that location.
FN	SMH-FN2294-V02	Bike-Sharing	Docking Station	The docking station shall report the number of bikes currently docked to the OS.
FN	SMH-FN2296-V01	Bike-Sharing	Docking Station	The docking station shall track the date and time when a bike is unlocked.
FN	SMH-FN2297-V01	Bike-Sharing	Docking Station	The docking station shall track the date and time when a bike is locked.

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2298-V02	Bike-Sharing	Docking Station	The docking station shall report the operational status of the docking station to the OS.
FN	SMH-FN2336-V01	IK	IK System Administration	<p>The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following:</p> <ul style="list-style-type: none"> • Inability to communicate through an interface • Inability to send/receive data • Service requests and queries extend longer than 10 seconds • Invalid or missing data has been detected
FN	SMH-FN2344-V02	IK	Touch-Screen Interface	The IK touch-screen content shall be configurable for services offered at each location.
IM	SMH-IM2366-V01	IK	Information Management	The IK system shall capture and log all data entered through the touch-screen interface for further analysis at the back office for purposes of enhancing location aware services and improving safety at each designated location.
SR	SMH-SR2377-V01	IK	IK System	The IK system shall accommodate multiple tiers of User data security to allow distinct privileges to access data based on User roles (e.g. public User, administrator, service accounts, City and COTA personnel, data miner, external agency, etc.)
FN	SMH-FN3070-V01	Bike-Sharing	Docking Station	The docking station shall support a bicycle in a stable upright position.
FN	SMH-FN3071-V01	Bike Racks	Racks	The bike racks shall support a bicycle in a stable upright position.

USER NEED: SMH-UN002-V01		USER: CITY		
Title:		Maintenance and Operations		
Description:		The City needs to cooperate with Property Owners/Stakeholders to provide resources for maintenance and operations of facilities and IKs.		
Priority:		Essential		
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
DR	SMH-DR2285-V01	Bike-Sharing	Bike-Sharing System	The bike-share company shall maintain and share monthly with the City a list of lost, stolen and vandalized bikes.
DR	SMH-DR2286-V01	Bike-Sharing	Bike-Sharing System	The bike-share company shall maintain and share monthly with the City a record of maintenance activities including but not limited to identification number and maintenance performed.
EN	SMH-EN2331-V02	IK	IK System Integration	All hardware shall undergo testing procedures and shall include the following: <ul style="list-style-type: none">• Factory acceptance testing• Installation testing• Performance testing.
EN	SMH-EN2333-V01	IK	Touch-Screen Interface	The IK touch-screen interface design elements and page renderings shall be flexible to enable future enhancements as information and data quantity and quality improves/evolves over time, including modular graphics, design templates controlling color schemes, fonts, backgrounds, etc., and implementation of web-development best practices, version control, notation and documentation.
FN	SMH-FN2336-V01	IK	IK System Administration	The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following: <ul style="list-style-type: none">• Inability to communicate through an interface• Inability to send/receive data• Service requests and queries extend longer than 10 seconds• Invalid or missing data has been detected
FN	SMH-FN2337-V02	IK	IK System Administration	The IK system software shall be capable of the automatic resolution of system abnormalities, security incidents, faults, and errors (to the extent possible).

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2339-V02	IK	IK System Monitoring	All IK system errors, warnings, and self-correcting actions shall be stored locally in ASCII text formatted log files at the IK for a minimum of 24 hours and sent to the OS at regularly scheduled intervals to ensure there are no gaps in log file data.
FN	SMH-FN2342-V01	IK	IK Display	The IK system shall be designed for unattended operation under normal circumstances, exclusive of manual data entry, public User access, and routine administrative functions.
FN	SMH-FN2345-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall prohibit unauthorized Users from accessing the OS or any GUI, IK, or network controls or settings, as outlined in the DMP and DPP.
FN	SMH-FN2347-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall be designed to withstand intentional or unintentional misuse (e.g. repeated tapping of keys) without system malfunction.
FN	SMH-FN2348-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall maintain a unique identifier for each IK to diagnose system malfunctions, provide information to the ECB service, as well as customize content per SMH location (location awareness).
FN	SMH-FN2349-V02	IK	Touch-Screen Interface	The IK touch-screen interface shall not permit access to data deemed to be confidential or inappropriate for public use, as outlined in the DMP and DPP.
FN	SMH-FN2350-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall utilize a commercial off-the-shelf KOS that resides on top of the OS (latest version of Windows, Linux, or Raspberry Pi), in accordance with the software requirements outlined in this SyRS.
MT	SMH-MT2367-V01	IK	IK System Administration	The IK system shall be designed such that administrative and maintenance activities that require the system to be taken off line can occur at periods of lowest public utilization (e.g. overnight) to maintain maximum system availability for public Users.
MT	SMH-MT2368-V01	IK	IK System Maintenance	The vendor shall maintain the IK and back-office IK system.

Requirement Type Code	Identifier	FG	Sub-Component	Description
MT	SMH-MT2397-V02	USB Charging	USB Maintenance	The IK system contractor shall perform maintenance, replacement, and annual functional testing for all USB charging ports available for public use.
IM	SMH-IM2365-V01	IK	IK System Software	The IK system backup files (server clone snapshot and data backups) shall be tested quarterly for recoverability integrity.
PY	SMH-PY2369-V01	IK	IK System Environment	All portions of the IK hardware and communications system shall be locked and secured to minimize the risk of tampering or damage by unauthorized individuals.
PY	SMH-PY2370-V01	IK	IK System Environment	IK equipment shall be oriented and ventilated in a manner consistent with applicable workplace safety, ergonomics, and operated within the environmental parameters recommended by the equipment manufacturers.
PY	SMH-PY2372-V01	IK	IK System Power	The IK system power supply shall be installed in accordance with national and local electrical codes and all central hardware shall be provided with an adequate supply of continuous AC power (i.e., protected from spikes and surges).
RG	SMH-RG2373-V01	IK	IK System Environment	Installation of IK in the City shall comply with building and construction city codes of Columbus, OH.
SR	SMH-SR2377-V01	IK	IK System	The IK system shall accommodate multiple tiers of User data security to allow distinct privileges to access data based on User roles (e.g. public User, administrator, service accounts, City and COTA personnel, data miner, external agency, etc.).
SR	SMH-SR2379-V01	IK	IK System Administration	<p>The IK system shall detect and automatically alert the IK system administrator when it detects a security incident such as the following:</p> <ul style="list-style-type: none"> • IK access door has been opened • Cybersecurity alert has been logged by the unified threat management software (anti-virus, malware detection, etc.) • Misuse of IK features such as recreational web browsing or attempts to intercept communications between interfaces

Requirement Type Code	Identifier	FG	Sub-Component	Description
LC	SMH-LC2460-V02	IK	Touch-Screen Interface	The IK touch-screen interface shall be designed with flexibility to allow future expansion such as the addition of new software tools, data sources, or other needs that may emerge in the future.
ST	SMH-ST3072-V01	IK	IK System Hardware	IK hardware shall be protected from environmental perils during transport, storage, installation, and operation such as moisture, humidity, weather, dust, smoke, heat, static electricity, magnetic fields, and vibration.

USER NEED:	SMH-UN003-V01	USER: TRAVELER
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Title:	User Interface Device
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Description:	Travelers need IKs at SMH locations to access MMTPA/CPS from which they can plan, manage and pay for multimodal travel trips and parking options throughout Columbus.
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Priority:	Essential
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Related Requirements, Constraints and System Interfaces

Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.
DP	SMH-DP2327-V01	IK	IK System Maintenance	Replacement and disposal of damaged parts on IK shall be performed by vendor.
DR	SMH-DR2328-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning information, real-time service information, transit bulletins and maps.

Requirement Type Code	Identifier	FG	Sub-Component	Description
EN	SMH-EN2330-V01	IK	IK System	<p>The IK system shall contain the minimum required system components for IK touch-screen products including the following:</p> <ul style="list-style-type: none"> • IK display strategically installed at six SMH locations as outlined in Chapter 2. System Description • IK software installed over an existing OS (latest version of Windows, Linux, or Raspberry Pi) as outlined by the product's system requirements • Back-office app server • Back-office database • Back-office storage drives • Back-office backup drives
EN	SMH-EN2332-V02	IK	IK System Scalability	<p>The IK system shall be designed with an open architecture intended to facilitate expansion of the functionality and/or scale of the IK system as new data sources, apps, features, standards and/or technologies emerge in the future.</p>
FN	SMH-FN2336-V01	IK	IK System Administration	<p>The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following:</p> <ul style="list-style-type: none"> • Inability to communicate through an interface • Inability to send/receive data • Service requests and queries extend longer than 10 seconds • Invalid or missing data has been detected
FN	SMH-FN2338-V01	IK	IK System Environment	<p>All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.</p>
FN	SMH-FN2340-V02	IK	IK System Redundancy	<p>The IK system shall reboot following a power loss.</p>
FN	SMH-FN2341-V02	IK	IK System Security	<p>The IK system shall limit the use of internet to the approved apps, services, and features offered through the interactive display, including trip-planning and payment via the MMTPA/CPS.</p>

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2342-V01	IK	IK Display	The IK system shall be designed for unattended operation under normal circumstances, exclusive of manual data entry, public User access, and routine administrative functions.
FN	SMH-FN2343-V02	IK	Operating System	The IK system shall send SMH location, trip mode, and timestamp data to OS for all trips generated at the respective IK.
FN	SMH-FN2344-V02	IK	Touch-Screen Interface	The IK touch-screen content shall be configurable for services offered at each location.
FN	SMH-FN2351-V01	IK	Touch-Screen Interface	Where source data is not available in real time, the touch screen shall utilize PDF and/or service board websites in the short term such as transit route maps, location-specific services or tourism information, etc.
FN	SMH-FN2352-V02	IK	Touch-Screen Menu	The IK touch-screen may incorporate a demonstration of the use of the screen, general information, and/or animation while in standby mode.
FN	SMH-FN2353-V02	IK	Touch-Screen Menu	The IK touch screen shall support a standby mode that displays a static or animated screen or series of screens.
FN	SMH-FN2354-V01	IK	Touch-Screen Menu	Users shall exit standby mode by touching the screen or activating any other IK controls. When standby mode is exited, the system shall display an initial start page with links to various submenus and content pages that allow the User to reach all information contained within the system.
IF	SMH-IF2315-V01	Comprehensive Trip Planning	CPS Integration	The CPS app shall be deployed and available for use at the IK display through the MMTPA app.
IF	SMH-IF2316-V01	Comprehensive Trip Planning	IK System Integration	The MMTPA app shall be deployed and available for use at the IK display.
IF	SMH-IF2355-V02	IK	IK Display Interface	The IK shall provide a secured, direct-connect interface to facilities for operational administration.
IF	SMH-IF2356-V02	IK	MMTPA Integration	The IK system shall provide access to a web- or app-based interface with the MMTPA/CPS system to provide CTP and trip-booking services and disseminate information regarding Mobility Providers, parking providers, and availability of various modes of transportation to the traveling public.

Requirement Type Code	Identifier	FG	Sub-Component	Description
IF	SMH-IF2357-V01	IK	MMTPA Integration	The interface to other SMH services offered at the SMH facility (e.g. car-, bike- and ride-sharing) shall be provided through the MMTPA/CPS interface, which provides CTP services for the SMH Traveler.
IF	SMH-IF2361-V02	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to various static maps within the SMH demonstration area.
IM	SMH-IM2364-V01	IK	Data Management	The IK system shall perform daily background verification of all external web links and provide immediate notification to the IK system administrator if any link fails verification.
IM	SMH-IM2365-V01	IK	IK System Software	The IK system backup files (server clone snapshot and data backups) shall be tested quarterly for recoverability integrity.
IM	SMH-IM2366-V01	IK	Information Management	The IK system shall capture and log all data entered through the touch-screen interface for further analysis at the back office for purposes of enhancing location aware services and improving safety at each designated location.
RG	SMH-RG2373-V01	IK	IK System Environment	Installation of IK in the City shall comply with building and construction city codes of Columbus, OH
RG	SMH-RG2374-V02	IK	IK System Scalability	The IK system shall adhere to object-oriented design principles to facilitate replacement or modification of individual components of the IK system without impacting the overall system.
SR	SMH-SR2376-V01	IK	IK System	The IK system components shall be protected by firewalls and equipped with security detection, prevention, and response mechanisms to guard against intentional and unintentional threats to the integrity of the system arising from unauthorized access, computer viruses and worms, system abnormalities or faults, and other sources of potential harm.
SR	SMH-SR2377-V01	IK	IK System	The IK system shall accommodate multiple tiers of User data security to allow distinct privileges to access data based on User roles (e.g. public User, administrator, service accounts, City and COTA personnel, data miner, external agency, etc.)

Requirement Type Code	Identifier	FG	Sub-Component	Description
SR	SMH-SR2378-V01	IK	IK System	The IK system shall be designed to preserve the privacy of individual public Users of the system and provide data protection, such as encrypting login credentials, payment information, and other sensitive data captured through the IK and transmitted over Wi-Fi or fiber.
SR	SMH-SR2380-V01	IK	IK System Security	The integrity of IK system apps, communications, and network links shall be secured through mechanisms such as password authentication.
FN	SMH-FN2441-V01	IK	IK System	The IK system shall reset back to the default language at the end of a User session or after a maximum two minutes of inactivity.
FN	SMH-FN2448-V01	IK	Touch-Screen Interface	Current transit route maps, location-specific services or tourism information, etc., shall be saved on the KOS, so data is available to be displayed even during periods of communication failure.
FN	SMH-FN2449-V01	IK	IK System Monitoring	IK system files shall be "revolving" or self-appending so that old data is continually overwritten, and system data does not reach capacity of available memory.
SR	SMH-SR2453-V02	IK	IK System Software	All IK software and security systems shall be reviewed by IK administrator quarterly for updates or as updated as new versions become available.
LC	SMH-LC2456-V01	Bike Racks	Scalability	Bike racks should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.
LC	SMH-LC2457-V01	Bike-Sharing	Scalability	Docking stations should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.
IM	SMH-IM3069-V01	IK	IK System Software	All IK software and security systems shall be reviewed quarterly for updates or as updated as new versions become available.
PR	SMH-PR3062-V01	IK	Touch-Screen Interface	The IK touch-screen interface display shall be at least 55" diagonal.
FN	SMH-FN2292-V02	IK	IK System	The IK shall allow the User to enter trip feedback such as the operational status of the just docked bike. The operational status could include the need for preventative and repair maintenance.

USER NEED: SMH-UN004-V01		USER: TRAVELER		
Title:		Public Wi-Fi		
Description:		Travelers need public Wi-Fi internet connectivity to aid in providing access to online resources and planning tools throughout Columbus.		
Priority:		Essential		
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.
AR	SMH-AR2399-V01	Wi-Fi Enabled	Wi-Fi Network Availability	The Wi-Fi network shall be fault tolerant and maintain continuous network uptime outside of the scheduled maintenance, 24 hours per day, 365 days per year.
DR	SMH-DR2400-V01	Wi-Fi Enabled	Wi-Fi Data Collection	SMH Wi-Fi enabled technologies shall track number of clients per access point.
DR	SMH-DR2401-V01	Wi-Fi Enabled	Wi-Fi Data Collection	SMH Wi-Fi technologies shall log User connection time stamp, IP, MAC address, OS, device manufacturer, sites visited, and connection status and length.
FN	SMH-FN2336-V01	IK	IK System Administration	The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following: <ul style="list-style-type: none">• Inability to communicate through an interface• Inability to send/receive data• Service requests and queries extend longer than 10 seconds• Invalid or missing data has been detected
FN	SMH-FN2338-V01	IK	IK System Environment	All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.
FN	SMH-FN2340-V02	IK	IK System Redundancy	The IK system shall reboot following a power loss.

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2403-V02	Wi-Fi Enabled	Wi-Fi Core Functionality	SMH shall permit electronic devices equipped with internet capabilities (phone, tablet, computer) to connect to the internet via Wi-Fi.
FN	SMH-FN2405-V01	Wi-Fi Enabled	Wi-Fi Standards	SMH may consider IEEE 802.11ai to enable FILS methods to enhance End-User experience in high-density WLAN environments.
FN	SMH-FN2406-V01	Wi-Fi Enabled	Wi-Fi Standards	Wi-Fi technologies shall follow IEEE 802.11 b/g/n standards to enable multi-gigabit throughput in the 2.4 GHz, 5GHz and 60GHz spectrum bands.
FN	SMH-FN2407-V01	Wi-Fi Enabled	Wi-Fi Usage	An active session with internet access shall be provisioned for the User when that User accepts the terms and conditions of service.
FN	SMH-FN2408-V01	Wi-Fi Enabled	Wi-Fi Usage	An active session with internet access shall not be provisioned for the User when that User declines the terms and conditions of service.
MT	SMH-MT2410-V01	Wi-Fi Enabled	Wi-Fi Network Maintenance	IK based Wi-Fi devices shall be managed and maintained by IK vendor.
PR	SMH-PR2411-V02	Wi-Fi Enabled	Wi-Fi Capacity	Wi-Fi technologies shall support a minimum of 10 simultaneously connected Users.
IF	SMH-IF2409-V01	Wi-Fi Enabled	Wi-Fi Enabled	Wi-Fi services shall be provided through the IK.
PY	SMH-PY2412-V01	Wi-Fi Enabled	Wi-Fi Construction	Wi-Fi equipment shall withstand indoor and outdoor environmental conditions such as high and low temperatures, humidity, rain, snow, etc.
RG	SMH-RG2413-V02	Wi-Fi Enabled	Wi-Fi Usage	Property Owner shall regulate use of all SMH Wi-Fi technologies.
RG	SMH-RG2414-V01	Wi-Fi Enabled	Wi-Fi Usage	Users may be redirected to a landing page designated by vendor or Property Owner when connecting to Wi-Fi technologies once the User accepts the terms and conditions of service.
RG	SMH-RG2415-V01	Wi-Fi Enabled	Wi-Fi Usage	Wi-Fi technologies shall present the User with a terms of use page designated by vendor or Property Owner to display the free Wi-Fi terms and conditions of service and prompt the User to accept.
SR	SMH-SR2416-V01	Wi-Fi Enabled	Wi-Fi Monitoring	A timer shall be implemented to track the length of time a Wi-Fi connection has been active.

Requirement Type Code	Identifier	FG	Sub-Component	Description
SR	SMH-SR2419-V01	Wi-Fi Enabled	Wi-Fi Monitoring	Usage shall be tracked on all Wi-Fi technologies, per device, to validate proper usage of public wireless as per COTA internet usage policy.
SR	SMH-SR2421-V01	Wi-Fi Enabled	Wi-Fi Security	Wi-Fi technologies shall terminate a connection if any of the following conditions have been met: <ul style="list-style-type: none"> • A violation of Wi-Fi technology usage has been identified • Connection has extended beyond 15 minutes
PR	SMH-PR2452-V01	IK	Touch-Screen Interface	IK displays shall meet City outdoor advertisement brightness standards and be capable of adjusting brightness based on varying outside light conditions, according to <u>Columbus Ordinance 3377.08 – Illumination and Special Effects</u> .
MT	SMH-MT3068-V01	Wi-Fi Enabled	Wi-Fi Network Maintenance	Stakeholder agency owned Wi-Fi devices shall be managed and maintained by Stakeholder agency.
PR	SMH-PR3064-V01	Wi-Fi Enabled	Wi-Fi Monitoring	The load on each Wi-Fi access point shall be monitored and flagged when there is an overloading issue associated with the access point.
PR	SMH-PR3063-V01	Wi-Fi Enabled	Wi-Fi Monitoring	The upload and download speed on each Wi-Fi access point shall be tracked, monitored, and changed, as necessary.

USER NEED: SMH-UN005-V01**USER: TRAVELER****Title: Facilities**

Description: Travelers need park-and-ride facilities with sufficient space to accommodate the parking needs of personal vehicles or car-share vehicles and make multimodal transfers.

Priority: Essential**Related Requirements, Constraints and System Interfaces**

Requirement Type Code	Identifier	FG	Sub-Component	Description
PR	SMH-PR2275-V01	Bike Racks	Racks	The placement of bike racks shall not impede flow of vehicle or pedestrian traffic.
RG	SMH-RG2276-V01	Bike Racks	Racks	The City or Property Owner shall approve the locations of the bike racks.

Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2381-V02	Park and Ride	Park-and-Ride Facility	At least one ADA-compliant parking space shall be available at each of the SMH locations for every 25 spaces. One out of six of the ADA-compliant spaces must be van accessible. An accessible car parking space must be a minimum of 96 inches wide, and a van space must be a minimum of 132 inches wide (a van space may be 96 inches if the access aisle is 96 inches or wider).
FN	SMH-FN2290-V02	Bike-Sharing	Docking Station	Bike-share docking station shall be installed at SMH locations.
FN	SMH-FN2310-V02	Car-Sharing	Parking Lot	The SMH facility shall provide designated parking spaces for car-share vehicles.
FN	SMH-FN2388-V02	Ride-Sharing	Parking Lot	Curb space shall be designated for pickup from ride-share and taxi services.
PR	SMH-PR2301-V02	Bike-Sharing	Bike-Sharing System	The bike-share docking station shall not impede flow of vehicle or pedestrian traffic.
PR	SMH-PR2302-V02	Bike-Sharing	Bike-Sharing System	Bikes that are parked in violation of City codes or are vandalized or inoperable shall be reported by SMH owning agency to bike-share company.
RG	SMH-RG2303-V01	Bike-Sharing	Bike-Sharing System	The docking stations shall be primarily located within the public right of way, along public streets and sidewalks, parks, trails, parking lots/garages, events venues, etc., or be located on private property, provided that the Property Owner agrees to allow 24/7 public access to the docking station.
PR	SMH-PR2382-V02	Park and Ride	Park-and-Ride Facility	The park and ride parking spaces shall allow 24/7 public access to the vehicles.
PR	SMH-PR2384-V02	Park and Ride	Park-and-Ride Facility	The park and ride designated parking spaces shall be located in locations that do not impede the regular flow of travel in the public right of way.
PR	SMH-PR2385-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall ensure the vehicles not be parked in a way that impedes the 5 feet clearance on sidewalks needed for ADA compliance.
PR	SMH-PR2392-V02	Ride-Sharing	Parking Lot	The City and Property Owner may designate parking areas or restrict car parking within certain areas.
RG	SMH-RG2393-V01	Ride-Sharing	Parking Lot	The locations of the ride-share parking lots shall be approved by the City and Property Owner.

Requirement Type Code	Identifier	FG	Sub-Component	Description
PY	SMH-PY2312-V01	Car-Sharing	Parking Lot	The car-share parking lots shall have a vertical clearance of at least 12 feet.
PY	SMH-PY2313-V01	Car-Sharing	Parking Lot	The car-share parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.
PY	SMH-PY2386-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall have a vertical clearance of at least 12 feet.
PY	SMH-PY2387-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall have an access aisle with a minimum width of 5 feet
FN	SMH-FN2442-V01	Dockless Device Zone	Dockless Parking Zone Facility	Designated paved area shall be made available for dockless devices such as scooters and ebikes at the SMH facility.
FN	SMH-FN2443-V01	Dockless Device Zone	Dockless Parking Zone Facility	Boundaries, symbols and/or text description of designated area for dockless devices shall be clearly outlined on pavement with paint.
RG	SMH-RG2447-V01	Dockless Device Zone	Dockless Parking Zone Facility	The City and Property Owner shall approve the locations of the dockless device zones.
PR	SMH-PR2450-V02	Dockless Device Zone	Dockless Parking Zone Facility	The dockless parking zone shall not be laid out in a manner which impedes the flow of vehicle or pedestrian traffic.
PY	SMH-PY2454-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.
RG	SMH-RG2461-V02	Bike-Sharing	Bike-Sharing System	The City and Property Owner shall approve the locations of the docking stations.
PR	SMH-PR2383-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall allow parked vehicles to maintain unimpeded access to roadway/driveway entrances and exits.

USER NEED: SMH-UN006-V01		USER: TRAVELER		
Title:	Real-Time Information			
Description:	Travelers need real-time information about COTA bus arrival and departure times to make informed decisions when traveling and to reduce uncertainty of when connections between modes will be possible. Travelers require posted information on available services along with general instruction on how to use the MMTPA/CPS.			
Priority:	Essential			
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.
DR	SMH-DR2328-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning information, real-time service information, transit bulletins and maps.
FN	SMH-FN2336-V01	IK	IK System Administration	The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following: <ul style="list-style-type: none">• Inability to communicate through an interface• Inability to send/receive data• Service requests and queries extend longer than 10 seconds• Invalid or missing data has been detected
FN	SMH-FN2338-V01	IK	IK System Environment	All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.
FN	SMH-FN2340-V02	IK	IK System Redundancy	The IK system shall reboot following a power loss.
FN	SMH-FN2344-V02	IK	Touch-Screen Interface	The IK touch-screen content shall be configurable for services offered at each location.

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2351-V01	IK	Touch-Screen Interface	Where source data is not available in real time, the touch screen shall utilize PDF and/or service board websites in the short term such as transit route maps, location-specific services or tourism information, etc.
IF	SMH-IF2360-V01	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to the COTA Real-Time Display.
IF	SMH-IF2361-V02	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to various static maps within the SMH demonstration area.
IM	SMH-IM2364-V01	IK	Data Management	The IK system shall perform daily background verification of all external web links and provide immediate notification to the IK system administrator if any link fails verification.

USER NEED: SMH-UN007-V01**USER: TRAVELER****Title:** Emergency Call Button**Description:** Travelers need to be in a location that is safe and provides them a means to contact emergency services.**Priority:** Essential**Related Requirements, Constraints and System Interfaces**

Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2318-V01	ECB	ECB Availability	The ECB service shall be made available 24 hours a day, seven days a week, 365 days a year.
AR	SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.
DR	SMH-DR2320-V01	ECB	ECB Data	ECB shall record the time, date, and location upon activation.
DR	SMH-DR2321-V02	ECB	ECB Data	The street address and GPS coordinates of the SMH facility shall be sent to the CECC to notify dispatchers of location of the help request.

Requirement Type Code	Identifier	FG	Sub-Component	Description
EN	SMH-EN2317-V01	ECB	ECB Monitoring	The ECB service shall undergo end-to-end testing by vendor on an annual basis.
FN	SMH-FN2323-V02	ECB	ECB System	When an ECB alarm is triggered, the ECB system shall perform the following functions: <ul style="list-style-type: none"> Establish a bidirectional voice-enabled communication medium from the IK to the CECC Activate the IK camera and record video to local DVR
FN	SMH-FN2338-V01	IK	IK System Environment	All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.
FN	SMH-FN2340-V02	IK	IK System Redundancy	The IK system shall reboot following a power loss.
IF	SMH-IF2325-V01	ECB	IK System Integration	An ECB interface shall be designed for public Users to alert the CECC officials in an emergency situation.
FN	SMH-FN3061-V01	IK	Camera	The IK shall include an integrated security camera and DVR.

USER NEED:	SMH-UN008-V01	USER: TRAVELER
Title:	Interactive Voice Response	
Description:	Travelers with sight impairments need alternative options to access trip-planning tools offered at IKs.	
Priority:	Essential	

Related Requirements, Constraints and System Interfaces

Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.

Requirement Type Code	Identifier	FG	Sub-Component	Description
EN	SMH-EN2332-V02	IK	IK System Scalability	The IK system shall be designed with an open architecture intended to facilitate expansion of the functionality and/or scale of the IK system as new data sources, apps, features, standards and/or technologies emerge in the future.
FN	SMH-FN2336-V01	IK	IK System Administration	The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following: <ul style="list-style-type: none"> • Inability to communicate through an interface • Inability to send/receive data • Service requests and queries extend longer than 10 seconds • Invalid or missing data has been detected
FN	SMH-FN2338-V01	IK	IK System Environment	All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.
FN	SMH-FN2340-V02	IK	IK System Redundancy	The IK system shall reboot following a power loss.
FN	SMH-FN2346-V01	IK	Touch-Screen Interface	The IK touch-screen interface and its controls shall conform to the applicable accessibility requirements of the ADA.
FN	SMH-FN2351-V01	IK	Touch-Screen Interface	Where source data is not available in real time, the touch screen shall utilize PDF and/or service board websites in the short term such as transit route maps, location-specific services or tourism information, etc.
RG	SMH-RG2374-V02	IK	IK System Scalability	The IK system shall adhere to object-oriented design principles to facilitate replacement or modification of individual components of the IK system without impacting the overall system.

USER NEED: SMH-UN009-V01		USER: TRAVELER		
Title:		USB Charging Ports		
Description:		Travelers need the ability to charge mobile devices during trip making process.		
Priority:		Desirable		
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
DR	SMH-DR2328-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning information, real-time service information, transit bulletins and maps.
FN	SMH-FN2394-V01	USB Charging	USB General	USB charging outlets shall be USB Type A 3.X standard.
FN	SMH-FN2395-V02	USB Charging	USB General	The USB charging service shall deliver free charging for Travelers to charge mobile devices.
MT	SMH-MT2397-V02	USB Charging	USB Maintenance	The IK system contractor shall perform maintenance, replacement, and annual functional testing for all USB charging ports available for public use.
IF	SMH-IF2363-V01	IK	USB Integration	The IK should include a minimum of four USB ports for charging mobile devices to SMH Travelers.
PY	SMH-PY2398-V01	USB Charging	USB Environment	The USB hardware shall withstand indoor and outdoor environmental conditions such as high and low temperatures, humidity, rain, snow, etc.

USER NEED: SMH-UN010-V01		USER: TRAVELER		
Title:		Educational Information		
Description:		Travelers need more detailed educational information about transportation service options available at SMH. Posted information needs to include instruction on how to use the services; for example, how to download and use the MMPTA, or information on how to use bike-share services.		
Priority:		Essential		
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2326-V02	IK	IK System Availability	The IK system shall incorporate system redundancies to the extent practical to guard against failure of individual hardware, software, network, or communications components and ensure maximum, persistent always-on availability, maintaining continuous operation outside of the scheduled maintenance 24 hours a day, seven days a week, 365 days a year.
DR	SMH-DR2328-V01	IK	Touch-Screen Interface	The IK touch-screen interface shall allow Travelers to access data contained in the OS through the MMTPA app such as schedule information, static service information (e.g. fares), trip-planning information, real-time service information, transit bulletins and maps.
EN	SMH-EN2332-V02	IK	IK System Scalability	The IK system shall be designed with an open architecture intended to facilitate expansion of the functionality and/or scale of the IK system as new data sources, apps, features, standards and/or technologies emerge in the future.
FN	SMH-FN2336-V01	IK	IK System Administration	The IK system shall detect and automatically notify the IK system administrator (operating vendor) when a functional abnormality has occurred such as the following: <ul style="list-style-type: none">• Inability to communicate through an interface• Inability to send/receive data• Service requests and queries extend longer than 10 seconds• Invalid or missing data has been detected

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2338-V01	IK	IK System Environment	All IK communications links shall utilize TCP/IP and possess high-speed bandwidth and availability to perform the functionalities described within this SyRS.
FN	SMH-FN2340-V02	IK	IK System Redundancy	The IK system shall reboot following a power loss.
FN	SMH-FN2344-V02	IK	Touch-Screen Interface	The IK touch-screen content shall be configurable for services offered at each location.
FN	SMH-FN2351-V01	IK	Touch-Screen Interface	Where source data is not available in real time, the touch screen shall utilize PDF and/or service board websites in the short term such as transit route maps, location-specific services or tourism information, etc.
IF	SMH-IF2359-V02	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to display any current alerts that describe events having a significant impact on transportation services.
IF	SMH-IF2362-V01	IK	Touch-Screen Menu	The IK touch screen shall provide Users with a link to Visitor Information, which includes location-aware content.
IM	SMH-IM2364-V01	IK	Data Management	The IK system shall perform daily background verification of all external web links and provide immediate notification to the IK system administrator if any link fails verification.
RG	SMH-RG2374-V02	IK	IK System Scalability	The IK system shall adhere to object-oriented design principles to facilitate replacement or modification of individual components of the IK system without impacting the overall system.

USER NEED:		SMH-UN011-V01			USER: TRAVELER
Title:		Bike Racks			
Description:		Travelers need access to bike racks to park personal and shared bicycles and transfer between modes.			
Priority:		Essential			
Related Requirements, Constraints and System Interfaces					
Requirement Type Code	Identifier	FG	Sub-Component	Description	
AR	SMH-AR2274-V02	Bike Racks	Racks	The minimum number of bike racks per SMH location should be equal to 5% of the total number of parking spaces.	

Requirement Type Code	Identifier	FG	Sub-Component	Description
PR	SMH-PR2275-V01	Bike Racks	Racks	The placement of bike racks shall not impede flow of vehicle or pedestrian traffic.
RG	SMH-RG2276-V01	Bike Racks	Racks	The City or Property Owner shall approve the locations of the bike racks.
AR	SMH-AR2282-V01	Bike-Sharing	Docking Station	The docking station shall be designed for persistent always-on availability, maintaining continuous operation 24 hours a day, seven days a week, 365 days a year.
FN	SMH-FN2290-V02	Bike-Sharing	Docking Station	Bike-share docking station shall be installed at SMH locations.
FN	SMH-FN2291-V02	Bike-Sharing	Docking Station	The docking station shall accept a secure code generated (through verified payment via MMTA and CPS) for unlocking the bikes.
FN	SMH-FN2293-V01	Bike-Sharing	Docking Station	The docking station shall be solar powered.
FN	SMH-FN2294-V02	Bike-Sharing	Docking Station	The docking station shall report the number of bikes currently docked to the OS.
FN	SMH-FN2296-V01	Bike-Sharing	Docking Station	The docking station shall track the date and time when a bike is unlocked.
FN	SMH-FN2297-V01	Bike-Sharing	Docking Station	The docking station shall track the date and time when a bike is locked.
FN	SMH-FN2298-V02	Bike-Sharing	Docking Station	The docking station shall report the operational status of the docking station to the OS.
PR	SMH-PR2301-V02	Bike-Sharing	Bike-Sharing System	The bike-share docking station shall not impede flow of vehicle or pedestrian traffic.
PR	SMH-PR2302-V02	Bike-Sharing	Bike-Sharing System	Bikes that are parked in violation of City codes or are vandalized or inoperable shall be reported by SMH owning agency to bike-share company.
RG	SMH-RG2303-V01	Bike-Sharing	Bike-Sharing System	The docking stations shall be primarily located within the public right of way, along public streets and sidewalks, parks, trails, parking lots/garages, events venues, etc., or be located on private property, provided that the Property Owner agrees to allow 24/7 public access to the docking station.
PY	SMH-PY2278-V01	Bike Racks	Racks	The bike racks shall be located on paved or pervious surface with a slope no greater than 3 percent

Requirement Type Code	Identifier	FG	Sub-Component	Description
PY	SMH-PY2279-V01	Bike Racks	Racks	The bike racks shall have a vertical clearance of at least 6 feet.
PY	SMH-PY2280-V01	Bike Racks	Racks	The bike racks shall have an access aisle with a minimum width of 5 feet
PY	SMH-PY2305-V01	Bike Racks	Docking Station	The bike-share docking station shall be located on paved or pervious surface with a slope of less than 3 percent.
PY	SMH-PY2306-V01	Bike-Sharing	Docking Station	The bike-share docking station shall have a vertical clearance of at least 6 feet.
PY	SMH-PY2307-V01	Bike-Sharing	Docking Station	The bike-share docking station shall have an access aisle with a minimum width of 5 feet.
SR	SMH-SR2308-V01	Bike-Sharing	Docking Station	The docking station shall permit the locking of the bicycle frame and one wheel to the rack.
LC	SMH-LC2455-V01	Park and Ride	Scalability	Additional parking spaces should be made available if warranted by increased demand for park-and-ride services.
LC	SMH-LC2456-V01	Bike Racks	Scalability	Bike racks should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.
LC	SMH-LC2445-V02	Dockless Device Zone	Scalability	Additional space for dockless equipment zone should be made available by Stakeholder agency if warranted by increased demand for this service.
LC	SMH-LC2457-V01	Bike-Sharing	Scalability	Docking stations should be modular in construction so that additional racks may be installed in the future with similar overall functional and aesthetic qualities.
LC	SMH-LC2458-V02	Car-Sharing	Scalability	Addition of parking spaces should be investigated if warranted by increased demand for car sharing services.
LC	SMH-LC2459-V01	Ride-Sharing	Scalability	Additional space for pickup/drop-off zone should be made available if warranted by increased demand for ride-sharing services.
RG	SMH-RG2461-V02	Bike-Sharing	Bike-Sharing System	The City and Property Owner shall approve the locations of the docking stations.
FN	SMH-FN2292-V02	IK	IK System	The IK shall allow the User to enter trip feedback such as the operational status of the just docked bike. The operational status could include the need for preventative and repair maintenance.

USER NEED: SMH-UN012-V01		USER: TRAVELER		
Title:	Language Support			
Description:	Travelers need the IK and IVR to support multiple languages. At a minimum, they should support English and Spanish languages.			
Priority:	Desirable			
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2335-V02	IK	IK System	The IK system shall support multiple languages. At a minimum, they shall support English and Spanish languages.
FN	SMH-FN3058-V01	IK	IK System	The IK system shall maintain English as its default language setting and provide Users the ability to select a language of choice.

USER NEED: SMH-UN013-V01		USER: COTA		
Title:	COTA Data			
Description:	COTA needs access to detailed travel data generated by the MMTPA/CPS and collected in the OS to forecast economic changes and travel behavior.			
Priority:	Desirable			
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
DR	SMH-DR2329-V01	IK	Touch-Screen Interface	The IK touch-screen interface content shall include static and real-time Traveler information to the extent that each data element is available from the OS retrieved through the GTFS real-time data feed. The screen should display arrivals in the next hour for that location.
FN	SMH-FN2352-V02	IK	Touch-Screen Menu	The IK touch screen may incorporate a demonstration of the use of the screen, general information, and/or animation while in standby mode.
FN	SMH-FN2353-V02	IK	Touch-Screen Menu	The IK touch screen shall support a standby mode that displays a static or animated screen or series of screens.

Requirement Type Code	Identifier	FG	Sub-Component	Description
FN	SMH-FN2354-V01	IK	Touch-Screen Menu	Users shall exit standby mode by touching the screen or activating any other IK controls. When standby mode is exited, the system shall display an initial start page with links to various submenus and content pages that allow the User to reach all information contained within the system.

USER NEED:	SMH-UN014-V01	USER: MOBILITY PROVIDERS
Title:	Mobility Provider Infrastructure	
Description:	Mobility Providers need adequate, readily identifiable (marked) spaces and designated passenger pickup/drop off zones that must not interfere with COTA operations to facilitate safe and effective operations of the SMH and eliminate confusion for Users in understanding where to connect between modes.	
Priority:	Essential	

Related Requirements, Constraints and System Interfaces

Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2381-V02	Park and Ride	Park-and-Ride Facility	At least one ADA-compliant parking space shall be available at each of the SMH locations for every 25 spaces. One out of six of the ADA-compliant spaces must be van accessible. An accessible car parking space must be a minimum of 96 inches wide, and a van space must be a minimum of 132 inches wide (a van space may be 96 inches if the access aisle is 96 inches or wider).
FN	SMH-FN2388-V02	Ride-Sharing	Parking Lot	Curb space shall be designated for pickup from ride-share and taxi services.
PR	SMH-PR2382-V02	Park and Ride	Park-and-Ride Facility	The park and ride parking spaces shall allow 24/7 public access to the vehicles.
PR	SMH-PR2384-V02	Park and Ride	Park-and-Ride Facility	The park and ride designated parking spaces shall be located in locations that do not impede the regular flow of travel in the public right of way.
PR	SMH-PR2385-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall ensure the vehicles not be parked in a way that impedes the 5 feet clearance on sidewalks needed for ADA compliance.
PR	SMH-PR2392-V02	Ride-Sharing	Parking Lot	The City and Property Owner may designate parking areas or restrict car parking within certain areas.

Requirement Type Code	Identifier	FG	Sub-Component	Description
RG	SMH-RG2393-V01	Ride-Sharing	Parking Lot	The locations of the ride-share parking lots shall be approved by the City and Property Owner.
IF	SMH-IF2389-V01	Ride-Sharing	MMTPA Integration	The ride-sharing service shall be provided through the MMTPA app.
PY	SMH-PY2312-V01	Car-Sharing	Parking Lot	The car-share parking lots shall have a vertical clearance of at least 12 feet.
PY	SMH-PY2313-V01	Car-Sharing	Parking Lot	The car-share parking lots shall be located on paved or pervious surfaces with a slope of less than 3 percent.
PY	SMH-PY2386-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall have a vertical clearance of at least 12 feet.
PY	SMH-PY2387-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall have an access aisle with a minimum width of 5 feet.
MT	SMH-MT2391-V01	Ride-Sharing	Vehicles	Each vehicle shall have a unique identifier that is visible to the User.
LC	SMH-LC2455-V01	Park and Ride	Scalability	Additional parking spaces should be made available if warranted by increased demand for park-and-ride services.
LC	SMH-LC2445-V02	Dockless Device Zone	Scalability	Additional space for dockless equipment zone should be made available by Stakeholder agency if warranted by increased demand for this service.
LC	SMH-LC2458-V02	Car-Sharing	Scalability	Addition of parking spaces should be investigated if warranted by increased demand for car sharing services.
LC	SMH-LC2459-V01	Ride-Sharing	Scalability	Additional space for pickup/drop-off zone should be made available if warranted by increased demand for ride-sharing services.
FN	SMH-FN3057-V01	Car-Sharing	Car-Sharing System	Car-sharing provider utilizing SMH facility shall report the number of available shared vehicles located at each SMH location to the OS.
PR	SMH-PR2383-V01	Park and Ride	Park-and-Ride Facility	The park-and-ride facility shall allow parked vehicles to maintain unimpeded access to roadway/driveway entrances and exits.

USER NEED: SMH-UN015-V01		USER: CITY OF COLUMBUS EMERGENCY DISPATCHER		
Title:	Emergency Call Button Integration			
Description:	The Emergency Dispatch Center needs the latitude and longitude for each IK to map them with their own unique street addresses into the Computer-Aided Dispatch (CAD) program. Two-way communications between the Dispatch Center and the caller is needed, and the IK must be capable of interfacing with the 911 telephone system because the CAD is isolated from the web.			
Priority:	Essential			
Related Requirements, Constraints and System Interfaces				
Requirement Type Code	Identifier	FG	Sub-Component	Description
AR	SMH-AR2318-V01	ECB	ECB Availability	The ECB service shall be made available 24 hours a day, seven days a week, 365 days a year.
DR	SMH-DR2320-V01	ECB	ECB Data	ECB shall record the time, date, and location upon activation.
DR	SMH-DR2321-V02	ECB	ECB Data	The street address and GPS coordinates of the SMH facility shall be sent to the CECC to notify dispatchers of location of the help request.
EN	SMH-EN2317-V01	ECB	ECB Monitoring	The ECB service shall undergo end-to-end testing by vendor on an annual basis.
FN	SMH-FN2322-V02	ECB	ECB System	The ECB system shall be capable of two-way voice communications and transmitting GPS location coordinates to the CECC.
FN	SMH-FN2323-V02	ECB	ECB System	When an ECB alarm is triggered, the ECB system shall perform the following functions: <ul style="list-style-type: none">• Establish a bidirectional voice-enabled communication medium from the IK to the CECC• Activate the IK camera and record video to local DVR
IF	SMH-IF2325-V01	ECB	IK System Integration	An ECB interface shall be designed for public Users to alert the CECC officials in an emergency situation.

Source: City of Columbus

Appendix D. Additional Relationship Matrices

Table 27: Constraints Needs Mapped to Requirements provides a mapping of the Constraints that are related to Requirements. These relations were created based off the User Needs defined in **Chapter 3. System Requirements** and are being managed in the RTM software tool Helix. The list has been exported for referencing.

Table 27: Constraints Needs Mapped to Requirements

Constraint ID	Reference	Req. ID
SMH-CN2424-V01	Constraint 1	SMH-FN2310-V02 SMH-FN2388-V02
SMH-CN2425-V01	Constraint 2	SMH-UN004-V01
SMH-CN2426-V01	Constraint 3	SMH-FN2351-V01 SMH-FN2353-V02
SMH-CN2427-V01	Constraint 4	SMH-RG2276-V01 SMH-FN2290-V02 SMH-FN2310-V02 SMH-FN2388-V02 SMH-PR2301-V02 SMH-RG2303-V01 SMH-PR2383-V01 SMH-PR2384-V02 SMH-PR2392-V02 SMH-RG2393-V01
SMH-CN2428-V01	Constraint 5	SMH-FN2403-V02 SMH-FN2405-V01 SMH-FN2406-V01 SMH-FN2407-V01 SMH-FN2408-V01 SMH-MT2410-V01 SMH-PR2411-V02 SMH-MT3068-V01 SMH-PR3064-V01 SMH-PR3063-V01
SMH-CN2429-V01	Constraint 6	SMH-IM2366-V01 SMH-FN2292-V02 SMH-FN2336-V01
SMH-CN2430-V01	Constraint 7	SMH-FN2403-V02 SMH-FN2407-V01 SMH-FN2408-V01

Constraint ID	Reference	Req. ID
SMH-CN3056-V01	Constraint 8	SMH-UN005-V01

Source: City of Columbus

Table 28: Interfaces Mapped to Requirements provides a mapping of the system interfaces that are related to Requirements. These relations were created based off the User Needs defined in **Chapter 3. System Requirements** and are being managed in the RTM software tool Helix. The list has been exported for referencing.

Table 28: Interfaces Mapped to Requirements

Interface ID	Reference	Req. ID
SMH-IX2431-V01	Interface 1.1	SMH-IF2315-V01 SMH-IF2356-V02 SMH-IF2359-V02 SMH-IF2360-V01 SMH-IF2361-V02 SMH-IF2362-V01
SMH-IX2432-V01	Interface 1.2	SMH-IF2316-V01 SMH-IF2357-V01 SMH-IF2389-V01
SMH-IX2433-V01	Interface 2.1	SMH-FN2322-V02 SMH-FN2323-V02 SMH-IF2325-V01 SMH-DR2321-V02
SMH-IX2434-V01	Interface 2.2	SMH-FN2322-V02 SMH-FN2323-V02
SMH-IX2435-V01	Interface 3	SMH-IF2355-V02
SMH-IX2436-V01	Interface 4	SMH-RG2413-V02
SMH-IX2437-V01	Interface 5	SMH-IF2363-V01
SMH-IX2438-V01	Interface 6.1	SMH-IF2409-V01

Source: City of Columbus

Table 29: Related Requirements provides a mapping of Requirements that are related to other Requirements. These relations were created based off the User Needs defined in **Chapter 3. System Requirements** and are being managed in the RTM software tool Helix. The list has been exported for referencing.

Table 29: Related Requirements

Req. ID	Related Requirements
SMH-SR2308-V01	SMH-UN011-V01

Req. ID	Related Requirements
SMH-PY2312-V01	SMH-UN005-V01 SMH-UN014-V01
SMH-PY2313-V01	SMH-UN005-V01 SMH-UN014-V01
SMH-FN2352-V02	SMH-FN3059-V01
SMH-FN2353-V02	SMH-FN3059-V01
SMH-FN2354-V01	SMH-FN3059-V01
SMH-IF2362-V01	SMH-UN010-V01 SMH-IX2431-V01
SMH-IF2363-V01	SMH-UN009-V01 SMH-IX2437-V01
SMH-IM2364-V01	SMH-UN003-V01 SMH-UN006-V01 SMH-UN010-V01
SMH-IM2365-V01	SMH-UN002-V01 SMH-UN003-V01
SMH-IM2366-V01	SMH-UN001-V01 SMH-UN003-V01
SMH-PY2369-V01	SMH-UN002-V01
SMH-PY2370-V01	SMH-UN002-V01
SMH-PY2372-V01	SMH-UN002-V01
SMH-RG2373-V01	SMH-UN002-V01 SMH-UN003-V01
SMH-RG2374-V02	SMH-UN003-V01 SMH-UN008-V01 SMH-UN010-V01
SMH-SR2376-V01	SMH-UN003-V01
SMH-SR2377-V01	SMH-UN001-V01 SMH-UN002-V01 SMH-UN003-V01
SMH-SR2378-V01	SMH-UN003-V01
SMH-SR2379-V01	SMH-UN002-V01
SMH-SR2380-V01	SMH-UN003-V01
SMH-PY2386-V01	SMH-UN005-V01 SMH-UN014-V01
SMH-PY2387-V01	SMH-UN005-V01 SMH-UN014-V01

Req. ID	Related Requirements
SMH-IF2389-V01	SMH-UN014-V01 SMH-IX2432-V01
SMH-PY2398-V01	SMH-UN009-V01
SMH-IF2409-V01	SMH-UN004-V01 SMH-IX2438-V01
SMH-PY2412-V01	SMH-UN004-V01 SMH-CN2428-V01
SMH-RG2413-V02	SMH-UN004-V01 SMH-CN2428-V01
SMH-RG2414-V01	SMH-UN004-V01 SMH-CN2428-V01
SMH-RG2415-V01	SMH-UN004-V01 SMH-CN2428-V01
SMH-SR2416-V01	SMH-UN004-V01 SMH-CN2428-V01
SMH-SR2419-V01	SMH-UN004-V01 SMH-CN2428-V01
SMH-SR2421-V01	SMH-UN004-V01 SMH-CN2428-V01
SMH-FN3059-V01	SMH-FN2352-V02 SMH-FN2353-V02 SMH-FN2354-V01

Source: City of Columbus

Appendix E. Acronyms and Definitions

Table 30: Acronym List contains project specific acronyms used throughout this document.

Table 30: Acronym List

Abbreviation/Acronym	Definition
ADA	Americans with Disabilities Act
API	Application Programming Interface
AR	Availability and Recovery (Requirements)
ASP	Application Service Provider
BRT	Bus Rapid Transit
CAD	Computer-Aided Dispatch
CECC	Columbus Emergency Call Center
CMAX	COTA's Bus Rapid Transit (BRT) Service
ConOps	Concept of Operations
COTA	Central Ohio Transit Authority
CPS	Common Payment System
CTP	Comprehensive Trip Planning
CVE	Connected Vehicle Environment
DMP	<i>Data Management Plan for the Smart Columbus Demonstration Program</i>
DMS	Data Management System
DP	Disposal (Requirements)
DPP	<i>Data Privacy Plan for the Smart Columbus Demonstration Program</i>
DR	Data (Requirements)
DSRC	Dedicated Short Range Communications
DVR	Digital Video Recorder
ECB	Emergency Call Button
EN	Enabling (Requirements)
FG	Functional Group
FHWA	Federal Highway Administration
FILS	Fast Initial Link Setup
FMLM	First Mile/Last Mile
FN	Functional (Requirements)
GPS	Global Positioning System
GUI	Graphical User Interface

Abbreviation/Acronym	Definition
IEEE	Institute of Electrical and Electronics Engineers
IF	Interfaces (Requirements)
IK	Interactive Kiosk
IM	Information Management (Requirements)
IP	Internet Protocol
ISP	Internet Service Provider
IT	Information Technology
ITS	Intelligent Transportation System
IVR	Interactive Voice Response
KOS	Kiosk Operating System
LC	Life-Cycle Sustainability (Requirements)
MAC	Media Access Control
MMPA	Multimodal Trip Planning Application
MT	Maintainability (Requirements)
NF	Non-Functional (Requirements)
OS	Operating System
PR	Performance (Requirements)
PY	Physical (Requirements)
Req. ID	Requirement ID
RG	Policy and Regulation (Requirements)
RTM	Requirements Traceability Matrix
RTVM	Requirements Traceability and Verification Matrix
SaaS	Software as a Service
SC	Smart Columbus
SMH	Smart Mobility Hub
SoS	System of Systems
SR	Security (Requirements)
ST	Storage and Transport (Requirements)
SyRS	System Requirement Specification
TCP/IP	Transmission Control Protocol/Internet Protocol
TNC	Transportation Network Company
USB	Universal Serial Bus
USDOT	U.S. Department of Transportation
WLAN	Wireless Local Area Network

Source: City of Columbus

Appendix F. Glossary

Table 31: Glossary contains project specific terms used throughout this document.

Table 31: Glossary

Term	Definition
App	A software application.
Travelers (End Users)	Travelers are End Users who utilize the features of SMHs to begin, pass through or complete their trips.
Commercial Off-the-Shelf System (COTS)	Software or hardware product that are ready-made and available for sale to the public.
Data Management System (DMS)	A secure, Software as a Service (SaaS) web-based app that allows management of an entire parking meter network.
Data Privacy	The reasonable expectation that data of a sensitive nature will be kept confidential, sanitized and/or encrypted, and respectfully and responsibly maintained by all Users, managers and collectors of the data.
Data Retention	The continued storage of data for compliance or business reasons.
Data Security	The tools, policies, practices and procedures used to protect data from being accessed, manipulated or destroyed or being leveraged by those with a malicious intent or without authorization, as well as the corrective actions taken when data breaches are suspected or have been identified.
Dependency	When one project, agency, or entity requires data or functionality provided by another project, agency or entity to meet its objectives.
Dockless	A station-free concept developed for bicycles that allows riders to end their rides and park the bikes anywhere. This mechanism offers affordable transit, attempts to solve FMLM issues, services areas without transit, and offers to cities ridership data.
Enabling Technologies	An innovation that alone or paired with an existing solution produces a better End User solution at a rapid rate.
Experience Columbus	An organization whose mission is to market and promote Columbus services, attractions, and facilities to visitors, meeting planners, convention delegates and residents.
Failure Operations	When a complete failure of the intersection occurs, primarily due to loss of power or other malfunctions.
Interactive Voice Response (IVR)	IVR technology allows a computer to interact with humans. Through voice prompts, a User tactilely enters tones using number keys on a keypad. In telecommunications, IVR allows customers to interact with a company's host system via a telephone keypad, after which customers can inquire about services through the IVR dialogue.
Multimodal Transportation	Travel done via more than one mode of transportation.

Term	Definition
Normal Operations	When a signalized intersection is cycling through its preplanned phases correctly, servicing all approaches including pedestrian phases.
Open Data	Information that is freely available for anyone to use and republish as they wish.
Open-Source Concepts	The notion of open collaboration and voluntary contribution for software development by writing and exchanging programming code.
Parking Facility	Land or a structure used for light-duty vehicle parking.
Procurement	The act of obtaining or acquiring goods, services or works, from a competitive bidding process.
Real-Time Data	Information that is delivered immediately after collection.
Requirement Number	An integer incrementing by one, indicating the number of Requirements established.
“v” Static Character	Static letter “v” represents the Requirement version.
Version Number	An integer incrementing by one, indicating the number of revisions made to the Requirement.
System Analytics or Data Analytics	The analysis of data, procedures or business practices to locate information which can be used to create more efficient solutions.
Software as a Service (SaaS)	An extension of the Application Service Provider (ASP) centralized computing model, the SaaS delivery model hosts and provides web-based interface access to a software app over a network. The service is managed centrally, in large data centers, most often in a cloud-computing environment.
Third Party	Organizations not affiliated with the Smart Columbus Program.
Transportation Network Companies (TNCs)	Private businesses, nonprofits and quasi-governmental agencies that offer one or more types of transportation for use in exchange for payment.

Source: City of Columbus



THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR