Big Mahn Tech & Sons

Functional Requirements Document: City Builder Simulation

1. Introduction

1.1 Purpose

This document outlines the functional requirements for the City Builder Simulation, specifying the core features and interactions between various components of the simulated city. The goal is to create a dynamic, realistic environment where the city's infrastructure, citizens, government, and services interact seamlessly, providing a comprehensive simulation experience.

1.2 Scope

The City Builder Simulation allows users to build, manage, and develop a city. It includes managing utilities, transportation, residential and commercial buildings, public services, and the movement and behavior of citizens. The simulation emphasizes realistic interdependencies, strategic planning, and efficient management.

---

2. System Overview

The system is divided into several subsystems that manage different aspects of the city:

- **Infrastructure**: Buildings, Roads, Utilities
- **Transportation**: Road Network, Public Transport, Traffic Management
- **Citizens**: Behavior, Movement, Interaction with Environment
- **Government**: Policy, Budget, Resource Allocation
- **Economy & Services**: Commerce, Public Services, Entertainment, Housing

---

3. Functional Requirements

3.1 Infrastructure Management

This subsystem handles the core physical structures of the city, including buildings, utilities, and road networks.

3.1.1 Building Management (Housing Department & Building Creator)

- **FR 3.1.1.1**: This component allows the government to construct, and demolish various types of buildings (residential, commercial, industrial or landmark).
- **FR 3.1.1.2**: Buildings shall have attributes like capacity, building cost, and utility consumption through the resource pointer.
- **FR 3.1.1.3**: The Department of PR shall monitor the state of buildings and notify the Housing Department if maintenance or additions are required then the Housing Department will perform relevant functions.

3.1.2 Utility Management (Department of Utilities)

- **FR 3.1.2.1**: This component manages the provision of utilities, including electricity, water, and waste management, to buildings.
- **FR 3.1.2.2**: Users shall be able to monitor utility consumption and address shortages by upgrading infrastructure.
- **FR 3.1.2.3**: The system shall allow for the maintenance of utility infrastructure for all buildings in the city.

3.1.3 Road Network (DepartmentOfTransportion, RoadNetwork, Node, Edge)

- **FR 3.1.3.1**: This component allows the creation and expansion of road networks graph to connect various buildings.
- **FR 3.1.3.2**: Roads shall facilitate the movement of citizens across the city.

3.2 Transportation Management (Mode of Transport Strategy)

This subsystem focuses on how citizens move through the city and interact with transportation systems.

3.2.1 Citizen Movement

- **FR 3.2.1.1**: This component simulates the movement of citizens based on daily routines (going to work, visiting entertainment venues, going home).
- **FR 3.2.1.2**: Citizens shall follow paths on the road network by using the mode of transport strategy on the road network graph.
- **FR 3.2.1.3**: The system shall implement different transportation modes (walking, public transport, train and air) based on the transport strategy, based on distance between start and end nodes.

3.3 Citizen Behavior (Citizen & Events Command)

This subsystem defines how citizens interact with the environment and make decisions.

3.3.1 Daily Routines

- **FR 3.3.1.1**: Citizens shall have predefined routines, including work, home, entertainment, and shopping activities.
- **FR 3.3.1.2**: The system shall allow for dynamic changes in routines based on external factors from predetermined randomized commands (Events Command).

3.3.2 Interactions with the Environment

- **FR 3.3.2.1**: Citizens shall interact with buildings and public spaces.
- **FR 3.3.2.2**: The Department of PR shall respond to citizen needs and satisfaction level, such as requests for more entertainment venues, lower taxes or more resource allocation.
- **FR 3.3.2.3**: Citizens shall react to changes in the city environment, such as new buildings, events, or policy changes.

3.4 Government & Policy Management (Government & Department Of PR)

This subsystem governs the city's administration and policy-making.

3.4.1 Budget & Resource Allocation (Department of Finance)

- **FR 3.4.1.1**: Finance Department manages the city's budget, allocating funds to various departments and infrastructure projects (add buildings or resources).
- **FR 3.4.1.2**: The system shall track expenses and revenues, including taxes collected from citizens and businesses by the **TaxManager** visiting the respective buildings.
- **FR 3.4.1.3**: The government can implement policies (tax reductions) to influence citizen behavior, satisfaction levels and economic growth.

3.4.2 Department Coordination

- **FR 3.4.2.1**: The Department of PR acts as a mediator that facilitates communication between departments and the Government.
- **FR 3.4.2.2**: Departments can make requests to each other (the Housing Department requesting utility upgrades for new residential areas).
- **FR 3.4.2.3**: The Department of PR notifies other departments when a service is required of them.

3.5 Economy & Services (Events Command & Commercial and Industrial Buildings)

This subsystem handles commercial activities, public services, and entertainment.

3.5.1 Commerce & Industry

- **FR 3.5.1.1**: Government will be able to establish commercial districts to boost the economy.
- **FR 3.5.1.2**: Businesses will require resources (water, electricity) and workers.

3.5.2 Public Services & Entertainment

- **FR 3.5.2.1**: Government can build and manage public services such as hospitals, schools.
- **FR 3.5.2.2**: Entertainment venues can be developed, influencing citizen satisfaction level and movement patterns.

3.6 Simulation Engine

The core of the simulation is the engine that manages dynamic interactions between different city components, processing events and managing city operations over time. The engine will simulate the passage of time in the city, allowing for the seamless integration of various subsystems (e.g., infrastructure, citizen behavior, government policies, transportation, and economy).

3.6.1 Time Progression

- **FR 3.6.1.1**: The simulation engine shall progress in a real-time or turn-based manner, where each iteration represents a fixed period (e.g., a day, month, or year).
- **FR 3.6.1.2**: During each iteration, the system shall handle routine operations such as updating buildings, managing resources, handling citizen needs, and evaluating policies.
- **FR 3.6.1.3**: The engine shall include a mechanism to track the passage of time and trigger certain events or milestones (e.g., fiscal year-end, city anniversaries, elections).

3.6.2 Random Event Handling

- **FR 3.6.2.1**: The engine shall randomly select and trigger **eventCommands** during iterations to simulate unforeseen circumstances that may impact city operations (e.g., natural disasters, economic booms, labor strikes).
- **FR 3.6.2.2**: Each **eventCommand** shall have predefined outcomes that can affect different aspects of the city (e.g., increased demand for utilities, temporary road closures, policy changes).

3.6.3 Standard Iteration Processing

- **FR 3.6.3.1**: In the absence of a triggered **eventCommand,** the simulation engine shall run a standard iteration, where city sectors, infrastructure, and citizens go about their regular routines.
- **FR 3.6.3.2**: The system shall update each city sector, adjusting for changes based on citizen behavior, resource usage, and government policies.
- **FR 3.6.3.3**: The engine shall facilitate regular tasks like handling citizen needs, managing resources, updating transportation, and evaluating economic and government policies.

3.6.5 Detailed Description

- **Time Management**: Each iteration of the loop represents a discrete period, during which the system processes all relevant activities. This can be adjusted to simulate a day, month, or year, depending on the level of detail required for the simulation.
- **Random Event Commands**: Events introduce variability and unpredictability into the simulation. For instance, a random economic boom event might increase commercial activity, while a natural disaster event could disrupt city services, requiring emergency responses.
- **Standard Iteration**: Routine operations ensure the city functions correctly. For example, citizens go to work, utilities are consumed, buildings age, and taxes are collected. The system regularly evaluates policies, which may lead to changes in how the city operates.
- **System-Wide Events**: Some events (e.g., yearly budget allocations, major policy updates) are not random but are scheduled. The system handles these events by coordinating between various city departments.

3.6.6 Subsystems Integration

The simulation engine serves as the backbone, ensuring all subsystems (e.g., **Infrastructure**, **Transportation**, **Citizens**, **Government**) interact smoothly:

- **Infrastructure Updates**: Adjust infrastructure status, handling maintenance, and upgrades.
- **Citizen Dynamics**: Track citizen activities, address changing needs, and simulate daily routines.
- **Government Oversight**: Apply budget allocations, manage policies, and coordinate departments.
- **Event Management**: Facilitate event responses by notifying relevant subsystems.

---

4. Interactions Between Subsystems

4.1 Communication via Department of PR

- The **Department of PR** will act as a mediator, observing the city's state and coordinating between different departments.
- It can observe issues (overcrowded buildings and dissatisfied citizens) and notify relevant departments (housing, utilities) to act.

4.2 Transportation Impact on Infrastructure

- The **Transportation** subsystem will directly affect **Citizen Movement** and **Infrastructure** by determining how efficiently citizens can access various parts of the city (Dijkstra's algorithm).
- Public transport improvements can lead to better resource allocation and less congestion.
